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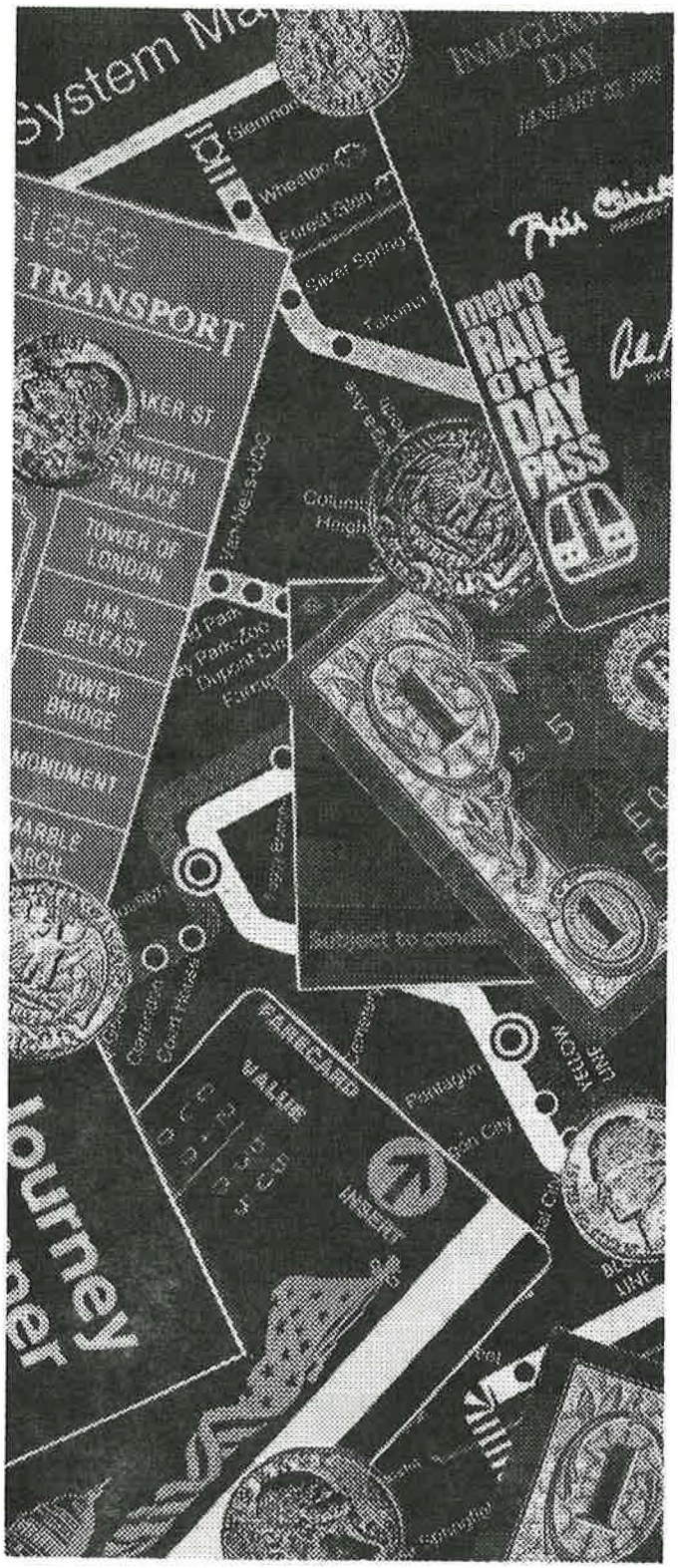

WORKSHOP ON TRANSIT FARE POLICY AND MANAGEMENT

Research Needs and Priorities

July 11–14, 1993

J. Erik Jonsson Woods Hole Center of the National Research Council

Woods Hole, Massachusetts

TRANSPORTATION RESEARCH BOARD
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WORKSHOP PROCEEDINGS

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J. Erik Jonsson Woods Hole Center
National Research Council
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Workshop on Transit Fare Policy and Management Research Needs and Priorities

July 11-14, 1993
J. Erik Jonsson Woods Hole Center
National Research Council
Woods Hole, Massachusetts

Presented by
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National Research Council

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Workshop Proceedings

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FOREWORD

These proceedings summarize the highlights from the *Workshop on Transit Fare Policy and Management Research Needs and Priorities*, which was held in the summer of 1993 in Woods Hole, Massachusetts. The workshop brought together representatives from transit agencies, consulting firms, equipment vendors, universities, and federal and local agencies to discuss research needs and priorities related to transit fare policy and management. The results of the workshop, which are presented in this document, provide the basis for the development of a robust, ongoing research program focusing on a wide range of fare-related issues.

The three-day Workshop, which was sponsored by the Transportation Research Board (TRB) of the National Research Council in cooperation with the Federal Transit Administration, was intended to be a working conference. Summaries of four resource papers and a status report on a current Transit Cooperative Research Project (TCRP) highlighted the opening session and helped stimulate ideas for later discussion. The majority of the Workshop was then spent in small working groups which identified, discussed, and ranked fare policy and management research needs.

As you will see by the workshop summaries, the groups discussed a variety of issues and identified a number of critical research needs. Thus, the results from the Workshop should be viewed as just the starting point for the development of a vibrant ongoing research program on transit fare policy and management. The results will be used to develop more detailed research problem statements that may be funded through a variety of sources, including the TCRP program.

The Workshop built on previous conferences held in the late 1970s and early 1980s. The recent renewed interest in transit research provides an ideal opportunity to further advance the state-of-the-art related to fare policies, fare collection technologies, and fare management. It is an exciting time to be involved in transit administration, operations, and research. I think the Workshop results echo both this excitement and the commitment of the participants to further the advancement of an ongoing transit fare policy and management research program.

A number of people contributed to the success of this Workshop and deserve recognition. First, I would like to thank the other members of the Workshop Steering Committee for the time and effort they put into organizing and leading the Workshop. Second, the authors of the resource papers did an excellent job of summarizing key issues and setting the stage for the working group discussions. Third, the TRB staff—especially Peter Shaw, W. Campbell Graeub, and Pierre Marc Daggett—did an outstanding job with the logistics for the Workshop. Finally, I would like to thank all of the participants for freely sharing their concerns, ideas, and visions on transit fare policy and management.

These proceedings are intended to help facilitate the development of a multifaceted fare-related research program that is responsive to the needs of transit systems, federal agencies, transit users, and industry groups. I hope these proceedings will stimulate your thinking and revive your interest in transit fare research. Your involvement in future activities will be critical to continuing the advancement of research projects and the state-of-the-practice related to fare policy and management.

Joel E. Markowitz

Steering Committee Chair

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WORKSHOP OVERVIEW

Joel E. Markowitz
Metropolitan Transportation Commission
Katherine F. Turnbull
Texas Transportation Institute

The *Workshop on Transit Fare Policy and Management Research Needs and Priorities* was held in Woods Hole, Massachusetts on July 11-14, 1993. The intent of the Workshop, which was sponsored by the Transportation Research Board (TRB) of the National Research Council in cooperation with the Federal Transit Administration (FTA), was to review past transit fare policy and management research projects, discuss current issues and research needs, and identify priority research projects. The results of the Workshop, as summarized in these proceedings, provide the basis for an ongoing research program advancing the state-of-the-practice related to fare policies, fare management, and fare collection methods and technologies.

This Workshop was not the first conference to be held on transit fare related issues. Rather, it builds on previous conferences conducted during the late 1970s and early 1980s. In 1979, the Urban Mass Transportation Administration (UMTA) sponsored a two-day forum in Virginia Beach, Virginia. The conference, *Transit Pricing Techniques to Improve Productivity*, examined the role fare pricing and fare innovations could play in improving transit efficiency and increasing the appeal of transit services. The results of this conference identified a number of research needs related to transit fare prepayment methods, free and reduced transit fares, system and market analyses, and technology advances to support new fare payment techniques.

This forum was followed by another fare-related conference in 1980. Again sponsored by UMTA, the *Future Directions for Transit Pricing* conference was held in September of 1980 at Woods Hole, Massachusetts. This conference examined recent experience and research activities addressing innovative fare pricing policies and techniques. The conference results included the identification of further research activities and demonstration projects related to transit pricing policies, innovative fare prepayment techniques, new fare collection technologies, and fare analysis tools.

Due to funding constraints and a redirection of the federal transit program, little transit research was conducted during the remainder of the 1980s. Thus, little activity occurred in response to the ideas and suggestions generated from these two conferences. Although many transit systems continued to examine fare policy and management issues—and in some cases implement innovative techniques—little effort was made to synthesize and share the results of these activities. As a result, a void existed for a number of years on research related to transit fare policy and management issues.

The Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991 provides renewed funding for transit research. Among other new initiatives, the ISTEA established the Transit Cooperative Research Program (TCRP). The TCRP, which is modeled after the successful National Cooperative Highway Research Program (NCHRP), is managed through the cooperative efforts of the transit industry, APTA, FTA, and TRB. A number of transit research projects are now underway as part of the first-year TCRP. For example, one of the first research studies to be awarded in the TCRP was the *Fare Policies, Structures, and Technologies* project.

At the same time, planning for a workshop on transit fare policy and management was being initiated. The actual proposal for the TRB and FTA sponsored workshop was approved by the TRB Executive Committee in June 1992. Official planning for the workshop started in the fall of 1992, with the appointment and first meeting of the Steering Committee. This group was responsible for organizing the Workshop, including identifying the key issues to be addressed in the resource papers and selecting the authors.

The invitation-only Workshop brought together key representatives from transit agencies, consulting firms, federal and local agencies, universities, and equipment vendors. Participants spent most of the three days in working groups discussing current issues and research needs related to transit fare policies, pricing strategies, and fare collection methods and technologies.

To help establish a common base for the working group discussions, the Workshop opened with presentations of the four resource papers. The presentations and papers—*Transit Fare Issues in the 1990s–Where are we, and how did we get here?* by Michael A. Kemp, *Evolving Fare Technologies* by R. Scott Rodda, *Transit Finance, Economics, and Pricing* by Armando M. Lago, and *Transit Fare Management and Operation Issues* by Richard J. Lobron—provided an excellent starting point for the working group discussions. In addition, a presentation on the TCRP *Fare Policies, Structures, and Technologies Study* also provided important information for the working groups.

Each of the four working groups—which were organized around the four resource paper topics—identified both critical issues and research needs

related to the specific topics. These were then reviewed, modified, and amplified by the other working groups. Thus, all groups had the opportunity to comment on all the issues and proposed research projects, enriching the overall outcome of the Workshop. The priority research studies for each topical area identified through this process are highlighted next.

GROUP 1—CHANGING ROLES OF TRANSIT AND FARE POLICY

High Priority

- Transit Fares within a Regional Transportation Pricing Strategy
- Fare Policy Development and Implementation
- Impact of National, Regional, and Local Policies on Transit Fare Policies
- Improvement in Fare Payment Methods
- Peer-to-Peer Fare Policy Review

Medium Priority

- Examination of Cost-Based Fare Pricing and User-Side Subsidies

Low Priority

- Fare Policies Related to the Americans with Disabilities Act

GROUP 2—EVOLVING FARE TECHNOLOGIES

High Priority

- Human Factors Research Related to Fare Collection
- Smart Cards and Innovative Fare Payment Technologies
- Fare Collection Technology Standards
- Integration of On-Board Equipment
- Intermodal Fare Operations

GROUP 3—FINANCE, ECONOMICS, AND PRICING

High Priority

- Demonstration and Evaluation of Stated Preference Surveys
- Disaggregate Fare Elasticities
- Development of Handbook on Fare Elasticity
- Impact of Recent Federal Legislation on Transit Ridership and Employer Pass Programs
- Evaluation of Deep Discount Programs
- Fare Integration Among Multiple Operators
- Best Practices in Transfers

Medium Priority

- Strategies for Pricing Bulk Transit Fare Purchases

Low Priority

- Demonstrating Pricing Promotions for Non-Work Travel

GROUP 4—MANAGEMENT AND OPERATION

High Priority

- Examining the Costs, Benefits, and Management Implications of Implementing Alternative Fare Structures
- Assessment of the Costs and Benefits of Cash and Cashless Fare Systems
- Management of Revenue Data
- Transit Revenue Collection, Auditing, and Internal Controls
- Employee Issues Related to Fare Collection

Medium Priority

- Effective Fare Marketing Programs
- Analysis of Privatizing Fare Revenue Functions

The identification of these transit fare policy and management research priorities, which are described more extensively in these proceedings, is intended to help facilitate the development of a multifaceted transit fare research program. Thus, the results from the Workshop and these proceedings represent the starting point for an ongoing, robust transit fare research program that is responsive to the needs of transit systems, federal and local agencies, transit users, and industry groups. It is realized that not all relevant issues and research needs were discussed extensively in the three day time period. Other efforts will be needed in the future to further refine and advance the efforts started at this Workshop.

The ISTEA, including the TCRP, and other research programs provide the opportunity to advance the work started at the *Workshop on Transit Fare Policy and Management*. Developing the preliminary research needs into more detailed TCRP problem statements represents one important activity to help implement the results of the Workshop. The proceedings from this Workshop will help guide these efforts and will assist in advancing the state-of-the-practice related to transit fare policies, fare pricing strategies, and fare collection methods and technologies.

WELCOME AND INTRODUCTION

Joel E. Markowitz
Metropolitan Transportation Commission
Chair, Workshop Steering Committee

It is a pleasure to welcome you to the Transportation Research Board's Workshop on Transit Fare Policy and Management. I am glad that you were able to attend this specialty Workshop and lend your expertise to the discussion of fare issues that will occur over the next three days. This is intended to be a working conference which we hope will help establish a new transit fare research agenda.

It has been a pleasure to serve as the Chair of the Workshop Steering Committee. I think the Committee has done an excellent job of organizing a very interesting conference. I would like to thank all of the Committee members for their hard work over the past year and for acting as moderators and recorders for the working groups during the Workshop.

I would also like to thank the authors of the four resource papers which form the basis for the four tracks of the workshop. These are: changing roles of transit and fare policy; evolving fare technologies; financing, economics, and pricing; and management and operations. The four resource papers, which you received in the mail, will be presented in the general sessions this afternoon and tomorrow morning. We hope that these will stimulate your thinking and focus the discussion in the working groups.

We are trying a new format with this Workshop. The structure of the next three days will be informal, but rigorous. You will be asked to actively participate in the working groups and to share your ideas on the current status of transit fare policy and management, help identify issues which should be examined more closely, and outline future research needs.

We realize that there is a great deal of overlap among the four different themes. Thus, although each group will have a major topic to focus on, you should feel free to discuss all four of the general themes. There will be four working group sessions, which each having a slightly different focus. During the first session you will be asked to outline a framework and structure for a research program based on the particular theme.

In the second session you will have the opportunity to review and comment on the outlines generated by the other three working groups. We hope this session will help refine and further develop the research approach for each of the four issue areas. In the second session you will also be asked to start to develop individual research problem statements on the issues identified as the most critical for your particular theme.

The third session will focus exclusively on the development of the research problem statements, which are intended to be a major product of the Workshop. A preliminary format for the problem statements will be provided, but the number, specific topics, suggested approaches, schedules, and funding levels will be determined by each group.

Finally, the last working session will be split into two parts. Each group will first have the opportunity to review the problem statements generated by the other groups. Based on these comments, each working group will then finalize the problem statements for the specific theme.

The intended outcome of the Workshop is a discussion of research areas related to transit fare policy and management for consideration by the Transit Research Board, the Federal Transit Administration, and other interested groups. The issues, research priorities, and level of detail in the individual problem statements will be identified and discussed by this group.

This Workshop is being held at an ideal time. The renewed interest in transit research, and the additional funding which is now available, provides an opportunity to conduct the priority studies emerging from this Workshop. Thus, your participation over the next three days will be instrumental in advancing a focused research approach on transit fare policy and management issues.

Thank you again for your attendance and participation in this Workshop. I look forward to working with you over the next three day to develop a focused research program and realistic problem statements addressing the priority needs related to each of the four transit fare policy and management themes.

Bert Arrillaga
Federal Transit Administration

Good afternoon and welcome to the Transportation Research Board Workshop on Transit Fare Policy and Management. I would like to thank you on behalf of the Federal Transit Administration (FTA) for responding to the invitation to participate in this Workshop. As Joel indicated, we are looking forward to a lively and productive discussion on the needs for research, demonstration projects, and possible technical assistance on the topic of how to better manage transit fares. This is a critical issue in transit today, and we hope the outcome of this conference will better define specific research needs in this area.

I also want to welcome you to the J. Erik Jonsson Woods Hole Center of the National Academy of Sciences, located in this beautiful and historic setting. The Transportation Research Board, especially Peter Shaw and Campbell Graeub, are to be thanked for working hard to make this facility available for the Workshop. In addition, I would like to recognize Peter Shaw, Joel Markowitz, and the Steering Committee for their efforts in making this Workshop possible. Even though the members of the Committee are listed in the program, I would like to take this opportunity to recognize them individually and thank them for their hard work. The members of the Steering Committee are: Kathryn Coffel, Tri-Met; Norman Diamond, Nextek Corporation; Brendon Hemily, Canadian Urban Transit Association; Lester A. Hoel, University of Virginia; Lloyd Johnson, Washington Metropolitan Transit Authority; Bill Loudon, JHK & Associates; Brian McCollom, MacDorman & Associates, Inc.; Jack Reilly, Capital District Transportation Authority; Joe C. Simonetti, Chicago Transit Authority; and Rich Weaver, American Public Transit Authority.

Last, but not least, I want to thank the authors of the resource papers. They did an excellent job of highlighting the major issues associated with each of the four themes in a very short time. The four authors—Michael A. Kemp, Armando M. Lago, R. Scott Rhodda, and Richard J. Lobron—deserve special recognition for their contribution to the Workshop.

You may not be aware, but this is the second national Woods Hole workshop on fare policy. The first one, which was held over ten years ago, addressed many of the same issues we will be discussing over the next few days. As a result of research budget cuts and other priorities, research on transit operational and fare issues has not been properly addressed during the last few years. Recently, however, there has been a renewed interest in this area. This interest appears to be driven by a number of factors.

First, the need for research in the area of fare policy and management has been identified in several different forums lately. FTA has held four Planning and Research Priorities Conferences over the last few years to obtain ideas from transit professionals on transit research needs. Issues related to transit fare policy, management, and technology have been rated as a high priority for additional research at all these conferences. Further, many of the recommendations and problem statements submitted to the newly established Transit Cooperative Research Program (TCRP) have addressed the critical need for research in this area. A significant study—Evaluation of Fare Policies, Structures, and Technologies—has been funded through the TCRP process. A status report on this project, which was one of the first TCRP projects to be started, will be presented Monday morning. As a matter of interest, it was during the Panel deliberations on this study that the suggestion was made for FTA to sponsor another research forum on fare issues.

A second factor driving the renewed interest in fare policies, structures, and technologies is the revitalized attention to and available funding for transit operational and management research. There is a new opportunity for the states to support transit research through the state appropriations for transit planning and research. Further, FTA is interested in funding projects in this area out of the national transit research program funds. The recent efforts within FTA to establish emphasis areas related to operational planning and transit management support this national research focus. Obviously, the Transit Cooperative Research Program also provides significant opportunities for funding all types of transit research, including projects related to fares. The TCRP is now in its second round of project funding. During the first year, the TCRP was funded at $8.9 million. The second year has been funded at $7.75 million. We are expecting a similar funding level of $7.75 million this year. Thus, you can see that this is a solidly funded program providing the opportunity to support research in a variety of transit areas.

In addition to developing specific project ideas, I hope this Workshop will provide the basis for more timely and consistent thinking regarding the changing issues and concerns relating to fare analysis and their implications for transit management. By continuing to support projects in this area, I hope we can build a solid body of knowledge that will truly help transit professionals and policy makers in their consideration of fare policies, their selection of fare collection equipment, and in their marketing of fares to the public.

The Steering Committee has developed an exciting Workshop program dealing with significant issues that have emerged during the last few years. A broad assortment of ideas and issues related to fare policies, technologies, and fare structures have evolved since the last Woods Hole Conference over ten years ago. For example, new fare collection techniques and methods have emerged. These include deep discounting and market based fares, expanded federal tax exemptions for transit travel, monthly pass subsidy programs such as Commuter Check, automatic fare collection systems, smart cards, electronic distribution systems, multi-operator joint ticket systems, computer applications for fare analysis, and employer billing systems. These represent just a few of the current examples. I am sure more projects will be discussed in the working groups. Further, you should feel free to identify additional innovative techniques that may be appropriate for research studies, demonstration projects, and operational tests.

In keeping with the tradition of the TRB research meetings, FTA will look closely at the issues, ideas, and research problem statements developed in the working groups over the next three days. It is anticipated that many will be appropriate for funding under the national transit research program or through the TCRP. Further, others may be considered for closer examination at the state and local levels. I challenge you to think creatively during the working group discussions over the next few days and to share what you learn at this Workshop with others within your agency or organization. I think you will find this to be a very productive Workshop.

Thank you again for your attendance and participation in this Workshop. I look forward to talking with old colleagues and friends again and making new acquaintances. I am sure that you will find the environment here at Woods Hole to be both inspiring and productive.

Subhash R. Mundle
Mundle and Associates
Chair, TRB Section E—Public Transportation

It is very thoughtful of the Workshop Steering Committee to provide this opportunity to welcome you on behalf of TRB Section E. I am primarily attending this Workshop as a participant, but in addition to being a consultant, I also serve as the Chairman of Section E—Public Transportation.

Many of you attending this Workshop are active participants in the different Committees of Section E. I would like to briefly highlight a few of the recent projects of the Committees within the Section for those of you who may not be aware of all our activities. Section E is one of the largest Sections in TRB. Section E has fourteen Committees and Task Forces that cover a variety of issues related to public transportation. These Committees and Task Forces are both functionally and modally oriented.

I think it is also one of the more exciting Sections within TRB. We have a very active research agenda focusing on a wide range of issues concerning all facets of public transportation. The Committees within the Section all have very active members who are willing to take on responsibilities and promote numerous projects and research studies. This Workshop provides an example of the enthusiastic participation and dynamic leadership of one of the Section E Committees.

Again, it is a pleasure to welcome you to this Workshop. I look forward to a very interesting and productive three days.

Peter L. Shaw
Transportation Research Board

I would also like to take this opportunity to welcome you to this Workshop. It is a pleasure for TRB to be sponsoring the first workshop on transit fare policy and management to be held in over a decade. I hope you will enjoy the setting here at Woods Hole and find it to be a very productive atmosphere for the development of a research approach addressing transit fare issues.

As noted by both Joel and Bert there currently appears to be numerous opportunities for transit research studies addressing high-priority issues. There are also many activities related to transit fare policies and management occurring throughout the country and the world right now. By helping to capture the current status of projects, and by identifying key areas where additional research is needed, this workshop will enhance the understanding of the issues associated with transit fare policy and management and will help define future research priorities.

The new Transit Cooperative Research Program (TCRP) provides an opportunity for funding high-priority research problem statements identified through this Workshop. There are really three possible ways that results from this Workshop may be used in the TCRP. First, high-priority problem statements can be submitted to the TCRP for consideration as research studies. Second, many of you may wish to participate on the panels that will further refine the focus of the research projects, identify the work tasks, review the proposals, and select a contractor. Finally, some of you may be interested in submitting proposals to conduct the actual studies.

I would like to recognize Pierre Marc Daggett, also of the TRB staff, for his assistance in organizing this Workshop. Please let us know if there is anything we can do to enhance the Workshop or your stay here at Woods Hole.

Working Group 1 - *Changing Roles of Transit and Fare Policy*
Facilitator - Kathryn Coffel, TRI-MET
Recorder - Daniel Boyle, Center for Urban Transportation Research
Resource Support - Michael Kemp, Charles River Associates, Inc.

Participants

Peter Benjamin, Washington Metropolitan Area Transit Authority
Richard Chimera, New York State Department of Transportation
Daniel Fleishman, Multisystems, Inc.
Steve Jackson, Booz-Allen & Hamilton, Inc.
Joel Markowitz, Metropolitan Transit Commission
Roy Nakadegawa, Bay Area Rapid Transit District
Richard Oram, R. L. Oram & Association
James Redeker, New Jersey Transit
Judy Schwenk, Volpe Center/Transportation Systems Center
Kenneth Stanley, Pierce Transit

Discussion of Issues

Working Group 1 examined the changing roles of transit and fare policy. One of the major concerns highlighted was the fact that fare policies and fare strategies are often developed in a vacuum, without adequate interaction among local policy makers, transit agency board members and professional staff, the public, and the media. Further, many transit agencies do not have explicit and adopted fare policies and fare strategies, but rather make fare changes on an ad hoc basis. This approach often has negative consequences for both the agency and the public.

The group discussed that from a business strategy perspective, transit agencies need to be able to predict revenues accurately. Fare revenues—which represent the amount of revenues generated from all types of passenger fares—are an important component of the overall budget of most transit agencies. Having a long range plan on when and how much fares will be raised or under what circumstances fare changes will be considered can enhance the accuracy of future financial planning.

The group also discussed fare policy from the perspective of transit users. Transit riders benefit from clearly articulated fare policies and fare strategies. Rather than random and unanticipated changes, an adopted set of policies and guidelines allows riders to anticipate fare changes. Further, fare policies can enhance riders' understanding of the reasons for fare changes and the factors the transit agency will consider in making any changes.

Research Needs and Studies

A variety of research needs and studies related to the changing roles of transit and fare policy were identified and discussed by Working Group 1. These focused on examining the current state-of-the-practice related to fare policies, the development of guidelines for use by transit agencies interested in the establishment of fare policies and fare strategies, the analyses of how national and local legislation influences fares, the examination of the impacts of a variety of factors on fare policies and fare structures, and analyses of the roles of different groups in the development and implementation of fare policies and programs.

The research needs and studies identified by Working Group 1 were reviewed, critiqued, and modified by the other working groups. The final listing of research needs are summarized next. The projects given high priority ratings are presented first followed by those given medium and priority ratings. The major components of the studies are highlighted along with the anticipated products.

High Priority

Transit Fares Within a Regional Transportation Pricing Strategy

Description—Transit fares represent one element of transportation pricing within a regional metropolitan area. Currently, transit fares are often established in a vacuum where the price of other modes are not considered. In order to move toward a more integrated intermodal regional transportation system, a number of issues must be explored and addressed. Elements to be included in this study are the cross elasticities of gasoline pricing and parking charges on transit use, the extent to which the decision-making process relating to parking rates and transit fares have been combined, and examination of the relationships between fares and factors such as employer

participation in transit subsidies, parking pricing and availability, zoning, and federal and local policies. The analysis should consider the role of transit pricing, the pricing of competitive modes, and the potential for policies at all levels of government to make transit pricing more effective. The use of case studies may be an appropriate technique for this analysis.

Product—The results of this research study would be summarized in a final report documenting the influences and interrelationships of these factors and the techniques and methods that can be used in the development of an intermodal regional transportation pricing strategy. The report would contain the results of the case study analysis, the impact of intermodal pricing, a set of guidelines or techniques for use in developing regional transportation pricing strategies, and suggestions for regional policies to enhance the consideration of intermodal pricing strategies.

Fare Policy Development and Implementation

Description—It appears that one factor which may be limiting the use of fare policies by transit agencies is the lack of a practical guide for use by staff to develop and implement fare policies, fare structures, and fare strategies. This research project would address this need. The study would examine different approaches which have been used by transit agencies to analyze, develop, and implement fare policies, fare structures, and fare pricing strategies. The research would examine the current state of the art related to the use of fare policies by transit agencies, including an analysis of the key elements, the key participants, the evaluation measures, communication techniques, and the outcome of different approaches and techniques. This would include fare policy objectives, agency objectives, how to develop a fare structure, the role of education and advertising, the relationship with service changes, fare sensitivity, comparisons with the competition, and ongoing monitoring programs. The role of professional staff, agency board members, local officials and the public would also be included in the analysis. Based on this information, the study would develop a set of guidelines for use by transit systems in developing fare policies, structures, and strategies. A case study approach may be appropriate for this research study.

Product—The results of this study, which would be documented in a final report, would include a summary of the current state of the art related to transit fare policies, fare structures, and fare pricing strategies. Further, the report would contain a set of practical guidelines for use by transit staff and board members to assist in developing, analyzing, implementing, and monitoring fare policies, structures, and pricing strategies. Thus, the outcome of the study would be of immediate use and benefit to transit systems.

Impact of National, Regional, and Local Policies on Transit Fare Policies

Description—Recent legislation and policies at the national, regional, and local level may influence transit systems and the use of all forms of public transportation. This research study would examine the impact these policies have had, and may have, on transit use and on fare policies. The analysis would include examining the possible impacts of the 1990 Clean Air Act Amendments, the 1991 Intermodal Surface Transportation Efficiency Act, and other federal and local policies. The study would examine the influence these may have on fare policies, and strategies, including the following:

- New fare instruments, such as employer passes or college passes;
- Methods of charging with new "purchaser"—employer versus rider;
- The costs of national and local policies and ways they affect fare levels and other services;
- Short- and long-term impacts; and
- Packaging fares with other non-transit strategies, such as parking, to achieve national policy goals.

Product—The results of this research study would provide a comprehensive assessment of the impact recent federal, regional, and local legislation and policies may have on transit use and transit fare policies. The results would be of use to transit systems in identifying and implementing appropriate fare policies and strategies to maximize the benefits of recent legislation.

Improvement in Fare Payment Methods

Description—Transit users must pay a fare each time they use the service. This can act as a determent to transit use by emphasizing the cost of transit each time a rider boards a vehicle. This is a significant disadvantage, especially when compared to the use of private vehicles. This research study would examine the feasibility of using new technology to make transit fare payment methods easier and more invisible. The impacts of possible approaches on ridership levels and revenues would be analyzed. Factors to be considered in the study would include approaches to making fare payment invisible to riders, the impacts of pre- and post-fare payment methods, the use of debit and stored value cards, unlimited rides for a flat payment, the

impact of exogenous variables on different fare payment methods, and other issues associated with fares.

Product—The results of this research study would document the impacts on transit ridership levels and fare revenues of different approaches to making fare payment easier and more invisible to users. The most feasible techniques would be summarized and possible demonstration projects to test these would be outlined. The results would be of use to transit systems, FTA, and other groups interested in increasing the use of all types of transit through improved fare payment techniques.

Peer-to-Peer Fare Policy Review

Description—One of the most common approaches used by transit systems in the development and review of fare policies is to examine what systems of similar size are doing. This peer-to-peer comparison provides a useful and practical method for systems to determine how they are performing and to identify possible approaches for improvement. Currently, most systems undertake this comparison on their own, resulting in duplication of efforts and wasted resources. This research study would develop a national peer-to-peer database on fare policies, fare structures, fare pricing strategies, and fare collection methods. It is anticipated that this research would utilize FTA Section 15 data, APTA fare survey data, and peer groups from different types and sizes of transit systems to develop a national fare structure and fare policy database. The study would also establish an ongoing monitoring program to ensure that the national database is maintained.

Product—The results of this research study would be the development of a national fare structure and fare policy database. This database would be set up to allow easy access by transit systems wishing to examine a peer-to-peer analysis of transit policies, structure, pricing strategies, and collection methods. This would provide a valuable resource to transit systems and would reduce duplication of efforts in the future. The study would also establish an ongoing monitoring and updating process to ensure that the national database remains current.

Medium Priority

Examination of Cost-Based Fare Pricing and User-Side Subsidies

Description—During the 1970s and 1980s, there was a great deal of interest in moving toward greater use of cost-based fare pricing, including user-side subsidies. This approach was strongly suggested at the 1980 *Future Directions for Transit Fare Pricing Conference*. Although some changes have been made in the last ten years, it does not appear that user-side subsidies have been used very extensively. This research study would examine the current state-of-the-art practice related to cost-based fare pricing and user-side subsidies. It would identify to what extent these approaches have been used, the issues associated with their use, and the future potential for greater use of these concepts.

Products—The research study would document the current experience with the use of cost-based fare pricing strategies, including user-side subsidy programs. It would also evaluate the issues associated with the use of these approaches and would provide a realistic assessment of the future potential for their use. The results would be of benefit to groups interested in possible implementation of cost-based fare pricing strategies.

Low Priority

Fare Policies Related to the Americans with Disabilities Act

Description—The Americans with Disabilities Act (ADA) contains a number of provisions relating to public transit services. For example, the ADA requires that transit systems providing regular route services must also provide specialized transit services to disabled individuals. The ADA, and subsequent rules issued by FTA, place further requirements on the service area, hours of service, fares, and other operating characteristics of the specialized services. Although fares from specialized services may be higher than those for regular route services, little analysis has been done on fare policies and pricing strategies for specialized transit services. This research project would evaluate current fare policies, fare structures, and pricing strategies for specialized transit services, and identify potential future approaches to better meet the requirements of the ADA. It is anticipated that a case study approach, focusing on peer-to-peer comparisons, would be used for this research.

Product—The results of this research study would provide a state-of-the-practice assessment of fare policies, structures, and pricing strategies currently being used with specialized transit services throughout the country. This analysis would provide transit agencies and other groups with a peer-to-peer comparison of the approaches currently in use. The results would identify additional approaches that transit systems may wish to consider to better meet the ADA requirements.

Working Group 2 - *Evolving Fare Technologies*
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Discussion of Issues

Working Group 2 examined a wide range of issues associated with fare collection technologies. Topics discussed included recent advancements in fare technology, the need for standards to ensure compatibility between different equipment vendors, the development of Smart Cards, the use of other innovative fare collection techniques, and the integration of fare technologies between different modes. The group also discussed using new fare technologies to help meet the requirements of the Americans with Disabilities Act (ADA).

The group discussed the different advances in fare collection technologies and noted that there appears to be great potential to simplify fare collection through the use of new techniques and technologies. Such approaches could make fare payment more convenient for passengers and could simplify fare collection for operators.

Research Needs and Studies

Working Group 2 identified a wide range of research needs relating to fare collection technologies. Based on the comments from the other groups, Working Group 2 reviewed the initial list of potential research studies and identified five priority research projects. The five studies address the areas of human factor concerns with new fare collection technologies, the use of Smart Cards and other innovative fare collection methods, the development of technology standards, the integration of on-board equipment, and the enhancement of vehicle-to-vehicle fare integration.

High Priority

Human Factors Research Related to Fare Collection

Description—There are many factors that may influence the use of different fare media by transit passengers. This research study would examine the human factors issues associated with the use of different fare collection techniques and technologies. It would consider such human factor considerations as form, fit, and function, color and graphics, ease of use, reduction of error, and customer understanding and satisfaction. These issues would be examined from the perspective of regular route transit riders and individuals using specialized paratransit services. Considerations to enhance the provision of services to specialized user groups and to meet the requirements of the ADA would be considered. The study would also examine the human factor issues for transit system employees with the use of different fare collection technologies. This would include operators, maintenance, and office personnel.

Product—The results of this research, which would be documented in a final report, would provide a comprehensive assessment of the human factor issues associated with the use of different fare collection techniques and technologies. By providing guidance on the best approaches to use to maximize customer understanding and satisfaction, and employee acceptance and ease of use, the research study would be of immediate benefit to transit systems and fare equipment vendors.

Smart Cards and Innovative Fare Payment Technologies

Description—One area that is currently receiving a good deal of interest is the potential use of Smart Cards and other innovative fare payment technologies. Recent advances in technology have made the use of these fare payment techniques more affordable and realistic. A major focus of the advanced public transportation systems (APTS) component of the intelligent vehicle-highway systems (IVHS) program is on Smart Card technology. This research study would help advance the state of the art in the use of Smart Cards by examining the costs and benefits of this fare payment technique, analyzing the advantages and limitations of different technologies, examining the potential for use with non-transit transactions, and identifying potential demonstration projects and operational tests.

Products—The result of this research study would be a comprehensive assessment of Smart Cards and other innovative fare payment technologies. This would include an analyses of the costs and benefits, advantages and limitations, and issues associated with the use of different technologies. This assessment would examine these issues from the standpoint of both transit users and transit operators. Further, the study would identify the potential for demonstration projects and operational tests to implement the more promising approaches.

Fare Collection Technology Standards

Description—Currently the lack of common standards among different fare collection equipment precludes a high level of compatibility. The need has been identified for common standards to better ensure the future compatibility and integration of fare collection equipment from different vendors. This research study would examine the current status of standards for different types of fare collection technologies and identify standards in related fields that may be appropriate for use in transit. Based on this information, a set of standards would be developed for different fare collection technologies. It is realized that a wide variety of groups must be involved if this project is to be successful. Thus, it is anticipated that the research study would involve representatives from transit agencies, federal organizations and agencies, and fare collection equipment supplies.

Product—The primary result of this research study would be the development of standards for different fare collection technologies. These would be documented in a final report that would also summarize the issues associated with the development and use of the standards and guidelines for implementing the standards. The results would be of benefit to transit systems and equipment vendors to help ensure future integration of fare collection technologies.

Integration of On-Board Equipment

Description—This research study would build on the previous project by examining system integration of fare collection equipment with other on-board equipment. The study would examine the system integration and interface issues associated with on-vehicle equipment for fare collection (fare boxes and ticket or pass validators), radios, destination signs, passenger counters, automatic vehicle location (AVL) systems, odometers, and other elements. The study would examine the costs and benefits associated with greater integration among all these system components and would develop general guidelines for moving toward greater systems integration.

Product—The results of this research study would provide a comprehensive assessment of the potential for greater integration among all on-board equipment. The final report would document the costs and benefits and issues associated with greater systems integration. It would also outline a set of general guidelines for greater integration of all on-vehicle components.

Intermodal Fare Operations

Description—This research study would examine the technology issues associated with moving toward an intermodal fare payment system. Issues to be examined include how technology can be used to integrate and standardize fare payment among different modes, concerns over paper transfers and proof-of-payment techniques, fare evasion, recording revenue allocation, and passenger counting requirements. Potential technology solutions to these issues would be identified and approaches for moving toward an intermodal fare system would be outlined. The study would also identify possible demonstration projects and operational tests to help promote full deployment of intermodal fare systems.

Product—The results of this research study would document how evolving technologies can be used to develop an intermodal fare payment system. The final report would summarize the issues examined and the potential approaches to address these concerns, the costs and benefits of intermodal fare systems, and possible demonstration projects and operational tests.

Working Group 3 - *Finance, Economics, and Pricing*
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Discussion of Issues

Working Group 3 discussed the financial, economic, and pricing issues associated with transit fare policies and the management of fare collection. A wide range of topics were identified by the group for further research. Issues discussed included fare elasticities, the relationships between fares and the cost of other transportation elements, and fare integration among different providers. Further, the group spent a good deal of time discussing the influence of deep discount programs, other fare pricing strategies, and the use of innovative fare collection techniques. The lack of research on these topics over the last 20 years was identified as a major shortcoming.

Working Group 3 also discussed a number of other issues related to fare policies and management. For example, examining fare pricing approaches to encourage riders to change from paratransit to regular-route services was identified as an area needing further research. The group also discussed a variety of issues associated with fare collection technologies, approaches to simplifying fare collection methods, and the need to examine the social and economic benefits of transit. Potential problem statements in these areas were forwarded to the working groups considering these topics.

Research Needs and Studies

In order to respond to the research needs related to finance, economics, and pricing, Working Group 3 identified nine research studies to assist in advancing the state of the art. The high priority problem statements focused primarily on fare elasticities, the influence of recent federal legislation, the evaluation of deep discount programs and other innovative fare pricing methods, and the examination of techniques to promote greater fare integration among different providers. Research topics ranked as lower priorities by the group included strategies for pricing bulk transit fare purchases and non-work travel fare pricing promotions.

High Priority

Demonstration and Evaluation of Stated Preference Surveys

Description—This research study would utilize stated preference surveys to help develop enhanced elasticity estimates for fare price changes. Stated preference surveys have been used in many other industries to develop elasticity estimates for price changes. Although some transit agencies have used stated preference surveys in the past, it appears that this technique has not been used extensively to assist in determining customer reaction to different fare pricing scenarios. The use of stated preference surveys offers increased flexibility and potential cost savings over revealed preference approaches that are currently being used by many groups within the transit industry.

This research would first document past efforts utilizing stated preference surveys in transit. A comprehensive literature review would be conducted to examine the experience with stated preference surveys. Further, additional available information from transit agencies and marketing groups would be collected and analyzed. Based on this analysis, a suggested approach and a set of guidelines would be developed for the use of stated preference surveys in transit. Further, examples of

stated preference surveys would be developed and tested at specific case study transit systems around the country. The results of these surveys would help refine current fare elasticities. Thus, the research study would provide additional information on stated preference surveys, guidelines for their use in transit, and specific data on fare elasticities.

Product—The results of this research study would provide both practical guidelines for transit agencies and other groups interested in conducting stated preference surveys, and more detailed information to help refine current fare elasticities. The final report prepared in the study would document the past use of stated preference surveys, provide a suggested approach and guidelines for the use of this method by transit agencies, document the results of the case study surveys, and analyze the results to enhance the current understanding of fare elasticities.

Disaggregate Fare Elasticities

Description—A good deal of research was conducted on transit fare elasticities during the 1970s. Very little work was done in this area during the 1980s, however, Currently, the Federal Transit Administration is funding a study to update previous work on fare elasticities and cross elasticities. This study has identified a number of gaps in current knowledge and areas where additional research is needed. The research suggested in this study would address these knowledge gaps.

Areas to be examined in greater detail in this research study would include the elasticities related to distance-based fares and the use of transit passes. Further, the cross elasticities of different fare media would be analyzed. In addition to examining these issues, the study would develop a program for the ongoing reporting of fare information by transit systems. This would provide for the ongoing collection, monitoring and analysis of needed fare elasticity data.

Product—The results of this research study would help expand the understanding and knowledge of disaggregate fare elasticities, especially those related to distance-based fares, transit passes, and multiple fare media. It would further provide a method for the ongoing reporting of fare-related information by transit agencies. The final report would provide a detailed analysis of the elasticities related to distance-based fares, transit passes, and multiple fare media and would outline the ongoing monitoring program.

Development of Handbooks on Fare Elasticity

Description—Fare elasticity and conducting fare analyses are complicated and difficult subjects, which are often not well understood by local transit agency staff members, board members, and other decision makers. Part of the problem appears to be the lack of a clear and easily understood handbook describing key elasticity concepts and providing guidance for conducting local fare analyses.

This research project would address this void through the development of a series of handbooks on different aspects of fare elasticities and fare analysis techniques. One handbook would be developed for technical staff members at transit agencies and other organizations. This handbook would describe key elasticity concepts, provide guidelines for conducting fare elasticity analyses, suggest data collection methods and techniques for conducting site-specific elasticity estimates, and examine the different software programs available to assist with fare analyses. It would also provide guidance on the use of fare elasticities developed in other metropolitan areas and the proper range of applications for fare elasticities. A review of commercially and locally developed fare evaluation software programs would be conducted as part of this research. This review would identify those most appropriate for use by local technical staff.

A separate handbook would be developed for board members and other decision makers. This handbook would be oriented toward explaining the basic concepts related to fare elasticities and the implications of different fare policies and pricing strategies. The intent of this handbook would be to introduce and explain the basic fare elasticity principles and practices to decision makers.

Product—The research study would produce two handbooks—one oriented toward local transit staff members and one oriented toward board members and decision makers. The first handbook would provide a valuable resource guide for technical staff members responsible for fare policy development, analysis, implementation, and evaluation. The second handbook would provide transit board members and other decision makers with a guide to the basic concepts related to fare elasticities, fare policies, and pricing strategies.

Impact of Recent Federal Legislation on Transit Ridership and Employer Pass Programs

Description—Recent federal legislation may influence transit ridership and the use of employer transit pass programs. Examples of recent legislation that may impact

the use of public transit include the 1990 Clean Air Act Amendments and changes in the federal tax code. The requirements of the Clean Air Act Amendments, especially those relating to employer trip reduction programs in air quality non-attainment areas, and the increase in the employer-provided transit benefits—from $21 to $60—have focused greater interest on employer transit programs.

This research study would analyze the impacts of these and other related measures on transit ridership and the use of employer transit pass programs. Based on a review of current experience, the research would also analyze the impact of raising the employer transit pass tax benefit higher than the current $60. Further, it would examine the ridership impacts of changes in automobile-related tax benefits and the use of transit checks and other innovative payment methods. The research would also identify available tools and techniques for use in estimating the potential impacts of these and other related measures on employer pass sales and transit ridership.

Product—The results of this research, which would be documented in a final report, would enhance the level of understanding related to the impact recent federal legislation and policies may have on transit ridership and employer transit pass programs. Further, it would analyze the potential impacts of additional changes in these policies, including raising the value of transit benefits. It would also provide practical tools and techniques for local transit systems to use in analyzing these and other possible changes.

Evaluation of Deep Discount Programs

Description—This research study would provide a structured evaluation of the transit fare deep discount concept and existing deep discount programs and other innovative approaches to transit fare payment. The use of deep discounting, which involves providing lower fares for riders who purchase pre-paid multi-ride fare media, has been implemented by a number of transit systems over the last few years. A variety of approaches and different pricing strategies have been used in these programs. To date, a comprehensive analysis has not been conducted documenting the different approaches and the related experience. This research study would fill this void through a structured evaluation of the current experience with the use of deep discount fare programs and other innovative approaches to transit fare payment. The research would identify current deep discount fare programs in use throughout North America and would describe the characteristics of each program. The study would further utilize existing information to examine the experience to date with the different programs and the impacts of each. This analysis would help identify the potential benefits, limitations, and issues associated with the use of deep discounting techniques.

Product—The results of this research study, which would be documented in a final report, would enhance the understanding of the current use and potential future application of transit fare deep discounting programs and other innovative techniques. The structured evaluation would provide technical staff and decision makers with needed information on the costs, benefits, impacts, and issues associated with the use of different deep discounting programs. The results would be used by these groups to enhance existing programs and to implement future strategies.

Fare Integration Among Multiple Operators

Description—Many areas—both urban and rural—have multiple providers of public transportation services. These may include multiple regular-route providers, as well as specialized services operated by paratransit providers and taxi companies. Presently, it appears that few areas have integrated fare programs among different providers. This research study would examine the current state of the practice with transit fare integration and would analyze the experience with different approaches.

The study would examine the issues often identified as barriers to greater fare integration among providers. These include reimbursement arrangements among provider, impacts on ridership, impacts on financial planning, the costs and benefits to individual operators, implementation issues, and available technologies. Using a case study approach, the research would provide guidelines for addressing and overcoming these issues.

Product—The results of this research study would be documented in a final report that would include a summary of the current state of the practice related to fare integration among multiple transit operators, the issues often encountered in fare integration, and approaches to address these concerns. Based on the case study analysis, it would also outline a set of general guidelines to help provide direction for transit systems interested in implementing integrated fare systems.

Best Practices in Transfers

Description—Most transit systems in the United States utilize transfers to allow passengers to change from one route to another or from one type of service to another. Although the use of transfers is a common feature among

transit agencies, many different approaches and requirements are currently being practiced. For example, differences exist in the time allowed for passengers to transfer, the direction of travel transfers may be used for, and the locations at which transfers may be used. Further, some systems charge for transfers, while others provide them for free. This research study would examine the current state of the practice with the use of transfers by transit systems. This synthesis report would examine the different pricing approaches and use requirements, and the experience with alternative techniques. The study would examine the impact of different approaches on revenue, ease of use for riders and operators, and other issues.

Products—The results of this research study would be documented in a state-of-the-practice synthesis report. The report would summarize the experience with different transfer policies and pricing strategies, the issues associated with different approaches, and the techniques that appear to be most successful for different types of transit services and situations.

Medium Priority

Strategies for Pricing Bulk Transit Fare Purchases

Description—Many transit systems currently sell bulk passes, tickets, or tokens to universities, schools, social service agencies, employers, or other groups at a discount. All groups, as well as the community in general, appear to benefit from these arrangements. To date, however, there has been little analysis done on the full impacts of these types of programs and which approaches provide the maximum benefits to all groups.

This research study would help fill this void by examining the advantages and disadvantages of different pricing strategies for bulk purchases and different arrangements between the transit agency and other groups. Strategies to be examined include full pricing, discount pricing, and marginal service costing.

Product—The results of this research study would be documented in a synthesis report outlining the state of the practice with bulk transit fare purchases. It would provide examples of current pricing strategies and arrangements being used by different transit systems and would analyze the advantages and disadvantages with different approaches.

Low Priority

Demonstrating Pricing Promotions for Non-Work Travel

Description—Currently, most fare pricing promotions are aimed at work trips and daily commuters. With the exception of off-peak fares for elderly individuals and some special retail promotions, it appears that little emphasis has been placed on fare pricing promotions for non-work travel. The performance of most transit systems could be improved through greater off-peak ridership, although it is generally believed that there is little potential for increasing non-work use of transit. This research project would identify and implement, and evaluate demonstration projects focusing on fare pricing promotions aimed at non-work travel.

Product—The results of this research would be a series of demonstration projects testing different approaches to encouraging greater non-work use of transit through fare pricing promotions. It is anticipated that the demonstrations would be planned, implemented, and evaluated to test different fare pricing promotions with different sizes and types of transit agencies.

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Discussion of Issues

Working Group 4 discussed the management and operational issues associated with the different aspects of fare policies, fare pricing strategies, and fare collection. A major focus of the discussion, which is reflected in the research problem statements, was on the management implications and requirements of current and alternative future fare policies and procedures. The group identified this as the general subject area within which more detailed research studies were outlined.

The working group further developed a framework for conducting the individual studies. In order to provide a complete cross section of issues, 10 elements were outlined to be considered in each of the individual research studies. Consideration of these elements would help ensure continuity and coordination among the different projects. The 10 elements deemed important in each study were:

- Implication of technology investment,
- Structure and technology of executive-level decisions,
- Revenue management decisions,
- Human resource elements,
- Marketing and customer issues,
- Revenue control operational considerations,
- Collection and service issues,
- Management information system (MIS), considerations and needs,
- Maintenance considerations and needs, and
- Intermodal issues and opportunities.

Research Needs and Studies

Working Group 4 identified an initial listing of 13 high and medium priority research studies. A number of these addressed related issues and were grouped into five high priority studies and two medium priority research projects. The high priority research needs focus on the general areas of the impacts of alternative fare structures, the costs and benefits of cash versus cashless fare systems, the management of revenue data, management and auditing issues, and personnel issues. The medium priority studies address the costs and benefits associated with the privatization of revenue-related functions and effective sales marketing programs for different fare structures.

Examining the Costs, Benefits, and Management Implications of Implementing Alternative Fare Structures

Description—This research study would examine the costs, benefits, and management implications of alternative fare structures. Issues to be considered in the study include the impact of different fare structures on regional revenue reconciliation, intermodalism, costs per transaction, cost to process collected revenue, and the potential for unanticipated consequences. The cost per transaction would further be refined to include operating—maintenance and collection—costs, media costs, and sales and commission costs. The study would also examine the impact of different structures on the ability to use prepayment and post-payment fare collection methods. Further, the study would assess the degree to which each alternative provides for the secure and cost-effective handling of cash. Finally, the research project would define the steps in the revenue collection process

and would develop a set of standard performance indicators.

Product—The results of the research study would be documented in a final report that would include the detailed assessment of the costs, benefits, and management implications of different fare structures. This would be of immediate use and benefit to transit systems and operators interested in examining future changes in their fare structures. Further, the definition of the steps in the revenue collection process and the development of a set of standard performance indicators would provide practical assistance to transit agencies.

Assessment of the Costs and Benefits of Cash and Cashless Fare Systems

Project Description—This research study would assess the cost and benefits of cash and cashless fare systems. Factors to be considered in the analysis include regional revenue reconciliation, intermodal connections, costs per transaction, costs to process collected revenue, cash handling, public understanding and acceptance, and marketing. The analysis of the costs and benefits of cash fare systems would further examine the issues associated with the handling of dollar bills, accountability, and the interface between bus and rail processing equipment. The study would also provide a step-by-step guide for implementing a cashless fare system.

Product—The results of this study would be documented in a final report that would outline the costs and benefits, and the advantages and disadvantages of cash and cashless fare systems. It would also provide a step-by-step guide for implementing cashless fare systems.

Management of Revenue Data

Description—This research study would examine different techniques for the management of revenue data generated from fare collection systems. The project would include a state-of-the-art assessment of current practices and the development of enhanced techniques and practices for improved management systems. Factors to be addressed in the study include the use of data by different user groups with a transit agency, the costs associated with data collection and data use, the need for standardization within the transit industry, and the potential impact of advanced technologies.

Product—The final report prepared for this research study would be of immediate use to transit systems interested in improving their revenue data management system. It would provide a summary of the current state-of-the-art practice and ways to improve revenue management systems.

Transit Revenue Collection, Auditing, and Internal Controls

Description—There are a number of issues associated with the internal management and operation of all aspects associated with transit fare revenue collection. These issues include, but are not limited to, where fare collection responsibilities should be located within a transit agency, what auditing and reconciliation controls are needed, how to prevent revenue losses, and what internal controls are needed to ensure proper accounting of fare revenues. All of these issues revolve around the secure nature of fare collection.

This research study would examine these issues in more detail and would develop guidelines and educational information for transit system staff members and policy boards. The study would examine where the responsibility for revenue related functions should be located within a transit organizational structure. It would also consider possible areas—both internal and external—where revenue losses might occur and would identify ways to reduce the likelihood of revenue losses. The project would also examine internal controls, such as internal controls questionnaires (ICQ), auditing, and reconciliation controls to help prevent revenue losses.

Product—The results of this research study, which would be documented in a final report, would identify the internal management and operational issues most commonly associated with fare collection controls. It would further provide guidelines on how best to organize the fare revenue related functions within a transit agency, and provide suggestions for internal and external controls, the use of ICQs and other techniques, and auditing and reconciliation controls. These guidelines would be of use and benefit to both technical staff and policy board members.

Employee Issues Related to Fare Collection

Description—Given the large amount of money involved with fare collection, it is critical that employees correctly handle and report all fare revenue. The potential for internal revenue loses, due to employee theft, is a concern to many transit systems. This research study would examine the issues associated with hiring and retention of employees responsible for the different fare revenue collection functions. The study would consider elements related to hiring, training, working conditions, knowledge

and skills, supervisory relationships, and motivation and honesty. It would also examine ways to help ensure the continued high performance of employees. In addition, the study would examine the potential effects on staff due to changes in fare policies and structures and would identify the best ways to address possible impacts and issues. This would include both changes in fare collection techniques and new policies and procedures.

Product—The results of this research study would be documented in a report that would examine the personnel issues associated with fare collection. It would summarize the best practices associated with hiring, training, supervision, and ongoing motivation. The results would be of use to transit managers and would provide ideas on techniques to improve current practices.

Medium Priority

Effective Fare Marketing Programs

Description—This research study would examine the elements needed to develop and implement effective sales marketing programs for different fare structures. It would examine the different strategies that transit systems could use to develop marketing programs and the specific techniques that can be employed in sales efforts. Strategies that would be addressed include the use of transit stores, pass and ticket outlets, mail distribution, and employer promoted programs.

Product—The research study would develop a manual, or cookbook, that would outline approaches for the development and implementation of sales marketing programs for different types of fare structures and payment methods. The final report would also document the results of the research study and provide ideas for transit systems wishing to improve their fare sales promotional activities.

Analysis of Privatizing Fare Revenue Functions

Description—This research study would examine the potential for using private sector businesses for some or all of the fare revenue-related functions conducted by public transit agencies. The study would examine the costs, benefits, and issues associated with privatizing different fare revenue-related functions. These may include fare sales activities, fare collection, fare processing, and fare management information systems. The results of this analysis would be a comprehensive analysis of the advantages, limitations, and issues associated with the use of private sector businesses to perform fare revenue-related activities now conducted by public transit agencies.

Product—The results of this research study, which would be documented in a final report, would provide an unbiased analysis of the costs, benefits, and issues associated with privatizing some or all of the fare revenue-related functions. The report would be of use to transit systems interested in possible ways to improve fare collection functions and improve efficiency.

Transit Fare Issues in the 1990s—Where Are We, and How Did We Get Here?

Michael A. Kemp
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Déjà Vu All Over Again

It's almost 13 years since 64 people gathered here, at the Erik Jonsson Woods Hole Center in September 1980, to discuss "Future Directions for Transit Pricing" *(1)*. Just like this one, that conference was under the auspices of the Transportation Research Board and the U.S. Department of Transportation, and in fact it marked the culmination, in some ways, of several years of UMTA activism on the subject of transit pricing. Since the mid-1970s, fare policies had been an important theme in the agency's Service and Methods Demonstration program, which had funded a wide range of demonstrations and research projects concerning (for instance) fare prepayment, promotional fare incentives, user-side subsidies, service-based pricing, time-of-day pricing, transfer policies, and fare collection techniques. During this era, UMTA was also far-sighted enough to realize that better pricing of *private vehicle* use in congested conditions had potential transportation and revenue impacts that are orders of magnitude larger than any conceivable implications of fancy *transit* pricing, and so some efforts had also been devoted, somewhat fruitlessly, to promoting road-pricing demonstrations.

A much larger conference at Virginia Beach in 1979 *(2)* had, in fact, provided a "show-and-tell" opportunity for the various transit pricing projects catalyzed by UMTA's R&D funding. The smaller select group invited to assemble at Woods Hole in 1980 were asked to be the forward thinkers, identifying directions and priorities both for industry practice and for UMTA involvement. However, shortly thereafter the federal R&D budgets were curtailed, and correspondingly UMTA's influence on pricing innovations waned throughout the 1980s. Now, with an increased emphasis on research and planning activities created by the funding mechanisms established by ISTEA, it is quite appropriate that we should be picking up where we left off, in this building, 13 years ago.

As I understand it, it's my job in this first resource paper to sketch out a road map of the territory we should try to cover: to review where we are now and how we got here, to point out what has changed and what may be on the horizon, and generally to set the *policy* context for the more detailed resource papers and working sessions that are to follow. In doing so, I will draw on both objective fact and subjective opinion in the hope that such a mix will better help to stimulate our subsequent discussions.

The year of the last Woods Hole conference, 1980, provides a good base year for me to use in talking about recent trends. One of my central contentions is that while in several ways quite a lot has changed or is in the process of changing, in other more fundamental ways *c'est* very much *la même chose.*

How little further we have come in some key ways over the last 13 years can be seen very clearly from the abstract of 1980 report *(1):*

> Despite the diversity of perspectives represented, there was unanimous agreement that current transit pricing practices are in need of much improvement. Largely due to social welfare concerns, it has been general policy and practice to keep transit fares low and to rely increasingly on sources of funding other than the farebox to cover the rapidly escalating costs of service provision. However, empirical evidence . . . indicates that low fares are inefficient income transfer measures, since they give an unnecessary subsidy to more affluent transit riders and result in relatively small mobility gains for low-income and carless individuals. Moreover, prevalent policies favoring low fares and reduced service levels tend to penalize not only transit riders (who might prefer better service at higher fares) but also transit operators (who could be recovering more revenues out of the farebox).
>
> Acknowledging the likelihood of dwindling subsidy funds, conference attendees concurred in the need for a more businesslike approach to transit pricing, encompassing: (1) a shift towards more cost-based pricing, which would mean substantial fare increases for most transit services; (2) increased attention to the quality of the transit product and its efficient production; and (3) greater separation of transit and welfare system functions. The following were identified as critical to the implementation of improved pricing practices: a workable mechanism for mitigating the adverse impacts of fare increases on low-income persons; improved transit cost information on which to base fare policy; improved fare collection methods to permit more complex fare structures; and improved procedures for fare policy formulation and analysis.

All of this is pretty much stuff that we could (and probably will) say again this week.

U.S. Transit Industry Since 1980

Table 1 summarizes key financial and productivity statistics for the U.S. national transit industry in 1970, 1980, and 1991, the latest year for which (preliminary) data have been published. Comparisons between 1980 and 1991 are muddied by major changes in statistical practices in 1984, when (among other things) data for commuter rail, urban ferryboats, and rural and small urban systems were added into the national totals. For this reason, separate growth rates are shown in the table for the pre- and post-1984 data.

The table shows that the level of transit service provided since 1980, measured in vehicle miles, has increased substantially. In the 1970s operating costs (in real terms) had increased almost five times as rapidly as output, but in the latter half of the 1980s the transit agencies proved to be better able to control the costs. Unfortunately, however, despite the expansion in service the total ridership appears to have declined slowly, and as a result, the mean operating cost per unlinked trip (in constant dollars) has trended upwards (see Figure 1).

The mean passenger revenue per unlinked trip has stayed relatively constant in real terms since at least 1984, at about 65 to 70 cents in 1991 prices. The ratio between passenger revenues and operating costs—frequently referred to as the "farebox recovery ratio"—has as a result continued to trend downwards, to about 31 percent by 1991 (see Figure 2). The average transit ride in 1991 cost $2.27 in operating costs, disregarding all of the capital costs, and the rider paid a fare averaging 70 cents, about 5 percent cheaper in real terms than in 1970 but perhaps as much as 40 percent more expensive in real terms than in 1980.

Of course, there's a great deal more to be said about transit policy in the 1980s than just these sterile statistics show. The federal government placed a strong emphasis throughout the decade on *private sector participation*, both in service provision and in funding. As we know, this didn't mean that formerly public agencies were sold off and turned overnight into private companies, *à la* Thatcher. Rather, the public agencies typically began to seek private providers for portions of their operations. In 1980, the so-called "purchased transportation" category in the national transit statistics was probably something less than $100 million in value, or less than 1½ percent of the industry's total operating costs. (In fact, "purchased transportation" was separately identified in the accounts only from 1984 onwards. In 1984, roughly $450 million was spent on purchased transportation). By 1991, the value had grown to almost $1.7 billion, or nearly 10 percent of the total operating costs.

Another major theme in the 1980s was the growth of interest in *"demand management"* policies in the face of rapidly increasing traffic congestion in some cities, particularly the largest sunbelt cities. The most innovative programs and public regulations—spurred by the mandates of the Clean Air Act amendments and the need for cities to come into compliance regarding air quality—began to look to medium- and large-sized companies to cajole or coerce their employees to abandon commuting in single-occupant vehicles (SOVs). This seems an eminently sensible idea, although objective evidence of its efficacy and relative cost-effectiveness is still rather sketchy and anecdotal. Such approaches have recently been given national impetus as a required response to air quality problems in "non-attainment areas."

Because carpooling is a closer substitute to SOV commuting than are typical transit services (despite the schedule inflexibility that is a big deterrent to pooling), there's little evidence that transit generically is a major beneficiary of employer-based trip reduction programs. As we think of transit pricing issues, it's worth noting that a two- or three-person carpool may well be cheaper per capita than taking the bus or subway, depending critically on the parking cost (if any) at the destination. The employer is often as much in a position to affect the end price of various mode choices as is the transit operator. Subsidization of transit passes may appear to be a relatively easy response (administratively speaking) to the employer's new responsibilities. However, trip reduction programs often place the burden of efficacy on the employer, and subsidizing transit won't be seen as an easy option for long if few people opt to use the transit services. Cheaper fares alone are likely to be an inadequate lure if the transit services fail to meet minimum acceptable travel time requirements for the complete, door-to-door commute.

A third major theme comes to my mind when I think about transit in the mid-1980s: the phrase *"customer driven,"* which came into vogue following the popular success of Tom Peters' *In Search of Excellence* and other similar books. It appeared to become obligatory for transit systems to testify to their customer-drivenness, but often the rhetoric seemed a little in advance of practice and it was difficult to see what change the adoption of this gospel made in the lives of the man or woman on the bus. Nevertheless, I think that all of the talk about customer-driven values did get transit systems thinking about *market segmentation*, among other things, and this has had some spillover into fare policy in the form of a greater interest in fare differentiation, both as a marketing device and a revenue-increasing device. I'll come back to this point later.

TABLE 1 Summary Statistics for U.S. National Transit Industry, 1970 to 1991

				Average annual rate of change		
	1970	1980	1991[1]	1970 to 1980	1980 to 1983 [2]	1984 [2] to 1991
Supply and costs						
Vehicle miles operated (billions)	1.88	2.09	3.35	1.1%	0.4%	2.9%
Total operating costs including taxes and depreciation[3] (billions of 1991 dollars)	$6.57	$10.83	$19.62	5.1%	2.4%	2.4%
Average cost per vehicle mile (in 1991 dollars)	$3.49	$5.18	$5.86	4.0%	2.0%	-0.5%
Average annual payroll costs per full-time employee (thousands of 1991 dollars)	$30.39	$28.31	$26.58	-0.7% [4]	-1.8%	-0.1%
Demand and financial results						
Unlinked trips carried (billions)	7.33	8.22	8.64	1.1% [4]	-1.4%	-0.3%
Passenger revenues (billions of 1991 dollars)	$5.40	$4.13	$6.06	-2.6%	0.8%	0.9%
Average fare per unlinked trip (in 1991 dollars)	$0.74	$0.50	$0.70	-3.8%	2.2%	1.2%
Net operating deficits (billions of 1991 dollars)	$0.95	$6.30	$12.60	20.8%	3.4%	3.5%
Average net deficit per unlinked trip						
— in 1991 dollars	$0.13	$0.77	$1.46	19.5% [4]	4.8%	3.8%
— in current year dollars	$0.04	$0.48	$1.46	28.3% [4]	11.8%	7.6%
Passenger revenue per dollar of operating cost	82.1%	38.1%	30.9%	-7.4%	-1.6%	-1.5%
Productivity measures						
Vehicle miles operated (thousands) per full-time employee	13.6	11.2	11.9	-2.0% [4]	-1.0%	1.9%
Unlinked trips per vehicle mile	3.89	3.93	2.58	0.1% [4]	-1.7%	-3.1%
Unlinked trips (thousands) per full-time employee	53.1	44.0	30.7	-1.9% [4]	-2.7%	-1.3%
Passenger revenue (in 1991 dollars) per vehicle mile	$2.87	$1.97	$1.81	-3.7%	0.4%	-1.9%
Passenger revenue (thousands of 1991 dollars) per full-time employee	$39.10	$22.06	$21.52	-5.6% [4]	-0.6%	-0.1%

Notes: [1] The 1991 figures are APTA's preliminary estimates.

[2] Before 1984, the data exclude commuter railroad, cable car, inclined plane, automated guideway, urban ferryboat, and rural and small urban systems. The pre- and post-1984 series are not strictly comparable.

[3] The depreciation included here is calculated solely for accounting purposes, and is not an adequate representation of the annualized capital consumption by the industry.

[4] Interim changes in definitions or statistical method make these rates suspect. The changes make the rates of increase in both employees and unlinked trips appear larger than they probably were.

Source: Derived from *(3)*.

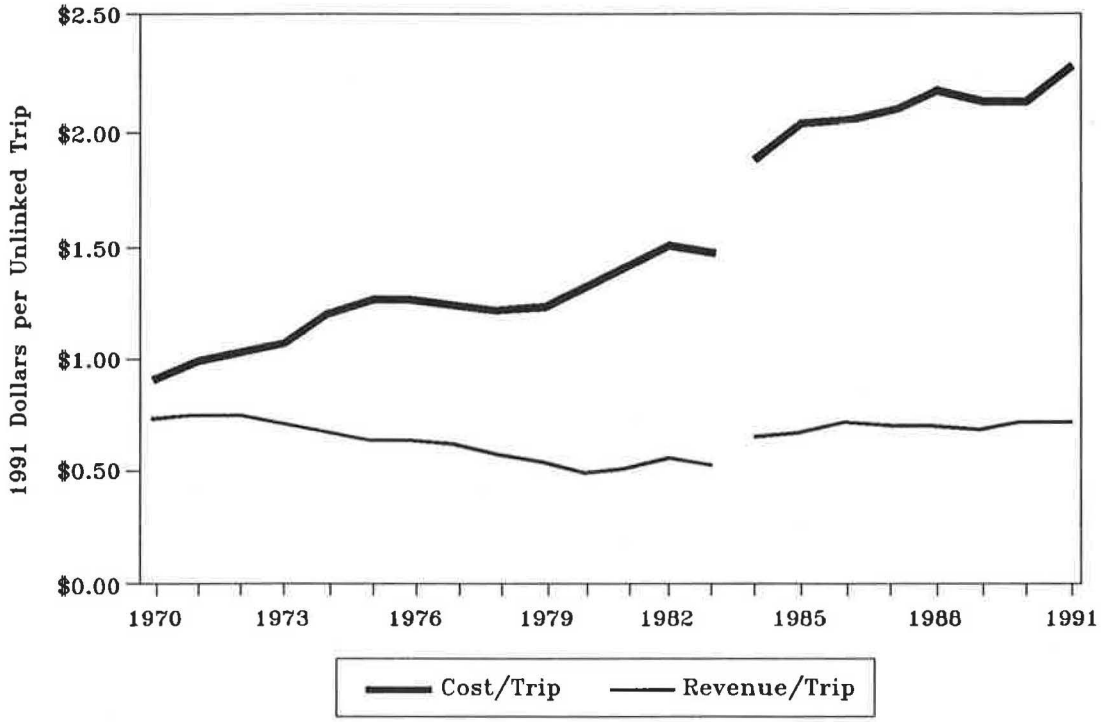

FIGURE 1 Cost and revenue per trip.

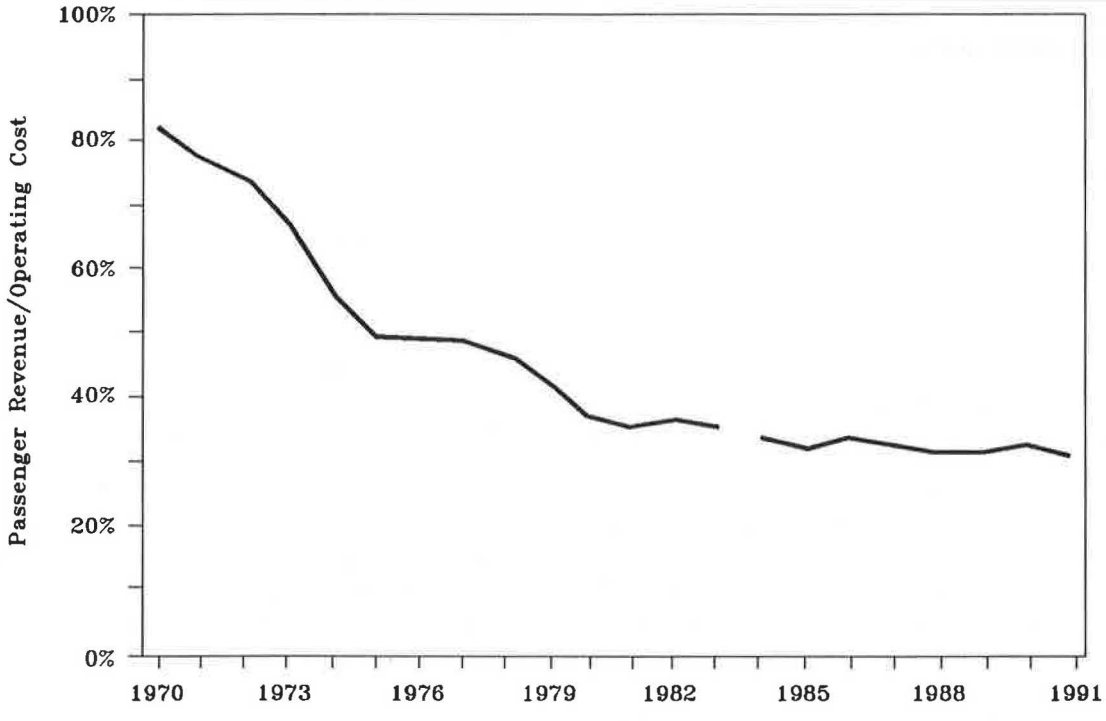

FIGURE 2 Farebox recovery ratio.

Returning more closely to recent trends in fare policy, I should note that since the mid-1970s the American Public Transit Association has been monitoring fares for fixed-route services by using a sample of about 300 transit systems drawn from the information compiled in its (now) annual *Transit Fare Summary* report *(4)*. Figure 3 shows the range of base adult cash fares reported by systems for each year since 1977, with the horizontal mark in each year indicating the mean such fare (per transit system, not per passenger). Figure 4 shows trends in the proportions of systems reporting zone-based fares, transfer charges, and peak-period surcharges, aspects to which I will return later in the paper. I suspect that some of the apparent volatility in these statistics from year to year is the result of data gaps and changes in the composition of the sample.

The 1993 APTA fare summary report includes a much more copious set of summary tables than hitherto. They describe the frequency distributions of fare levels and fare structure features, and this summary provides a convenient picture of what transit systems are currently doing. In the following sections, I will address in turn a range of fare policy issues, and draw liberally on the APTA data to indicate the current situation.

Fare Levels

As we have seen, the boards of transit agencies did a much better job in the 1980s than they had in the 1970s in increasing fares to match the general inflation, but they still didn't keep pace with transit operating costs. The primary influencing factor here presumably was the cutback in federal operating assistance: between 1980 and 1991 that declined by 46 percent in real terms. In response, the states and localities increased their assistance markedly (by 110 percent in real terms over those 11 years), and as a result the farebox recovery ratio could continue to decline slightly from year to year despite the federal cutbacks.

So while the 1970s' rapid fall in reliance on farebox revenue has been halted, we haven't seen anything remotely fitting the 1980 conference's prescription of ". . . a shift towards cost-based pricing, which would mean substantial fare increases for most transit services." What *is* this obviously very strong attraction of low fares? It's pretty much the same now as it was in 1980, 1975, or 1970, I would contend. It's an amalgam of three important considerations:

- The general nervousness of elected officials of being associated with very visible price increases;
- Social welfare concerns about the effect of fare increases on low-income segments of the population, linked with a strong reluctance to try user-side subsidy mechanisms to address that problem; and
- The fear of losing passengers to lower occupancy vehicles more rapidly than at the moment.

Transportation policy analysts have been commenting on these concerns for a long time, for at least the last 30 years. We have said that low fares for *everyone* is a very inefficient way of ensuring mobility for the less well-to-do, and that it should be a relatively easy matter to target the subsidies so as to separate the efficiency and social welfare objectives of transit pricing. We have pointed out that, notwithstanding the underpricing of congested road space and the unequal tax treatment of transit and private vehicle commuting costs, the cross-elasticity of auto use with respect to transit fares is very low in most situations. We have said that ridership defections to private vehicles are much more likely to be linked to dissatisfactions with *service* levels than with *fare* levels. The transportation system efficiency argument for low fares is a very shaky one.

Well, somehow we must have been saying these things in the wrong places, or to the wrong people, or perhaps more likely, in the wrong language. Transit managers and board members have been notably underwhelmed by the idea of user-ride subsidies, and perhaps at this meeting we should spend some time asking ourselves why. My guess is that transit professionals may feel that to establish more formal links with the human service networks regarding the *mainstream* transit services—as distinct from services to special user groups—is for various reasons an unattractive proposition. It may be seen as likely to diffuse the already diverse and often unarticulated goals of the publicly-owned transit system even more.

Returning to the subject of general fare levels, I note from the 1993 APTA fare summary that:

- About 31 percent of systems now have base adult cash fares that are at or above the dreaded $1 "barrier" level. Over 36 percent of the reporting systems have a base fare in the 75 to 95 cents range.
- Of 282 systems, only one had reduced its base fare between 1991 and 1993; 65 (23 percent) had made increases over those two years, but 216 (77 percent) had not had increases. Fare increases were more common for heavy or light rail services than for bus services (see Table 2).

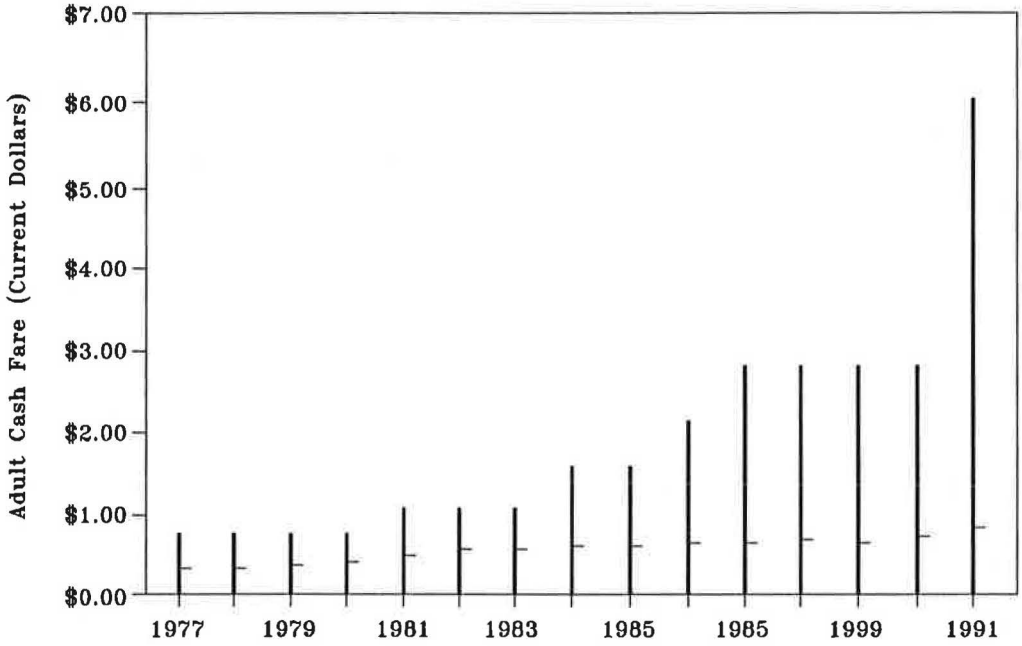

FIGURE 3 Adult cash fares.

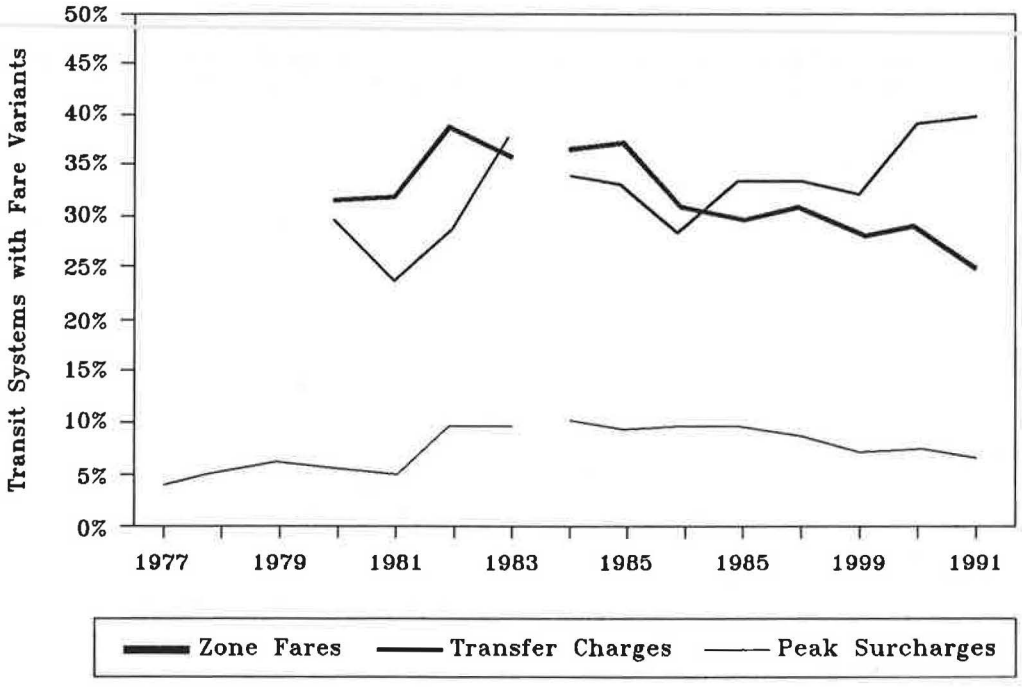

FIGURE 4 Fare structure features.

TABLE 2 Base Adult Cash Fare Levels in 1993

	Median Fare ($)	Mean Fare ($)	Fare Increases, 1991–1993 (%)	
			Reporting	Change in Mean Fare
Motor bus	0.75	0.79	23	3.9
Heavy rail	1.25	1.15	42	6.5
Light rail	1.00	1.07	43	8.1
Commuter rail	2.00	2.48	20	8.3
All transit services	0.75	0.86	23	4.9

Source: *(4)*

Fare Increase Policies

About 94 percent of systems appear to have no formal policy as to when or how frequently fares should be raised; they adjust the fare levels "as necessary." Almost 5 percent of systems do have a formally specified frequency for fare adjustments, be it annually (just less than 2 percent), biannually, or less often. For only about 1 percent are fare increases triggered automatically by some indicator of the system's financial performance.

Although an indicator like the farebox recovery ratio will not automatically trigger increases for most systems, a much larger proportion of operators do have to meet recovery ratio targets for each year, specified either by the agency's board or by the sponsoring governments. About one quarter of the systems have a mandated minimum recovery ratio, and another 11 percent have a specific goal to aim for. Most frequently, it is the state governments that set these thresholds or goals.

I have sometimes been asked whether relatively frequent (say annual) fare increases are "better" than the more customary spasmodic adjustments. The questioner is usually interested in the comparative *revenue* impacts of the two policies, to which I have to answer, "I don't really know, but I suspect that there's not much difference from a long-term revenue point of view." The few systems that have adopted the discipline of a tight ratio recovery target and an annual fare adjustment seem to consider the benefits less in terms of financials but more in terms of system governance and local politics. To be able to point to a law or regulation, imposed possibly by a higher tier of government or by a previous generation of elected officials, can help to distance the current elected officials from the responsibility for this year's fare increase.

Bulk Purchases

Over two-thirds of all systems now have *monthly* unlimited-ride passes, according to the APTA data, and about one in ten systems has a *weekly* pass. The weekly passes are much more common for rail services than for bus services. A weekday pass and a weekend/holiday pass are each offered by about 10 percent of systems. For the median transit system, the monthly pass is priced at about 35 adult cash one-way fares, and the weekly pass at about 10.

Introducing unlimited-ride commutation tickets was pushed in the 1970s as an appropriate fare medium to use in enlisting the employer's help in distributing tickets . . . and perhaps in subsidizing them, too. But except in the relatively rare circumstances conducive to modal shifts, the economics of commutation tickets are not generally good for the transit operator. The introduction of unlimited-ride passes is likely to produce a drop in revenues in most cases *(6)*.

Multiride tickets, good for a specified number of trips, are also used by about two-thirds of all systems. The most popular version is the 10-trip ticket, used by about 40 percent of operators, and the 20-trip ticket, sold by one in six operators. The median savings from purchasing these instruments is around 10 percent.

There is another form of bulk purchase discount—that offered to ticket "wholesalers" to enlarge the range of distribution channels for payment media. These might include large employers, or retail or service establishments. APTA reports that in 1991 over half of the transit agencies sold tickets through retail outlets of some form, but the data do not show what commission arrangements were necessary to encourage such third-party sales.

Fare Differentiation

Differentiating fares between passengers on the basis of their trip characteristics (such as trip length or time of traveling) can be considerably more attractive financially to the transit system than offering bulk discounts. Fare differentiation in various forms—cost-based pricing, service-based pricing, and so on—was much on our minds in 1980 because Bob Cervero and Marty Wachs were here to report on their recently completed research that showed the inefficiency of flat fares in the context of some specific city case studies *(5)*. The economic theory is basically simple: if the fare elasticities and the costs of service provision vary significantly between different segments of the market, then it should prove possible to increase revenues without significantly reducing demand by tailoring fares to the different segments of the market, *if feasible and enforceable ways can be found to do that.* The last proviso is important, because the implementation logistics can significantly constrain what it makes sense to do. The airlines have been very successful with fare differentiation in recent years (for example, in charging low elasticity business travelers higher fares than the people making more price-sensitive discretionary trips), but much of what is feasible in the airline context has no immediate analog in the transit setting.

When I joined CRA in 1984, I inherited a project that was exploring the conditions under which transit fare differentiation (particularly distance-based fares) is likely to have the most favorable financial outcomes. We did this by theoretical analysis and simulation of the situation in some hypothetical, oversimplified contexts. We showed (unsurprisingly) that fare differentiation can indeed make a lot of sense if the relevant fare elasticities and costs are sufficiently diverse, but we also drew some other general conclusions *(7)*:

- Most of the gains came in the *initial* attempt to differentiate fares (for example, in moving from one fare zone to two). Diminishing financial returns can set in rapidly as the number of fare levels is increased (not counting the administrative cost and potential demand-side impacts of having a more complex fare structure). Using eight fare zones on a long route won't achieve much more than using three or four.
- The achievable net gains may be modest. This means that the improvement in (say) user benefits or subsidy reduction need to be compared carefully with the additional continuing administration costs.
- The potential gains from fare differentiation grow larger as
  - The farebox recovery ratio increases;
  - The fare sensitivity increases for the riders in the fare classes that are most costly to serve (note that often the more-costly-to-serve people, in particular the peak-period travelers, are *less* price-sensitive than other riders);
  - The disparity increases in the marginal costs of serving the different fare classes; and
  - The more costly-to-serve fare class constitutes between one third and one half of the total ridership at the flat fare.
- At low operating ratios, the scope for making gains is quite small.
- Minimizing subsidy while holding ridership steady is not a sensible objective. When total ridership is held constant, financial gains to the transit system can only be achieved at the expense of leaving the users (as a whole) substantially less well-off than with flat fares. If the concern is to minimize harmful effects on the existing ridership base, then a preferable objective would be to hold total *user benefits* constant instead of ridership.
- Setting fares to the nearest nickel can have potentially large effects. When one computes the fares that will theoretically produce the largest gains, and then rounds them each to the nearest nickel, the net economic gains to society don't change much from the "optimum" situation. However, how those gains are distributed between the passengers and the subsidizer may change quite markedly. This is obviously important if a major objective is to reduce the subsidy.

The year-to-year volatility in the APTA data on distance-based fares (see Figure 4) makes it difficult to detect any consistent trend. The data for time-of-day pricing (typically peak period surcharges) show greater regularity, however. If we can believe the figures, they suggest that peak surcharges were most popular in the mid-1980s—at the time of UMTA's comprehensive report on the practice *(8)*—and they have declined steadily since then. I've heard of a number of properties that have ceased using peak surcharges, so APTA's picture may be correct. Perhaps we can discuss the reality of, and possible reasons for, this decline in our sessions this week.

Another form of fare differentiation—by trip frequency—arises in the concept of so-called "deep discount" fares *(9)*. Essentially, this uses fare increase situations to increase the level of price differentiation between the media used by frequent travelers (or heavy prepayers) and those used by the infrequent casual riders.

So, for example, the price of monthly passes might remain unchanged as the price of one-way tickets rises. Under favorable conditions, it may be possible for a property to undergo at least one fare restructuring in which revenues are increased with little if any loss in ridership. Chicago *(10)*, Denver, Madison, and other cities purportedly have experienced this magic. Doubtless more will follow. I've yet to see a good comprehensive synthesis of the experience, however, or a strong analysis of the "optimum" level of frequency-based fare differentiation to achieve various desired goals.

Fare Collection Technology

I stressed earlier that logistical feasibility was a *sine qua non* for the worthwhileness of pursuing fare differentiation policies. We've been hampered often by limitations in our fare collection technologies, and slow to grasp and take full advantage of the technology-related advances that have been made since 1970.

But at the moment we're in one of those cycles in transportation where we go on a "technological high." It's not so much the people-moving technology we're entranced by this time—we did that one 25 years ago—it's more the information and microprocessor technology. "Intelligent Vehicle/Highway Systems" are to be our savior now, and indeed—lest you should think my flippant tone too cynical—as a long-time believer in the thesis that many of our *transportation* problems are really *information* and *communications* problems, I do believe strongly that we can make significant improvements in transportation by using smarter systems.

In the fare collection field, our own particular technological *wunderkind* is to be the "smart card," if a few remaining issues of performance and cost can be worked out (as I fully expect them to be). This has the potential to bill or decrement for system usage that could take account of a wide range of travel characteristics, so effectively it may remove the logistical barriers to many different forms of price differentiation.

I think it's a useful exercise to list the ways in which one might conceivably wish to differentiate fares if given half a chance to do so, and the following list provides a start. Any or all of these things could be on our transit fare policy horizon, given the expected favorable technological developments.

Differentiation by type of *traveler*

- Demographic and socioeconomic aspects (e.g., age, financial capacity)
- Affiliation (e.g., transit employee, school, university, employer, social service agency)
- Mobility impairment
- Frequency of use
- Payment method (e.g., standing order, direct debit, credit card)
- Time commitment of purchase (e.g., annual pass, monthly pass)

Differentiation by type of *trip*

- Specific origin or destination points
- Transit trip length
- Transit trip duration
- Quality of service (e.g., speeds, level of crowding) by corridor or line
- Quality or price of competing services (highway congestion, highway/bridge tolls, etc.)
- Timing of trip (peak/offpeak, day of week)
- Routing of trip
- Direction of trip
- Use of complementary modes (e.g., feeder buses to rail)
- Size of travel party

Differentiation for *other reasons*

- Market building fare reductions
- Sales commissions for fare media distribution channels
- Joint promotion with other businesses or uses for the payment media
- "Two-part" fare structures (a time-based subscription and a use-based charge)

But every time I begin to get overly excited about any technological advance, I have to remember how easy it is to get so wrapped up in technological fervor that we neglect to consider the mundane behavioral, economic, or political aspects of the situation. For successful progress, we need the confluence of all of these considerations, not just the technological part. I have to remind myself that while "smart cards" may facilitate all sorts of smart fares, many feasible fare innovations haven't been entirely constrained in the past by the available fare collection technology. For example, while flat fares have been the norm in the United States, British public transport operators have a long tradition of distance-based fares using fairly rudimentary machinery and ticketing systems, while those in continental Europe have a tradition of time-based fares. These methods of charging predate technologically sophisticated methods of fare collection.

In considering the pros and cons of the various possible types of fare differentiation listed previously, attention will shift from the technical constraints to the *political* constraints. The fare differentiation schemes that are financially advantageous to the transit agency and newly feasible with smart card technology will have to pass a *fairness* test to be acceptable to the traveling public. We will need to be able to explain, cogently and convincingly,

to the crowded, strap-hanging peak period subway rider in New York (for example) why it is "fair" to charge him more for his trip than we charge people traveling in more spacious conditions in the offpeak. And our explanation obviously cannot just be, "You're less likely to defect!"

I expect we'll be talking a lot about technology this week, since it's the way in which things have changed the most since 1980. I hope that as we do so we will be keeping clearly in front of us the political and financial forces that surround transit managers and board members.

Fare Integration, Coordination, and the Like

Today's fare collection technology, never mind tomorrow's, is creating opportunities for much greater integration and coordination of fares between operators and systems, consistent with some political forces that have encouraged greater coordination generally among regional providers. I expect we'll be hearing a lot about the progress toward fare coordination in the Bay Area and elsewhere.

Again, this is an area where I feel our enthusiasm for what we are *able* to do should be tempered with some serious assessment of whether it's worth doing. Sir Alan Walters once remarked that the only sensible meaning he can place on the terms "integration" and "coordination" is that which simulates private enterprise market solutions *(11)*. I think there's some truth there. Before we put a lot of effort into fare integration everywhere, let's at least make sure that that feature has some real value to significant numbers of users or potential users.

Fare Policy Climate in 1993

Skeptical as I may appear to be about some of the specific developments, I do want to end on a genuinely positive note. I believe that the fare policy climate *has* changed for the better since 1980, from a combination of many of the reasons and trends I have noted:

- The emphasis on being "consumer-driven," on "Total Quality Management," has helped sensitize transit officials at a minimum to the possibility of market segmentation, to the possible returns to marketing activities, and ultimately to the possible advantages of fare differentiation policies.
- The emphasis on the employer as a potentially powerful shaper of commutation patterns stresses to transit that there is still a lot of potentially fertile ground to be covered in terms of distributing fare media through employers, notwithstanding transit's justifiable chagrin about unequal tax treatment.
- The mounting enthusiasm for smart card technology in fare collection applications, which could facilitate forms of fare differentiation that in the past have been logistically cumbersome.

So today far more transit officials are asking sensible questions about fares. As they begin to consider the possibilities, they are demanding a lot of those of us who are in the analysis business; they often don't understand the complexity of what they ask. "What do you mean, you can't forecast reliably the effects of introducing a new 10-trip peak ticket for students if we also introduce a weekly offpeak pass at the same time?" But that's another paper.

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Evolving Fare Technologies

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Introduction

The scope of fare technologies available in today's market is much broader than just a few years ago. In addition, the pace of deployment of new technologies has accelerated considerably. As a result, transit agencies are faced with many confusing choices when contemplating a new fare system. The wrong choice could leave the agency with equipment that becomes obsolete in only a few years or that is costly to maintain and operate. The focus of this paper is to examine evolving fare technologies and to begin the thought process that will lead to strategies for implementation of new fare equipment.

System Definitions

Fare collection systems for public transportation take on many faces depending on the mode of operation, size of system, and fare policy in place. They all reflect the same basic objectives, however:

- Collect fares in the most economic manner,
- Provide a user friendly environment,
- Provide an audit trail for verification of fares collected versus patrons carried, and
- Encourage fare payment and discourage evasion.

Attempting to meet these objectives results in various system configurations which are usually driven by the mode of transportation. For example rapid transit systems in the U.S. are most often gated and recent light rail systems usually use proof of purchase techniques. Bus systems typically utilize fareboxes with payment upon entry and the older commuter rail systems use conductors to validate tickets on-board. For the purposes of this paper, four basic systems are defined in Table 1.

There are many combinations and permutations of these basic systems. Any system can be integrated into one common system with one fare media and a central computer. The common piece of equipment for each system is the central computer. More often than not the central computer is only adaptable to the one mode through limitations on hardware or software. Most of the remaining equipment is unique to the specific mode of operation.

Equipment Definitions

To meet the needs of the various system configurations, manufacturers have responded over the years with the development of a complete range of fare equipment. Each piece of equipment is specifically designed to efficiently serve the fare policy in place.

The types of equipment given in Table 1 are described next.

Ticket Vending Machines

Ticket Vending Machines (TVMs) offer self-service ticket sales for flat-fare and distance based transit systems. Simple TVMs accept either coins or tokens, and issue a single ticket for a predetermined fare category. Full-feature TVMs dispense a variety of tickets, accept banknotes, coins, credit cards, debit cards, and make change; in addition, some provide automated fare and route information through various user displays. Full-feature TVMs also offer data processing and communication capabilities which provide a data link to a central computer network for automated data collection, maintenance, and equipment support.

Fare Gates

Fare gates provide the entrance and exit control required for the implementation of a closed fare collection system. Fare gate equipment includes the barrier device, coin and token acceptors, and/or magnetic ticket readers. Future gates will undoubtedly include smart card readers by proximity or by insertion.

Validators

Paper ticket validators are used primarily to validate pre-purchased tickets. As passengers enter the system, the validator prints the time of day, date, route, and zone information on the ticket. The validated ticket is then used as proof of payment for fare inspectors.

For bus applications, validation equipment is often of the magnetic type. These validators accept tickets and transfers and read and write magnetic information as required. Reciprocating readers and magnetic

TABLE 1 Basic Fare Systems

System Name	Most Common Fare Media	Modes Served in North America	Equipment Required	Other Possible Equipment
Proof of Purchase	Paper Ticket	Light Rail Comuter Rail Rapid Transit	Ticket Vendor	Ticket Office Machine Validator Central Computer
Payment on Entry (farebox)	Bills and Coins Tokens	Bus Light Rail	Farebox	Central Computer Transfer Issuer Validator
Conductor Validated	Paper Tickets	Commuter Rail	Ticket Office Machine	Ticket Vendor Central Computer Hand-Held Devices
Barrier	Magnetic Ticket	Rapid Transit Light Rail	Ticket Vendor Gates	Addfare Machine Central Computer

swipe-through readers are two types of magnetic ticket readers commonly used. Many of these validators also offer printing on the tickets. Smart card bus validators are also available. These validators perform the same functions as the magnetic type but printing on the fare media is not accomplished.

Fareboxes

Fareboxes provide a means for depositing fares on buses and sometimes light rail. Electronic fareboxes can be equipped with both coin and bill acceptors, visual displays that show the amount paid, and other data collection features.

For electronic registering fareboxes, ridership and accounting data is usually polled from a farebox at the time of vault exchange. The ridership information can then be transferred via modem to a central computer where statistical reports are tabulated.

Hand-Held Devices

Hand-held and portable fare collection devices are now being used by transit properties for ticket sales and validation. Hand-held validators are used by roving fare inspectors to time stamp single and multi-ride tickets. These battery powered devices are compact, lightweight, and weather protected.

Ticket Office Machines

Ticket office machines provide a fully automated ticket dispensing system. Office ticketing is performed by designated ticket agents, who use the office equipment to encode either paper or magnetic fare tickets with the appropriate information for a passenger's destination. Office ticketing machines offer data collection and communications capabilities, providing complete accountability for all transactions. Printed reports are available in addition to digitized data, which can be communicated to a central computer.

Central Computer

A central computer is defined here as a computer that collects data from more than one piece of fare equipment and provides informational reports as required. The collection of data can be accomplished through the use of dial-up or dedicated telephone lines and hard wire or radio transmission. A central computer can act as host computer for credit/debit card transactions by directing a request to the appropriate clearing institution for credit authority. Central computers are also used to capture transactional data for multi-agency fare integration. This data is used to apportion funds to each agency based on actual usage of multi-agency stored value fare media.

Addfare Machines

Addfare machines are generally used only in barrier systems with distance based fares. These machines allow a patron to add value to a ticket in order to make it good for exit. Some systems provide for a last ride bonus which eliminates the need for addfare machines.

Fare Media Definitions

In general terms, fare media is any instrument that is rendered or held as proof of purchase for a ride on a transit system. Fare media can be pre-purchased or cash can be used as fare media. The most common forms of fare media are next.

Cash

Coin and paper currency are the simplest of fare media. Most TVMs and fareboxes are equipped to accept all types of coins and the lower denomination bills.

Tokens

Tokens are pre-purchased and are unique to each transit system. They are usually used in systems with flat fares, but tokens can also be used in a zone system as the base fare.

Paper Tickets

Paper tickets are pre-purchased at TVMs or ticket offices and provide the passenger with the right of passage. Many transit properties offer books or blocks of single ride paper tickets, at discount prices.

Multiple ride paper tickets are also available at many transit properties and provide passage on the system for a number of trips. These tickets are validated by various means for each usage.

Magnetic Tickets

Magnetic tickets are a form of fare media which includes magnetically encoded information. This information can be read and rewritten allowing this fare media to store value for a specific number of trips. Monthly passes are often magnetically encoded tickets.

Smart Cards

Smart cards include an electrical circuit embedded into a card which is usually the size of a credit card. These circuits vary from strictly memory type to full microprocessor type with all inherent capabilities. Unlike magnetic cards, their memory is not limited and security is enhanced by the abilities of the microprocessor. In past applications the card was brought into electrical contact to be read and rewritten. For newer applications the smart card is brought into close proximity to the reader and data is transferred without electrical contact.

Debit Cards

Although not normally thought of as fare media, bank debit cards could someday become the common fare media that can be used on any system. Debit cards of the future will likely contain an electronic chip (smart card) with the capability of becoming an electronic purse for cashless payment in many places including transit.

Historical Perspective

In order to speak fully to the technological developments in the area of transit fare collection, it is useful to examine the history of fare collection over the past century.

The implementation of public transit began in the 1830s with the introduction of horse drawn wagons. The passengers entered the wagon from the rear and a leather trough was placed in the center of the wagon into which the passengers were to insert their coins for the ride. The trough enabled the collection of fares without the driver having to leave his seat. Oftentimes the number of coins inserted did not match the number of riders on the wagon. As a result, the wagons were redesigned to require the passengers to enter the wagon from the front and give the driver the coins directly.

In the 1880s several events occurred which changed the face of fare collection from its simple beginnings. Up until that time if more than one vehicle was required to travel to a destination, the passenger paid a separate fare for each vehicle. The first big change involved enterprising investors who bought up not only north-south routes but also east west routes and connected them with the "transfer." The use of public transportation increased overnight as it became more economical to ride.

The invention of the cable car and the electric traction motor did away with the horse and provided increased speed, hill climbing ability, and the new cars were able to haul many more passengers than a simple wagon. This in turn required the owners of these cars to hire people to operate the cars and to collect the fares. This gave rise to the invention of the fare box and the fare register.

Early fare collection was of two basic types. In both cases the operators made change for the passengers. First was the registering farebox, where the coin fares were inserted into a "meter" which counted the coins and gave them back to the driver to use to make change. At the end of the day, the operator removed the meter from the car and settled with the company by paying the amounts required by the meter.

The second type of fare collection involved the use of a conductor. In this arrangement, the passenger gave the conductor the fare and the conductor reached up to pull a

cord. This cord rang a bell and recorded the fare on a mechanical meter: one fare, one ding. At the end of the day, the conductor would have to hand over money equaling the number of fares registered.

In the early part of the 20th century, the use of trolley cars was complemented by interurban railways. The interurbans and commuter trains relied mostly on tickets rather than onboard cash fares. Tickets were sold at stations and canceled by conductors on the train. This system accommodated distance based fares.

The early subway systems used tickets initially. Turnstiles were introduced fairly quickly, however, which were mostly mechanical and were able to accept and process only a single coin. Initially fares were a nickel. When the fares increased, the coin became a "token" and was sold for whatever the current fare was. Mechanical turnstiles were developed in the 1920s and are still in use today in such cities as New York and Boston.

The motorbus did not make its appearance until the early 1900s. With the depression of the 1930s, many trolley companies were bought up by companies controlled by General Motors, Esso Oil, and Firestone, with the intent of converting them to gasoline operated buses. The same fareboxes used on trolleys were fitted to motorbuses.

Introduction of New Technologies

Between the years of 1965 and 1970 several events occurred which again changed the course of fare collection. Crime, which until that time was not an issue on buses, began to be a problem relative to drivers having access to money to make change. This led to the almost universal conversion to "exact fare" and the emergence of the locked cashbox. The driver of the bus no longer had access to the money to make change and the passengers were required to have the correct change upon boarding.

Through the 1960s, the bus operator was required to determine if the correct fare had been paid. The driver had to visually inspect and mentally count the inserted fares to do this. In the early 1970s, Duncan Industries introduced the first electronic registering farebox. It was different in two respects; it counted the coins before the coins landed on the inspection plate and it had a dollar bill transport to permit paper money to be inserted and registered. These first electronic fareboxes had mechanical meters which had to be recorded manually.

In 1965 the success of early experiments using magnetically encoded information led the planners of the Bay Area Rapid Transit (BART) to decide to incorporate magnetically encoded tickets in their system to permit graduated fares instead of the conventional coin turnstile. Thus, BART developed all of the required elements for a modern fare collection system, including the tickets, the vending machines, the gates, and the exclusive use of tickets instead of cash.

BART opened in 1972. It was followed by the Washington Metro, which used a similar system, in 1975. Both systems use the same type of magnetic tickets and "bi-parting" faregates.

The next advancement was due to the advent of the microprocessor in the 1970s. This gave the equipment not only processing power, but also the electronic memory, which made mechanical registers obsolete and permitted data transmission to a centralized location by use of dedicated wires or phone lines.

Problems Encountered

The application of new technologies over the years has not been without its own set of problems. Some of these problems are described next.

Fraud

Internal fraud has been and remains the number one problem. In the early days, drivers used a number of ingenious methods for preventing the meter wheels from turning to register the fares. With the use of "locked boxes," openings were used to introduce wires and rods to "fish" out the inserted money.

The marriage of the mechanical registering meters to the locked box was not successful at deterring theft due to the large volume of coins inserted. The meters often became jammed due to the coin overflow resulting from the low coin capacity of the cash box.

As fares increased, the number of coins on the inspection plate also increased. With the "locked box" the driver was no longer responsible for the proceeds, so they stopped trying to count the inserted coins. With one coin on top of another it was difficult to determine if the correct fare had been paid, especially when passengers purposely inserted small denomination coins to pay the fare.

Paper Money

When the fares approached 85 cents, the flood of dollar bills also jammed the fareboxes. The meters could not count bills and the locked boxes required the bills to be folded so small that in many instances only one half a bill was inserted. The increased use of dollar bills also was the beginning of the end for the vacuum extraction system. In its height, it was used in Boston, New York, Kansas City, Sacramento, Long Beach, Atlanta, Orange County, Santa Monica, San Francisco, and many other cities. Today only Boston and New York retain the

vacuum system—and they do not accept paper money even though their fares are over one dollar.

Increased fares also posed a problem for the mechanical turnstiles. While the sale of tokens continued, transit properties wanted electronic validation of coins and tokens instead of simple mechanical sensing. Counterfeits were eating into revenues in major subway systems and there were few real methods of determining genuine from bogus tokens without electronic detection. In the 1970s and 1980s, Chicago, Atlanta, Miami, and the MUNI system in San Francisco all introduced electronic coin acceptors into their turnstiles to accept coins as well as tokens.

Technical Obsolescence

One of the major problems being faced by transit agencies today is obsolescence. There are three major aspects to obsolescence. First are those items of equipment which are more than 10 years old and for which there are few, if any, spare parts. It is not economically feasible for the manufacturer to keep inventories of such parts, as model changes lead to newer and better products. As a result, prices for parts have become higher and the order time has increased for those parts that are available. The result of this trend is poorer maintenance and a rapid decline in equipment operation.

A second problem is technical obsolescence. This is where the benefits of the new equipment are such that there is significant financial return in buying the new equipment, even though the older equipment is perfectly functional. An example of this is when fareboxes are changed out for new ones with data capabilities and/or ticket processing abilities.

The third problem area involves equipment sophistication. Software, as well as hardware, is difficult to maintain due to unique designs. While the equipment of today is better in terms of quality than in past years, the unique mandated designs and modifications in terms of hardware and software, coupled with normally low production quantities of a given model for a given customer, often results in each customer getting "custom" equipment. This is to be contrasted with the "standard" equipment which was developed and sold over the years. Given the interrelationship of electronic equipment, when it works its works well and when it doesn't, the entire system is subject to failure.

Trends

Through the years various trends have taken place that have had a great impact on the current state of fare technology. The most significant of these is examined next. These are discussed to help gain insight into today's trends and potential future changes.

Proof of Payment

In the early 1970s, a bold experiment took place in Europe. This experiment involved requiring the passenger to pay the fare on or off the vehicle and obtain a printed receipt rather than having the driver of the bus or tram collect the fare. The receipt would then be shown to an inspector when requested. This was the development of the "honor system" or, more accurately, the "proof of payment" system. In Europe, where there is a strong transit infrastructure and a strong respect for authority, this concept took hold and has been extensively developed. It has been slow to come to the United States, however.

In the late 1970s and 1980s, several light rail systems were planned and implemented in the United States and Canada. Taking from the successful results in Europe, these new systems utilized the "proof of payment" system.

This was done for several reasons. First, the use of multi-car trains made on-board fare collection in the conventional manner difficult. Second, the systems did not want to have conductors collecting tickets and fares. Finally, these systems did not have "stations" in the conventional sense, so the use of controls such as turnstiles was out.

Due to the success on the initial light rail systems, the City of Portland decided to experiment with "proof of payment" on their bus system. After a trial period, this experiment was deemed to be unsuccessful. Some of the reasons attributed to this failure were a complex fare policy, free fares in the central business district, and the lack of equipment specifically suited for the job.

Ticket Vending

In order to facilitate the "proof of purchase" systems, stations were equipped with paper ticket vending and validating machines. Most of the technology, if not the machines themselves, came from Europe. The evolution of these machines has been from simple mechanical dispensing machines with mechanical validation, to full service machines, employing electronic displays, coin and bill acceptance, along with credit and bank card acceptance, for the purchase of tickets.

From a trend perspective, the machines are becoming more sophisticated in terms of their ability to interface with the passenger. In addition to simply accepting money and vending tickets, these machines now employ color

interactive touch screens along with spoken instructions—often in various selectable languages.

Less Cash to Cashless

With the increasing cost of collecting and counting money, transit agencies are promoting the use of tickets. Aside from removing the cash from the buses, this also provides the cash "up front" before the service is rendered. The advantage to the passenger is the elimination of the need to pay each time the system is used. In fact, many transit passes and multi-ride tickets can be "charged" to a bank or credit card, making the transaction even more transparent.

Accepting fare media on-board means that the bus fare collection equipment must process tickets, passes, and other media, in addition to cash. Over the past few years, many of the new fareboxes bought and installed included magnetic card readers to enable this type of fare media to be machine read.

Information

Until recently, bus fare collection equipment was intended to collect and secure collected fares and provide a very little, if any, data relating to the process. With the introduction of electronics, the aspect of data collection and reporting took off. The need and dependence on information has greatly increased recently. Whole MIS departments can now be found to collect, process, disseminate, and store information.

The employment of cheaper, faster, and more powerful computers along with associated memory devices has enabled fare collection data systems to start to evolve into transactional databases. This means information on a given transaction is saved as a separate packet of information as opposed to being merged with other data as is conventional. This also means that the rides of each passenger or card holder can be individually tracked through the system. The problems and benefits of such a system have yet to be determined. But numerous potentials exist related to marketing incentives and variable fare determinations.

Evolving Technologies

The historical perspective provided a view of how far fare technologies have come in a relatively short period of time. Through this evolutionary process, today's technologies now offer a wide array of options for all types of transit modes and allow complete system integration through computer networking when necessary. Manufacturers continue to improve their products and add new features, usually at a rate faster than the natural implementation process of most transit properties. In many cases new products have been developed in anticipation of a future need. These products are tested in the manufacturers' laboratories first and then sometimes offered free of charge to an agency for limited live testing. Each manufacturer has its own unique approach to research and development. Quite often companies are purchased in order to capture an advanced product that would lend itself to future applications in the transit world.

Provided below is a review of the product lines of the manufacturers with equipment in the North American market or those who are poised to enter the market in the near future. Table 2 lists these manufacturers and provides a quick overview of their capabilities and where their equipment has been purchased. The list is intended to provide examples of the different types of companies and products available. The list is not intended to provide any type of endorsement.

AES

Headquartered in Perth, Australia, this company is best known for its pioneering work in smart card technology and associated applications to bus validation systems. Beginning in 1986, AES has installed several systems in Australia. Their local offices are in Mississanga, Ontario where they serve their current customer GO-Transit and market their products to the rest of Canada and the U.S. For GO-Transit, AES is supplying ticket vending machines and electronic transfer machines.

The initial smart card applications developed by AES were of the contact type. However, their recent programs, including the one in Manchester, England, are of the contactless type. The Manchester program is described later in the Case-Study section.

AES has indicated an interest in entering the U.S. market but has been held back by "Buy American" regulations and the widespread use of flat fares. The principle behind their bus products is its adaptability to zone or distance based fares. As distance based fares become more popular in the United States to maximize revenue, this market may entice AES to begin proposing on new jobs.

Ascom

From their headquarters in Gumligan, Switzerland, Ascom specializes in manufacturing ticket vending machines and markets this product worldwide. They have several standard models ranging from the simplest coin only machine to a full service machine that accepts credit and

TABLE 2 Examples of Fare Equipment Suppliers

Manufacturer	North American Location	Headquarters Location	Product Line[a]	Applications[b]
AES	Mississauga, Ontario	Australia	TVMs Gates Fareboxes MVAL SCBVAL TOMs	Go Transit (Comm) Australia (Bus) Manchester (Bus) New Zealand (Bus) Norway (Bus)
Ascom	Philadelphia, Pennsylvania	Switzerland	TVMS Gates MBVAL	San Diego (LRT) NJ Transit (Comm) Los Angeles (Comm) Portland (LRT) San Jose (LRT) Philadelphia (Comm) Vancouver (LRT) Calgary (LRT) Europe (all modes) Hong Kong (LRT)
CGA	White Plains, New York	France	TVMs Gates MBVAL	Baltimore (HRT) Boston (HRT) Buffalo (LRT) Oakland (MBVAL) France (all modes) Hong Kong (HRT) Taipei (HRT)
Cubic	San Diego, California	San Diego, California	TVMs Gates Fareboxes MBVAL	BART (HRT) New York (HRT) Washington, D.C. (HRT) Chicago (Metra) Philadelphia (PATCO) London (HRT) Singapore (HRT) Hong Kong (HRT) Sydney (Comm)
Dassault	New York City	France	TVMs Gates	Los Angeles (LRT&HRT) PATH (HRT) France (all modes)
GFI-Genfare	Chicago, Illinois	Chicago, Illinois	TVMs Gates Fareboxes MBVAL	Los Angeles (LRT&HRT) PATH (HRT) Philadelphia (HRT)

(*continued on next page*)

TABLE 2 (*continued*)

Manufacturer	North American Location	Headquarters Location	Product Line[a]	Applications[b]
Sodeco	New York	Switzerland	BV	BART (HRT) PCS (Comm) LIRR (Comm) MNCR (Comm) Baltimore (LRT&HRT) Los Angeles (Comm) Switzerland (all modes) Germany (all modes)
Scheidt & Bachmann	Dallas, Texas	Germany	TVMs	LIRR (Comm) MNCR (Comm) PCS (Comm) Baltimore (LRT&HRT) St. Louis (LRT) BART (HRT) Germany (all modes)
Schlumberger	Virginia	France	TVMs	Buffalo (LRT) VRE (Comm) Memphis (LRT) Tallahassee (Bus) France (all modes)
Thorn Transit Systems	Toronto	England	TVMs TOMS Gates	Stockholm (HRT) Hong Kong (HRT) Seoul (HRT) England (all modes) Ankara (HRT)

[a]Abbreviations:
BV = Bill Validators
TVMs = Ticket Vending Machines
RFBVAL = Radio Frequency Bus Validators
TOMs = Ticket Office Machines
MBVAL = Magnetic Bus Validators
SCBVAL = Smart Card Bus Validators
LRT = Light Rail Transit
Comm = Commuter Rail
HRT = Heavy Rail Transit
PCS = Peninsula Commuter Service (San Francisco)
LIRR = Long Island Railroad
MNCR = Metro North Commuter Railroad
VRE = Virginia Railway Express

[b]Bus applications not listed for U.S. unless combined with rail integration or special demonstration program

debit cards. Through their sister company, Monetel of France, they also offer gates and a line of bus equipment. Their local subsidiary company, Ascom Automation Inc., is located in Philadelphia and markets Ascom's product throughout North America. The vast majority of their TVMs issue paper tickets. However, they have the capability to vend magnetic tickets also. For example, their vendors for British Rail issue magnetic tickets which are good for use on the London Underground.

In Biel, Switzerland, Ascom is providing equipment for a smart card demonstration program. In this project, contact type smart cards are used for purchases at retail stores, the post office, and for purchase of rides on public transportation.

Among Ascom's new products are TVMs with information centers. These TVMs are connected to computers with vast amounts of data on restaurants, shopping, sightseeing, and public transportation. Patrons would use this menu driven feature to plan a trip. After the trip is planned the necessary tickets could be purchased by credit or debit card at the same machine. This new TVM also includes voice response. Ascom has also completed research and development on a contactless smart card system for gates and bus validators. These new products are being introduced through their marketing program.

CGA

CGA, located in France, specializes in providing equipment for gated systems using magnetic tickets. Besides providing gates for the Paris Metro and TVMs for French National Railways, CGA has major installations in Taipei, Baltimore, the Lille and Lyon Metros, and the Orly-VAL line. They are represented in North America by Alta Technologies, in White Plains, New York.

CGA also has a full line of bus equipment and has participated in a smart card demonstration program in Blois, France. They are now engaged in research and development for contactless type smart card and attempting to narrow down the type of technology to be used for transfer of data.

Cubic

Cubic, which is located in San Diego, specializes in equipment for systems using magnetic tickets. Cubic also has a product line for buses including electronic registering fareboxes and magnetic validators and ticket issuers. The bus equipment is primarily marketed in North America, whereas their magnetic ticket barrier systems are sold worldwide. Recent contracts include New York City and Sydney, Australia.

As an added feature to their gated systems and for use on buses, Cubic has developed a contactless farecard known as "Go-Card." The card allows entry to a barrier system by simply touching it to a target on the gate. It can also be used for transfer to bus by touching a target on-board. Each time the card touches a target, a value is subtracted depending on the nature and distance of the trip. This system has been demonstrated on the London Underground and is about to be demonstrated at WMATA.

Dassault

From its headquarters in St. Cloud, France, this company manufacturers TVMs and gates for systems in France and has also participated with GFI on programs in Los Angeles and PATH. From their local office in New York City they market airline ticketing equipment as well as transit fare equipment.

GFI-Genfare

Located near Chicago, this company began as a farebox and coin accepting gate manufacturer and has steadily expanded its product line to include TVMs, magnetic gates, and magnetic bus validators. Their predecessor company, Duncan, developed the first electronic registering farebox sold in the United States in early 1970s. Since that time they have continually updated this product line. Today, they offer a magnetic bus validator known as the "TRIM" unit. This unit issues thermally printed paper or plastic tickets and validates tickets for transfer or full fare journeys. This system has been sold to several bus properties including Los Angeles (MTA) where it is part of an interagency demonstration program.

GFI-Genfare, through an agreement with Dassault, has sold TVMs to Los Angeles and PATH. GFI produced the cabinet and the bill unit and performed final assembly. Dassault supplied the ticket and coin systems and much of the electronics.

Sodeco

Headquartered in Geneva, Switzerland, this company specializes in manufacturing banknote acceptors. Their product includes an escrow feature for up to 15 bills and a bill vault with capacity from 1,000 to 2,000 bills. Recent models can accept bills in any orientation. Their product has become the recent standard in the European and North American market.

Scheidt & Bachmann

The headquarters and manufacturing facilities for Scheidt & Bachmann are located in Moenchengladbach, Germany. The company specializes in TVMs, but also has a line of bus equipment for the German market. They have manufactured more than 4,000 TVMs for the German market alone. Recently, Scheidt & Bachmann have won several jobs in the U.S. including projects on the Long Island Railroad, Metro North, Baltimore, St. Louis, BART, and the San Francisco Peninsula Commute Service. For the programs in the U.S., Scheidt & Bachmann is represented by Agent Systems of Dallas, Texas. In addition to providing a marketing and program management arm, Agent Systems develops software for the central computer networks provided for their U.S. contracts.

Schlumberger

Headquartered in Montrouge, France, Schlumberger has recently set up offices and manufacturing facilities in Chesapeake, Virginia. Their product line includes TVMs, magnetic and smart card bus validators, and portable inspection devices. They have equipment in Italy, Spain, France, and the U.S.

Recent contracts in the U.S. include TVMs for the Virginia Railway Express, Buffalo light rail, Tallahassee and the Memphis vintage street car line. They also demonstrated their smart card systems in Pittsburgh and Los Angeles.

Thorn Transit Systems

Located in Wells, England, Thorn Transit Systems has a full range of fare equipment, including magnetic barrier systems, TVMs, and bus validation and ticket issuing equipment. Recent contracts include systems in Stockholm, Hong Kong, Seoul, and Ankara. Although not presently active in North America, they have hired a representative to investigate the potential for this market.

Case Studies

In order to meet the objectives described in the beginning of this paper, most transit agencies wish to move in the direction of more advanced fare equipment. Although there are often several obstacles to this advancement, two major ones come to mind:

- Funding, and
- Fear of equipment not proven elsewhere first.

Funding is always an obstacle, but it can be overcome if a real need can be demonstrated. However, policy boards are not about to invest in full scale programs with technologies that are not proven. BART took a bold leap of faith when they implemented a magnetic card distance-based fare system. Many of BART's other systems also involved great leaps of faith and they paid the price initially with several serious problems. Although today BART is thought to be one of the finest systems in the world, these early problems led other agencies to be cautious when implementing new technologies.

The preferred method today is to begin a program with a small demonstration test phase before the entire system is implemented. This enables the agency to make a small initial investment and to determine if the new technology has technical or human factor faults before commitment to full scale replacement is made. Several demonstration programs, varying in size and complexity, are currently in progress. A review of those most pertinent to transit is presented next.

Los Angeles Bus Integration

The Los Angeles County Metropolitan Transportation Authority (MTA) has embarked upon a program to integrate fare collection for the separate bus and rail systems operating in Los Angeles County. The first step in this program is to equip approximately 300 buses with ticket validators to allow patrons to transfer from one system to the next using one fare media. GFI-Genfare won the contract and will be utilizing a version of their TRIM unit. If initial testing is successful, additional buses will be equipped.

San Francisco Bay Area

The Metropolitan Transportation Commission (MTC) has spearheaded a program in the San Francisco Bay Area to institute one common fare media that will be accepted by all transit operators. Because BART serves nearly all the Bay Area Communities, the media was naturally chosen to be a magnetic ticket. Before widespread implementation, MTC chose to outfit the buses of Central Contra Costa Transit Authority (CCCTA) with magnetic card validators as a first step. These validators were designed by CGA of France and built in the U.S. After initial trials on one bus route went well, full implementation on all CCCTA buses is now in progress. Tickets are available to the general public from outlets, and ticket vendors will soon be installed in BART stations to augment the outlets. Remaining value is printed on the ticket for both bus and BART riders.

WMATA

The Washington Metropolitan Area Transit Authority (WMATA) has selected Cubic to supply their "Go-Card" system for a three phase demonstration program. The first phase includes installation of one target in each of 14 mezzanines on the Metro system. This installation would also include a target (reader) on one TVM in each mezzanine. For the second phase, 21 feeder buses will be equipped with targets to allow transfers and to test the equipment in the bus environment. The final phase will include the installation of targets in parking lots adjacent to the stations which are part of the demonstration programs. This equipment will feed information into the existing central computer which will allow WMATA to examine the data and make intelligent decisions regarding a more widespread use of a touch-and-go type system.

GO Transit

GO-Transit has issued a request for proposal (RFP) and is now in the process of selecting a contractor for a demonstration of a proximity card type system for use on the commuter rail system and feeder buses from the Mississauga bus system.

Two commuter rail stations and 45 buses will be used during the program. If successful, GO-Transit hopes that a similar system can be implemented in the greater Toronto area.

Biel, Switzerland

Sponsored by the Post Office in Switzerland, a rechargeable contact type smart card program is being conducted in Biel. In addition to being used on transit, the smart card is also good for retailers, hotels, restaurants, gas stations, and the post office. Smart cards are issued free and can be charged with value at machines or at specific outlets. Presently they are investigating its use for public telephones.

Manchester, England

Manchester, England has begun a very ambitious program to outfit their buses with a proximity smart card system. Thirty-two separate bus operators will be included in this program with a total of 2,700 buses. The joint venture of Scanpoint and AES has been awarded the contract for the project. Beyond the application to transit, plans include the use of the smart card for retail, public registration, pay phones, and school meals.

Implementation Alternatives

From the foregoing we have become acquainted with the way fare equipment has evolved through history and we have learned what technologies are now considered state of the art and those which are still evolving. Example demonstration programs have also been examined. But the question still remains—what is the best approach for a transit agency to implement advanced technologies? It is clear from the examples that initial small scale demonstration programs are preferred to reduce the potential risk. Even this approach begs other questions such as

- Should the specifications be specific as to the technology?
- How large should the demonstration programs be in order to provide meaningful results?
- How does the agency arrive at the technological direction?
- How tight should the program schedule be?

The last question related to schedule captures one of the critical problems related to demonstration programs. In some cases the demonstration program schedule is stretched out to such an extent that the technology being tested becomes nearly obsolete. This is not to say that demonstration programs should be eliminated or unrealistically scheduled, but they should be given high priority with adequate resources. Too often demonstration programs are allowed to languish and precious time is wasted.

The other key question from the list above is the level of detail to be specified. Hardware specifications tend to limit competition and yet performance specifications leave the details to the manufacturer and can lead to misunderstandings as to the specific hardware features. Usually a demonstration program can be best served by performance specifications especially if a negotiated procurement is possible.

The size of the demonstration program is also a critical factor. A program that is too small may fall short of proving the technology is reliable and acceptable to the average patron. Large programs may eat into budgets and usually require more time to complete. Unfortunately there is no secret formula for the optimum program. Each agency must analyze their specific needs and create a program that most effectively meets those needs.

Finally, the technological direction may be the most difficult choice. Predicting the future in this rapidly changing environment is nearly impossible. Some of the factors that must be evaluated include

- Potential cost for full system,
- Long-term ability to integrate system with other technological changes,
- Schedule for full system implementation, and
- Maturity of technology in transit environment.

The final choice can be either very specific, which may limit competition, or an open concept allowing several technologies to compete. Either way the specifications must be clear at the time the RFP is issued.

Conclusion

In summary, fare technology appears to be at the brink of major developments that will shape the future of how fares are collected on all modes of public transportation. Transit agencies have a choice of waiting on the sidelines for an appropriate technology to develop for their

application, or becoming active through studies, demonstration programs, and full scale implementation to help shape the future. If too many agencies choose the former, the technological advances will not be guided by transit specific needs.

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Transit Finance, Economics, and Pricing

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This paper analyzes issues in transit finance focusing mainly on fares and fare-related problems. Special attention is devoted to fare media and problems of fare/technology integration.

Prevalence of Fare Structures

Twelve years ago the Urban Mass Transportation Administration/Service and Methods Demonstration (UMTA/SMD) Woods Hole Conference focused on problems of fare revenue and the need for increased revenue collection by changing from flat fares to other fare structures. At that time, nearly 90 percent of all American Public Transit Association (APTA) members relied on flat fares structures.

As shown in Table 1, the APTA 1993 Transit Fare Summary showed some movement away from flat fare systems. Of the bus systems reporting to the APTA fare survey, 5.2 percent charged time-of-day fares and an additional 37.1 percent had zone surcharges, with speed surcharges (express or premium service) showing in 26.1 percent of all fare structures reporting. However, there is no reason to get carried away by these figures since the zone surcharges typically include a large zone covering the central city and a more distant zone covering the suburban neighborhoods. Sometimes a Central Business District (CBD) zone is also included. There is a need for several more zones (or distance charges) if the revenue generation potential of zone fares is to be realized. Particularly distressing is the relatively small incidence of time-of-day fares, the fare structure that shows more difference in fare categories with respect to fare elasticities of demand.

Commuter rail showed the most divergence from flat fare systems, showing higher proportions of systems charging for distances and time-of-day. The rail systems (heavy, light, and commuter) showed a preference for distance-based over the time-of-day fare structures. All of the modes presented in Table 1, except commuter rail, showed an overwhelming preference for flat fares.

Evidence Supporting the Revenue Raising Inferiority of Flat Fares

The objective of raising fare revenues by shifting into alternative fare structures has not been met because of a combination of factors involving the ease and convenience of administering flat fares structures, as well as by research gaps and doubts concerning the alleged superiority of time-of-day fares and distance/zone fares in raising fare revenues at minimum ridership losses.

The push for the adoption of time-of-day fares and distance/zone fares received a shot in the arm ten years ago when, in the same year, a UMTA-sponsored University of California at Los Angeles (UCLA) study by professors Martin Wachs and Robert Cervero (*1*), among others, concluded that very significant gains in revenues, exceeding by 20 to 30 percent the revenues of flat fare systems, could be achieved by having three large California systems (Oakland, Los Angeles, and San Diego) shift from flat fares to combinations of time-of-day/distance-based fares. In the same year, UMTA released an Ecosometrics (*2*) report on fare and service elasticities which showed numerous cases where peak hour fare elasticities were approximately half the value of base period fare elasticities, and selected cases from the British experience of fare elasticities, in which fare elasticities increased with distance of travel.

Research conducted since then has failed to resolve these gaps in knowledge. Professor Robert Cervero's (*3*) study of peak hour surcharges found cases where the peak hour fare elasticity was not much lower than the base period fare elasticity, in effect nullifying the alleged superiority of peak hour charges. Regarding fare elasticities by distance/zone we know from the UMTA/SMD demonstrations of the late seventies that intra-CBD transit ridership is more elastic than central city ridership (*2,4*), but there is still a gap in knowledge regarding whether distance-based fare elasticities increase with distance.

No wonder then, that faced with these uncertainties, the transit industry has opted for maintaining their reliance on flat fare systems.

Deep Discount Fare

A new revolutionary concept of fare discounting has appeared in the literature and has been applied in several transit properties. This concept, labelled the "deep fare discount" option, consists of offering (20 to 30 percent) discount on short term 10-tickets, day passes, and 10-pack tokens programs. The concept has been applied in Allentown, Pennsylvania; Lafayette, Indiana; Milwaukee, Wisconsin; Chicago, Illinois; and Richmond, Virginia. Table 2 presents the record of the applications of deep fare discounts in several American properties. Because of its importance we present a detailed analysis of this option.

TABLE 1 Prevalence of Fare Structures Among APTA Members, 1993

Fare Structure Elements	Motor Bus	Trolley Bus	Heavy Rail	Light Rail	Commuter
Distance or Zone Surcharges	37.1%	20.0%	38.5%	25.0%	88.2%
Parking Surcharges	1.7%	0.0%	53.8%	6.3%	47.1%
Speed Surcharges	26.1%	0.0%	7.7%	6.3%	0.0%
Time-of-Day Surcharges	5.2%	20.0%	7.7%	12.5%	23.5%
Transfer Surcharges - Same Mode	27.8%	20.0%	15.4%	18.8%	0.0%
Transfer Charges - Other Modes	7.6%	40.0%	46.2%	43.8%	11.8%
APTA Systems Reporting	291	5	13	16	17

Source: (*8*, pp. 20-18 and 20-19)

Basic Underpinnings

The key concept behind "Deep Discount Fares" (*5*) is that the fare elasticities for occasional transit riders (generally ϵ = -0.4 or -0.5) and for choice riders (close to ϵ = -1.0) are more elastic than the fare elasticities for all adult cash riders (ϵ = -0.2 or -0.3). Since occasional riders generally ride while paying via multi-ride tickets, 10-pack tokens or cash, the argument of the "Deep Discount Fare" proponents is that it is cost-effective to increase cash fares, while reducing the prices of multiple ride tickets (and 10-pack tokens). The result of this cross-subsidy, claim the deep discount fare proponents, is that both revenues and ridership may be increased by the "Deep Discount Fares" pricing strategy.

The increase in both ridership and revenues is claimed to occur because the occasional riders are among the most fare-sensitive of the transit rider segments, and these riders increase their number of trips by a larger amount than the decrease in the trips of cash paying riders. This argument is correct and obvious as analyzed in the context of the fare elasticities of demand.

The benefits of "Deep Discount Fares" are exaggerated by claiming that they can increase ridership and revenue even if cash fares are not increased. However, this is clearly incorrect as explained next. In order for decreases in the prices of multi-ride tickets—and other fare instruments applicable to occasional riders—to result in increases in both revenues and ridership in the absence of cash fare increases, the fare elasticities of these fare instruments applicable to occasional riders would have to be larger than unity ($\epsilon > -1.0$). Yet, we have been unable to find one case where a fare elasticity larger than unity has been estimated for any system in the United States, Canada, or Great Britain.

All the fare elasticities of choice riders estimated for Chicago, Denver, San Francisco, and London are lower than unity, and that is the case also of the fare elasticities of ticket programs estimated in U.S. settings. However, we are in agreement with the deep discount fare proponents' more reasonable conclusion that "revenue losses are minimized when the discounts are especially targeted to low frequency riders through the use of direct mail coupons limiting the savings to a single purchase of super-discounted tickets."(*5*)

In conclusion, for the deep fare discounts to result in both ridership and revenue increases, in the absence of a coordinated action to increase cash fares, requires fare elasticities for occasional riders and multi-trip tickets greater than one. The increase in both ridership and revenue is unlikely to occur without the cross-subsidy discussed earlier.

Pricing Complications When Pass Programs Exist

While the basic underpinnings of the "Deep Discount Fares" policy, when accompanied by a cross-subsidy with cash fare increases, are theoretically correct and easy to understand, a more complex situation arises when pass programs are also available. Monthly and weekly pass programs serve commuter riders, which have among the lowest fare elasticities of any transit ridership market segment. A correct pricing decision to restrict the "Deep Discount Fares" to the more elastic markets, would have to exclude discounting the pass programs, which have notoriously low elasticities. A contrary decision to give deep discounts to the pass riders would certainly result in revenue losses, since weekly and monthly pass riders are very inelastic. In fact, they are more inelastic than the cash riders that do not shift to multi-ride tickets as a result of the "Deep Discount Fare" strategy.

TABLE 2 EXPERIENCE WITH DEEP DISCOUNT FARES

Property	LANTA	Greater Lafayette Public Transit Corporation	Milwaukee County Transit System
City	Allentown, PA	Lafayette, IN	Milwaukee, WI
Date of Action	April 1, 1987	January 1988	January 1987
Cash Fare Increase	+50% (peak), +30% (off-peak)	cash fare of $0.50	+18%
Ticket Price Reduction	10-ride ticket price & 40-ride tickets price: -20%	10 ride tickets for $4.00 (20-23% discounts)	10-ride ticket price: -9%
Pass Price Reduction	No passes are available	Introduced Adult Summer Pass (no information on price)	Weekly pass trip: -9%
Passenger Changes	+5%	+5%	+1.3%
Revenue Changes	+10%	+0.50% or +2% in adult fare revenues including pass revenues (depending on the source)	-0.5%
Notes:	A major reorganization of bus services occurred in the 2nd semester of 1986	Mail coupons good for $1.00 discounts on the tickets sent to 30,000 homes	New and expanded service on key South Side routes coincided with major freeway construction program
	Distributed the ticket programs by mail with additional discount coupons (of 20%)		Senior fares went up 25% (because they are half the cash fare)

Source: R. Oram. *Deep Discount Fares*. Prepared for UMTA's Office of Budget and Policy, August 1988.

Extending the "Deep Discount Fares" to pass plans results in revenue losses, as evident in the experience of the Milwaukee County Transit System. In Milwaukee, discounts of nine percent in both 10-trip tickets and weekly pass programs resulted in an overall revenue loss of -0.5 percent for the system in spite of a significant 18 percent increase in cash fares and an expansion of service. The point is, given that most transit properties already have pass programs, the design of a "Deep Discount Fares" policies for most of these properties is not straightforward.

While the correct design policy—not discussed in the basic deep discount fares document—may be not to extend the deep discounts to the pass programs in order to avoid revenue losses, this raises equity problems which are discussed next.

Cross Subsidies and Equity Considerations

The "Deep Discount Fares" policies require a concomitant action to increase cash fares in order to result in increases in both ridership and revenues, thus highlighting the issue of cross-subsidies. The cross-subsidy issue consists of the fact that those cash fare riders that do not shift to multi-ride tickets experience higher fares and thus subsidize those cash fare riders that shift to multi-ride tickets in response to the fare discounts for ticket programs.

The subsidized multi-ride ticket buyers are by definition the most elastic of the cash fare riders, that is, the choice riders. Those remaining cash fare riders which subsidize the multi-ride ticket buyers are among the most inelastic of the cash fare riders, that is the captive riders. The result of the cross-subsidy is that the captive riders, generally low income riders, end up cross-subsidizing the more affluent choice riders.

The issue of cross-subsidy gets even more complicated if the monthly pass plans are brought into the analysis. If the "Deep Discount Fares" are not extended to the pass riders (which may be necessary given the low fare elasticities of pass plans), then we will have a situation where occasional riders are subsidized by both regular riders and commuters. In summary, "Deep Fare Discounting," while based on good economics, has inequity implications that may affect its applicability in some transit settings.(*6*)

Size of Occasional Rider Market

Given the strategy of "Deep Discount Fares" to cross-subsidize the occasional riders, the success of this policy will somewhat depend on the size of this market segment. Deep discount fare advocates claim that the market is sizable and that current on-board survey techniques—with their 20 to 30 percent response rates—underestimate the market for occasional riders.

While it is true that most of the transit riders are occasional riders, these occasional riders hardly ever account for more than 30 percent of all the transit trips. Table 3 summarizes the experience of several systems, supporting the fact that the occasional riders constitute around 30 percent of the market. This finding was validated by LANTA in Allentown, Pennsylvania, which found that "30 percent of the LANTA passengers took the bus once in a while."(*7*) Noteworthy in Table 3 is the fact that in some cities the occasional rider market is substantial, exceeding the average of 30 percent of all transit trips. These cities, which include some smaller cities but also Seattle, would seem to be candidates for a "Deep Discount Fares" strategy. Thus, the widespread applicability of this concept is exaggerated; the concept is more applicable to systems with substantial numbers of occasional riders.

Targeting the Discounts Offered

Deep discount fare proponents correctly emphasize the need for marketing and the success of marketing efforts in the three sites. Particularly impressive was the effort in Allentown and Lafayette to target the discounts via mail coupons. In Allentown nearly 100,000 discount coupons were mailed, while 30,000 discount coupons were also mailed in Lafayette. This is good marketing at work!

Summary

In spite of its exaggerated claims, "Deep Discount Fares" is an appropriate policy when accompanied with cash fare increases in a variety of transit settings characterized by large numbers of occasional riders.

The claim that "Deep Discount Fares" can result in revenue increases even without the accompanying cash fare increases appears spurious. However, "Deep Discount Fares" may be the least expensive discount fares strategy in terms of minimizing the revenue losses. There are also important equity considerations that may complicate the issue of adopting "Deep Discount Fares."

Three more recent applications of the deep discount fares were made by the Chicago Transit Authority, the Metropolitan Transit Commission in Minneapolis-St. Paul, and by the Greater Richmond Transit Commission. In these applications the base fare was significantly raised to cover whatever revenue losses would result from the shifting of cash riders to the short-term fare media. There is a need to conduct an independent evaluation of these applications of deep discount fares and of whatever other applications are undertaken in the near future.

TABLE 3 COMPARISON OF FREQUENT VS. OCCASIONAL RIDERS IN SELECTED TRANSIT SYSTEMS

Weekly Trips Taken	Percent of Weekly Transit Trips										
	Sacramento (CA)	Syracuse (NY)	Mobile (AL)	Portland (ME)	Columbia (SC)	Winston-Salem (NC)	Wilmington (NC)	Denver (CO)	Toledo (OH)	Burlington (IA)	Tuscaloosa (AL)
4-7 days/week	68%	74%	75%	70%	71%	73%	64%	76%	72%	55%	46%
1-3 days/week	21	20	22	21	21	21	31	5	6	27	5
Less than 1 day/week	11	6	3	9	8	6	5	9	12	18	9

	Percent of Weekly Transit Trips			
	Seattle (WA)	Louisville (KY)	Santa Cruz (CA)	Fond du Lac (WI)
More than 10 trips/week	17%	20%	53%	9%
7-10 trips/week	38	60		18
5-6 trips/week	20	20	26	28
3-4 trips/week	21		16	24
1-2 trips/week				21
Less than 1 trip/week			6	

Source: On-board surveys of selected transit properties, 1970-1985.

Fare Changes and Discounting

The 1993 APTA fare survey (*8*) referred to earlier shows that 23.1 percent of the APTA bus systems changed fares during the period 1991-1993, a relatively low rate when contrasted with heavy rail at 42.9 percent and light rail at 41.7 percent. Twenty percent of the commuter rail systems belonging to APTA changed fares during the two years in question. This reluctance to change fares on a periodic basis may reflect the fact that the recent economic period of the mid-eighties and early nineties has been characterized by the lack of inflationary pressures. However, this inertia in postponing fare changes eventually results in larger percentage fare increases with their concomitant adverse effect on ridership. Because of the prevalence of fare discounts in alternative fare media, the following paragraphs describe the incidence of discounting practices.

Discounts for Special Services

No discounts for special services are offered in heavy rail systems, while commuter rail services offer discounts over base fares only in local service. The most frequent discount for special service is the CBD circulator service which shows up in 21.6 percent of the bus systems and in 25 percent of the light rail systems responding to the APTA survey. The most frequent special service discounts in bus systems concern feeder service and parking lot shuttles, with each appearing in 3.8 percent of the systems, transit mall and shopping shuttles at 4.4 percent combined, and university service at 2.4 percent. Discounting the fare for these special services is warranted if the services are provided during the base period, but that is not always the case.

Discounts for Passes

One of the findings of the UMTA/SMD demonstrations of the late seventies and early eighties concerned the futility of offering large discounts on pass media. The reason for the futility is that offering large discounts on passes results in the cannibalization of the cash riders, which shift their purchases to passes to take advantage of lower fares and result in net cash losses. Fortunately, the findings of the UMTA/SMD demonstrations appear to have been taken into account in the current pricing policies of pass programs. Sixty-seven percent of the bus systems have passes, whose median price multiple is 35 rides a month. This is slightly under the approximate range required to avoid large cash revenue losses. Comparable monthly pass price multiplies for heavy rail are 38 monthly rides, and for light rail the median price is 36 monthly rides. Only in the commuter rail monthly passes, where median price is 28 rides, is the pass price policy likely to result in large cash fare revenue losses.

Weekly passes show median prices of nine weekly rides for motorbus and commuter rail systems, ten weekly rides for heavy and light rail systems. Again the discount appears appropriate and will not result in major revenue losses.

Discounts for Tickets, Token, and Cards

According to the APTA 1993 Fare Survey, the median price for ticket and token programs is as follows: 10-trip instruments have median discounts of ten percent for buses, 11 percent for heavy and light rail, and 13 percent for commuter rail systems. The 20-trip instruments have median price discounts of ten percent for bus, light rail, and commuter rail systems. These discount rates appear appropriate in normal cases, but not when the desire is to apply deep fare discounts via 10-trip tickets and 10-token packs.

Social Discounts

Single-trip reduced fare discounts are offered to a variety of population groups that are deemed to require special financial assistance on the part of governmental decision makers. These groups include senior citizens, disabled persons, and students. Most of these fare discounts are offered at all times of the day, rather than restricting them to the less expensive base period where there is excess capacity. Seventy-six percent of all bus systems offer reduced fares at all times of the day for senior citizens and disabled persons. In only 15 to 17 percent of the bus systems are reduced fares restricted to weekday non-peak hours for both senior citizens and disabled persons. Only less than two percent of the bus systems restrict reduced fares to weekday non-peak hours for elementary and secondary school children. In the case of senior citizens, 56.4 percent of the bus systems offer discounts ranging from 46 to 54 percent of base fares, with another 11 percent of the systems offering fare discounts of 62 to 70 percent of base fares. There is no appreciable departure from these ranges for heavy and light rail systems. However, more frequent time-of-day restrictions and smaller fare discount levels appear in the case of commuter rail systems.

While most of the social discounts are mandated by legislation, such as the Urban Mass Transportation Act of 1972, as amended, the time has come to ask whether the revenue losses from the social discounts should be restricted to times of day where there is excess capacity

or whether the social discounts should be considered mainly as one of the strategies to divert disabled and senior citizens from the expensive demand-responsive systems into fixed bus accessible transit systems.

There are two opposite schools of thought regarding social discounts. The first view, reflected in the Urban Transportation Act of 1972, as amended, is that in exchange for Federal government subsidies to the local properties, reduced fares be extended to needy segments of the population such as senior citizens and disabled persons. A second school of thought argues that transit properties provide a very poor job in targeting the really needy and that the role of transit at the most should be to provide "user side" subsidies, such as transportation stamps to social service agencies for selling to their client population. I confess a professional bias in favor of the second school of thought.

Promotional/Business Discounts

Promotional discounts are generally offered to new movers into the transit service area and perhaps to choice riders that can be identified through the mail. While promotional discounts show poor retention rates after the promotional period is ended, they should nevertheless be an integral part of a marketing program. More difficult to justify are discounts offered for shopping, transit mall, and other such trips unless the retailers finance a large part of the discount, or unless the trips are taken during the less expensive off-peak hours.

Free Transit

The benefits and costs of free transit services were the subject of several studies and demonstrations in the seventies. A 1970 pathbreaking study by Charles River Associates (*9*) concluded that given the low fare elasticities that characterize transit, the revenue losses would not be compensated by savings in fare cash collection costs and that only a limited amount of new or generated riders would be attracted to the free transit service. UMTA/SMD demonstrations of free transit service in Denver and Trenton during the seventies confirmed the Charles River earlier conclusions. The demonstrations found a very large number of teenagers and school kids taking free "joyrides" and that few adult riders taking essential trips were generated by the free transit experiments.(*10,11*)

FARE MEDIA AND DISTRIBUTION METHODS

The effectiveness of fare media depends on designs that are fraud-resistant and on the distribution methods. The convenience afforded by prepayment systems is significant. Prepayment media offered at no discount generally achieve penetration rates of 8 to 12 percent of all ridership. Monthly passes priced at 28 to 30 monthly rides achieve penetration rates of approximately 50 percent, but at a high cost in terms of diverted fare cash revenue losses. It is important to note that prepayment offers benefits to the transit riders who purchase it. The most effective option for avoiding fraud in fare media is through the use of magnetic cards and magnetic fare collection equipment, a topic discussed later in this section.

Prevailing Distribution Methods

Some 58 percent of the bus systems responding to the APTA fare survey used the transit headquarters to sell fare media while 54 percent reported using retail outlets. Further, 51 percent of the bus systems had mail distribution programs while 25.1 percent of the systems had employer outlet programs.

In the case of heavy and light rail systems, most of them used retail outlets including 76.9 percent for heavy rail systems to sell fare media, followed by outlets at transit headquarters. Fifty-three percent of these heavy rail systems used mail distribution and 31 percent had employer outlet programs. In summary, there has been a significant growth in the distribution of fare media through non-traditional methods since the early eighties when mail and employer programs were basically non-existent.

Similarly, 12 percent of the bus systems accept credit card payments, proportion which rises through heavy rail, 23.1 percent, light rail, 50 percent, and commuter rail 70.6 percent. Thus, there has also been significant growth in the use of credit cards as payment methods. Selling fare media through automated teller machines (ATMs) is in its beginning stages: five commuter rail systems, four bus systems, two heavy rail, and two light rail systems use ATM. This proportion should be promoted to increase since it is an effective distribution method.

Number of Location of Outlets

One of the usual reasons for the failure of prepayment plans to achieve significant ridership penetration is that not enough outlets are provided or that they are inaccessible. In Cincinnati, only nine outlets were available for distributing the monthly pass in 1982, a factor which led to penetration rates below 12 percent for the monthly pass.

Table 4 presents information on outlets and prepayment instruments sold in selected transit properties. Most of the properties with large numbers of outlets depend on a

vigorous program of employer outlets. Other aspects of prepayment distribution include policies on consignment fees and types of outlets.

Types of Outlets: Transit Versus Employer/Public Outlets Versus Direct Mail Distribution

Methods of selling prepayment instruments involve transit-operated sales outlets, public and employer sales outlets, public outlets with sales contracts, direct mail order, telephone order, pre-authorized bank payments, and automatic vending machines.

The general view of the effectiveness of these sales methods is that the choice between them depends to some extent on the volume of sales at each outlet. Figure 1 presents standardized costs at 11 American transit properties, showing that with the exception of sales contracts that provide variable commission rates, sales distribution methods exhibit economies of scale at relatively low sales volumes. At high volumes all five methods have constant average costs.

As shown in Figure 1, telephone order and direct mail programs are relatively expensive programs to operate with little or no economies of scale. In order to make them cost effective, they should only be employed at low volumes and marketed to those transit users without access to the less expensive sales outlets.

Depending on the sales commission rates asked by public and private sales outlets, it may be less expensive for the transit company to staff and maintain a sales outlet if high outlet volumes are obtained. Generally, a staff-operated outlet is less expensive than public outlets charging more than 2.5 percent in commissions only at volumes of more than 10,000 pass sales per month. Because few staff-operated outlets meet this test, most staff-operated outlets must therefore be judged and justified on grounds other than pass sales.

Employer-Based Programs

The early eighties showed an extensive UMTA/SMD effort in promoting employer-based marketing programs.(*12*) The employer-based programs consisted of selling fare media—monthly passes, but also tickets—through employers. In some cases, the employee would pay for the fare media through payroll deductions, in other instances they could purchase the fare media directly from a company employee, specifically assigned the fare media selling function. The normal discounts on monthly passes and trip tickets were usually applied. The experience with employer-based programs was that they were expensive to administer unless only large firms were targeted. The costs of selling fare media through employers were several times the multiple of selling them through transit outlets or even large volume retailers and banks at 1 to 2 percent commission.

Employer-based programs are also used in areas subject to pollution containment plans. In these cases, the employers are required to subsidize transit fare media at amounts comparable to the subsidization of parking by the employer. In summary, only in cases of large employers or in air pollution containment areas are these programs effective.

A recent development in this regard is contained in the energy bill passed by Congress on October 8, 1992. Under this bill, employers may provide up to $60 per month in tax-free transit benefits to their employees. The $60 monthly cap is equivalent to the average cost of commuting by transit nationally. The same bill places a cap of $155 per month on the tax-free parking privileges previously provided by employers to employees without any previous limit or cap. While just a few years ago, employers could provide their employees unlimited tax-free parking benefits, the restriction of the parking cap to $155 per month is still too high; it is by no means equitable in comparison to the $60 cap for transit, since only in a few large metropolitan areas are parking charges in the range of $155 per month.(*13*)

Electronic Fund Transfers (EFT) and Other Billing Methods

Selling fare media through EFTs (pre-authorized payments, etc.) is still at a infancy. A UMTA/SMD demonstration of prepayment distribution methods in Sacramento found that the costs of pre-authorized payments were the highest of all the distribution methods demonstrated.(*14*) There is a need to research the costs of EFT and other distribution methods and compare them with more conventional methods.

Current Fare Collection Equipment Capabilities

Most of the transit systems still rely on tokens and in non-magnetic passes and single trip tickets. Use of magnetic coded cards is still insignificant except for heavy rail systems. For example, stored value magnetic cards are in use in 53.8 percent of all heavy rail systems while magnetic stored time cards are used by 15.4 percent of the same systems. In commuter rail, the comparable quantities are 11.8 percent for stored value magnetic cards and 5.9 percent for magnetic stored time cards. Only 4.5 percent of the bus systems use magnetic stored value and 0.7 percent use magnetic stored time cards.

TABLE 4 Supply of Outlets at Selected Transit Properties

Property	Location	No. of Outlets	Instruments Sold per Month	Instruments Sold per Month per Outlet
SEPTA	Philadelphia	92	76,870	836
Metro	Seattle	150	44,560	297
Tri-Met	Portland	109	19,870	182
MARTA	Atlanta	21	18,800	895
Ciy of Honolulu	Honolulu	66	23,995	363
MDTD	Miami	103	12,000	116
GRTC	Richmond	60	23,549	392

Source: Patrick Mayworm and Armando M. Lago, The Costs of Transit Fare Prepayment Plans and Their Distribution Systems, in *Transportation Research Record 972* (1984), except for the Richmond data, which was estimated by Ecosometrics for June 1989.

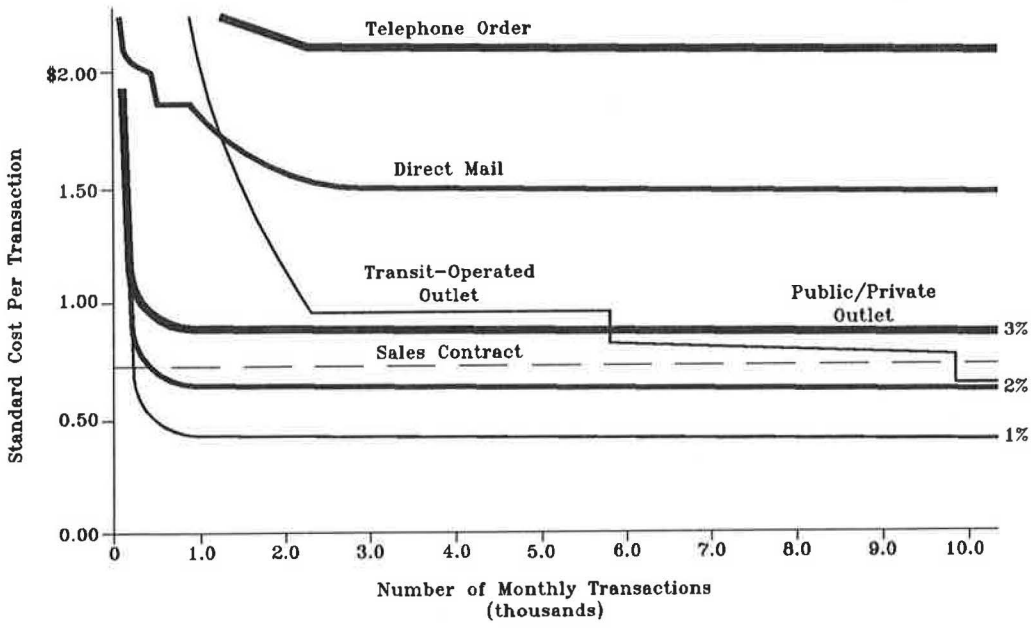

FIGURE 1 Comparison of average costs for five distribution methods at high sales volume (*16*).

The lack of fare collection equipment capabilities in most systems will make it difficult to apply the complex fare structure systems used in Western Europe, which include a combination of time-of-day and distance/zone fare structures. Forty-six percent of the heavy rail systems have magnetic card readers, while 23.1 percent have magnetic card swipe readers. But magnetic fare collection equipment is almost nonexistent in the bus, light rail, and commuter rail systems.

Regarding bus systems, 56 percent have electronic fareboxes and only three percent use cash-only vending machines, while one percent have ATM/credit card vending machines. Cash-only vending machines, which are used by 37.5 percent of the systems, and ATM/credit card vending machines, 6.3 percent of the systems, show only a limited presence on light rail systems. Only commuter rail systems show a significant proportion of ATM/credit card vending machines, with 35.3 percent of the systems reporting their use.

The fare equipment collection area would benefit from the attention and technical assistance supplied via the Federal Transit Administration (FTA). The same growth in non-conventional distribution methods of fare media that occurred in the eighties spurred by UMTA/SMD feasibility studies and demonstrations could happen in the fare collection equipment method if supported by a program of studies and demonstrations.

Transfer Policies and Effect on Demand

The effect of transfers on transit demand is a combination of three factors: 1) the level of transfer surcharges, 2) the number of transfers required on a trip, and 3) the transfer wait time. While the elasticity of demand for transit charges is approximately the same as the fare elasticity, the elasticity of transfer wait times and of the number of transfers is generally greater than the fare elasticity associated with transit surcharges. This topic has received little attention in the literature, yet its impact on transit demand is important. There is a need to estimate the elasticities of transfer times and the number of transfers and to analyze the effects of transit demand on service designs such as the pulse system and other designs that result in increased numbers of transfers. Demonstrations of alternative transfer service designs to analyze the cost-effectiveness of different systems is also needed.

As shown previously in Table 1, the 1993 APTA fare survey showed that 27.8 percent of the bus systems have transit surcharges and that 8.9 percent of these systems do not offer transfers. The extent of bus transfer surcharges is less in the other modes, such as heavy, light, and commuter rail.

Regulatory Framework for Transit Fare Policies

The cumbersome regulatory process that accompanies fare changes accounts partly for the lack of a systematic approach to conducting even bi-year (every two years) changes in fare levels. Most respondents to the 1993 APTA survey replied that fare changes are done when necessary rather than according to some periodic policy. One major contrast with utility pricing is that utility sector regulation is characterized by rate of return regulation, where the regulatory board ascertains the costs—capital and operating—of the utility firm and the pricing that is compatible with a specific and approved financial rate of return. Ever since the early seventies no transit properties have been able to achieve a positive rate of return on investment. The failure to achieve a positive rate of return on investment to cover equipment and investment needs of this industry eventually led to the public sector take-over of a transit service essentially supplied within the private sector.

Not being able to be regulated like a public utility, fare policy attention has focused on fare recovery targets. Most bus systems, some 64.3 percent, have no fare recovery targets or goals; however, fare recovery policies appear more frequently in heavy and light rail systems. Approximately 38 to 39 percent of the heavy and light rail systems do not have a fare recovery requirement or goal. Commuter rail systems fall between the bus and heavy rail systems.

Most of the efforts to impose a fare recovery requirement or goal follow from state governments, whose fare recovery targets apply to 54 percent of the bus systems subject to fare recovery targets, to 50 percent of the heavy rail systems, to 60 percent of the light rail systems subject to fare recovery policies, and to 62.5 percent of commuter rail systems. Transit systems boards are responsible for 25 to 32 percent of the fare recovery targets, depending on the type of system.

However, it is interesting to note that the fare recovery policies do not flow from any study of the benefits and costs of transit, that is, they do not flow from the "value of money" studies conducted in other counties like the United Kingdom (UK).(*15*) In the UK case, the benefits per dollar of subsidy are estimated for large and medium systems and the levels of transit subsidy—or the converse, the required fare recovery target—requirements are determined via an analytical process. Perhaps it is time to initiate these "value of money" studies in American transit properties.

TABLE 5 Summary of Gaps in Knowledge, Demonstration, and Research Needs

Concepts	Gaps in Knowledge	Demonstrations/ Experiments	Research Needs
1. Time-of-Day Fares	Elasticities by time-of-day	Demonstrations needed of a change from a flat fare system	Research studies on elasticities by time-of-day
2. Distance/Zone Fares	Elasticities by distance are unknown/uncertain	Demonstrations/evaluations are needed of a change from flat fare systems	Research studies of elasticities by distance/zone
3. Deep Discount Fares	Elasticities of occasional riders, purchasers of tickets and token packs	Demonstrations/evaluations of deep discount fare systems are needed (Chicago, Richmond, among others)	Research studies on elasticities of deep discounts
4. Effect of Transfers on Demand	Elasticities of no. of transfers and transfer times Effects of transfer systems on demand (pulse system, etc.)	 Demonstration/evaluations of transfer systems are needed	Research studies on elasticities are needed Research on transfer systems are needed
5. Fare Collection Equipment	Cost effectiveness vs. conventional fare collection	Demonstrations/evaluations of cost effectiveness are needed	Feasibility studies of fare equipment
6. Fare Recovery Policies	Value of money in American systems		Value of money studies

Strategic Changes: Preliminary Thoughts

The earlier comments suggest that some of the gaps in knowledge discussed in the previous Woods Hole conference remain. In addition, the lack of magnetic fare collection equipment in place will make it difficult to apply the complex fare revenue structures prevailing in Europe. There is also the danger of proceeding with fare collection technology for the sake of technology per se, without regard to their effects on the transit property costs. Some of the initial demonstrations of non-conventional fare media distribution methods, such as EFT, direct mail, and credit card charges, conducted in Sacramento by UMTA/SMD showed these new distribution methods as more expensive than the conventional methods. The strategy should then be to conduct demonstrations of the new technology for fare collections in actual settings and to estimate their cost-effective feasibility through independent evaluations.

The 1993 APTA fare survey has shown an appreciable gain in implementation of the UMTA/SMD demonstrations on pass pricing and fare media distribution conducted in the late seventies and early eighties. The FTA should take these survey results to show the promise of returns from their involvement in a new demonstration/evaluation/research program on transit pricing and fare collection. Table 5 presents a summary of the gaps in knowledge and demonstration needs.

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Transit Fare Management and Operation Issues

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Introduction

In recent years, transportation systems throughout the United States have been seeking alternatives to the historic methods of funding their operations. Among the possibilities which have been receiving particular attention is the expansion of user fees for this purpose. Mass transit organizations have relied upon user fees in the form of passenger fares throughout their history, albeit with varying levels of success. As governmental support for transit continues to tighten, greater emphasis on farebox revenue will be necessary to maintain service.

At the same time, societal changes have greatly aggravated the concerns which face revenue management, particularly concerning the security, control and protection of the revenues and associated personnel. As fare levels have risen, and overall economic conditions have weakened, the temptation placed on persons in the revenue stream, has intensified. Additionally, an increased awareness of passenger sensitivities has placed a greater responsibility on revenue agents and collectors to deal with passengers with an eye towards customer service.

Accordingly, revenue managers are faced with a new array of issues in their daily activities. To assist in this effort, managers can rely on the availability of technological advancements in sales and collection, however the management of this technology can present yet another burden.

Through this paper, we examine the approaches and tools which can be applied to the task of managing the revenue process.

Initially, a general perspective of the responsibilities and philosophies of management which should be considered in assessing revenue activities is presented. Focus then shifts to some of the specific tools which can be applied in the management of the revenue process. The prospect of transferring revenue activities to contracted parties in a number of revenue areas is discussed as well as the opportunity to identify private assistance in performing or financing improvements to existing systems.

Finally, several suggestions are presented for attention and research focus by the transit industry in an arena which certainly will undergo extensive scrutiny in the coming years by transit providers, funding agencies and our customers, the riding public.

General Conditions

A study performed for the Urban Mass Transportation Administration (UMTA, now the Federal Transit Administration—FTA) by Watson Rice & Co. noted that a 1986 UMTA Fare Collection Task Force estimated that transit revenue shortfalls created through evasion and theft exceeded $400 million or 15% of collected revenue annually.(*1*) Although a large portion of this loss is attributable to abuses by the public, such as fare shorting, counterfeiting and fare avoidance, a substantial element of the problem can be assumed to exist internally.

The vast majority of public fare evasion can only be corrected with the assistance of police and the legal system. Only through the well-publicized capture, trial and punishment of offenders can the evasion of fares by transit customers be discouraged and curtailed. Bus drivers and transit cashiers can only address these conditions within the context of their primary functions, that is the safe operation of a vehicle and limiting access to the system through the use of available resources. Any excessive or heroic actions on the part of these employees can only lead to service disruptions, passenger inconvenience and risk to the health and safety of the employee and others.

Accordingly, revenue management should focus its attention and resources primarily on those areas of revenue control over which some measure of improved security and control can be achieved.

With regard to abuse by the public, revenue managers and the senior management of the transit agency should work aggressively and cooperatively with appropriate authorities, such as the local police, district attorneys and government officials. With regard to internal theft or misappropriation, a variety of actions can be taken to enhance the level of revenue protection existing in the transit environment.

Management Issues

Revenue management entails a variety of responsibilities and attendant concerns. Today's revenue operations entail several major areas of responsibility—the sales, collection and processing of the firm's revenue. Many of the areas under management have counterparts in private industry, however, the combination of the tasks within one organization is truly unique.

In many instances, the similarities between transit and commercial applications are quite direct. For example, transit sales functions require sensitivity to customer service interactions, in the same fashion as a bank teller operation.

However, although most commercial organizations perform numerous sales transactions daily, very few receive the volumes of cash which must be handled on a daily basis in the transit environment. An issue such as the protection of unreconcilable cash is relatively unknown in private industry, since product inventory and the known volume of customers is generally available to a business. Unfortunately, due to historic operating conditions and the absence of appropriate technology, this problem is faced by the many transit properties which are using non-reporting collection devices.

With greater use of advanced technologies in the industry, the opportunity to improve revenue systems in transit is enormous. However, substantial improvement can be achieved through means other than technology. Such change should be developed in tandem with the many other alterations to the transit environment, such as the need to enhance the overall quality of customer relations as well as to create additional efficiencies in personnel utilization.

Control Issues

Revenue department management should be extremely familiar with the concept of internal control, as defined below. All activities and plans should be developed with extreme sensitivity to relevant impacts on the control of revenue and all related instruments, personnel, facilities and equipment.

> Internal Control comprises the plan of organization and all of the coordinate methods and measures adopted within a business to safeguard its assets, check the accuracy and reliability of its accounting data, promote operational efficiency, and encourage adherence to prescribed managerial policies . . . a "system" of internal control extends beyond those matters which related directly to the functions of the accounting and financial departments. [Statement on Acctg. Stndrds No. 1 (¶320.09)(*2*)]

Since 1983, the average revenue received for an unlinked transit trip has increased by 70%.(*3*) Passenger revenue, in total, has increased by almost 100% to over $6 Billion in 1991.(*3*) As a result, the amount of coin and currency moving through the average transit system on a daily basis has grown dramatically during this period, with the exposure to loss expanding in equal cadence. Many transit firms have been unable to replace technologies or practices at a pace sufficient to ensure protection of this influx of revenue.

In some of these cases, paper transfer stock, printed in bulk on a daily basis, is distributed to every vehicle operator in the system for passenger use. It is doubtful that transit systems with such programs have taken steps to control the transfer stock in the same fashion as cash, despite the fact that the value of an adult base fare and accordingly the value of a transfer has increased from pennies to over 80 cents.(*3*)

Such conditions warrant an extensive review of all revenue activities and programs to establish the appropriateness of existing activities in the current transit fare environment.

Reliance on Technology

In today's revenue environment, much attention is placed on the use of highly sophisticated technological equipment to sell, collect and analyze revenue transactions. Such attention is well placed, since the volumes and complexity of today's fare systems require technological assistance, such as is now available through registering fareboxes, light data transfer, and electronic access controls. However, the use of technology can not replace the need to rely primarily on the revenue employee as the chief ingredient to successful performance.

The most sophisticated technology requires human intervention to pull vaults, perform maintenance, install ticket inventory and control the process. Analytical tools and programs are only as effective as the employees who must design and interpret the output of such resources.

Accordingly, with each investment in tomorrow's sales and collection equipment, the transit firm must provide revenue management with adequate resources to properly hire, train, and assist the revenue employees who will use the equipment. Such investment in human capital can ensure the success of any investment in equipment. Conversely, an absence of such human capital can ensure the absolute failure of any technological program.

Corporate Sensitivity to Revenue Issues

Transit authorities have historically had little incentive to consider revenue issues as a high priority within their organizations. The ability to readily obtain operating revenues from non-farebox sources, such as taxes or grants has caused the attention to revenue collection and control to become diminished. Unlike most private firms, where revenue is the primary reason for existence, public sector entities have found that the performance of the operation is first and foremost in the attention of senior management and the various governing bodies.

The previously cited UMTA study noted that senior

management tends to hold the public responsible for revenue loss. The study reports that ". . . most transit executives avidly deny that internal theft exists within their organizations saying 'Our people don't steal.' Conversely, most lower level managers and supervisors and security personnel blame fellow employees for revenue loss."(*1*)

Such a lack of focus on revenue concerns at the corporate level is a major cause of revenue problems at many transit firms. Revenue issues are often assigned to managers who coincidentally hold responsibility for transportation, maintenance or accounting functions. Thus, the ability to focus specific effort on revenue issues is often reduced due to other pressing issues.

This attitudinal conflict must be corrected before meaningful change in the revenue process can be accomplished. As the funding structures of transit properties continue to move from governmental grant assistance to alternative funding modes, greater attention will certainly be focused on this arena.

Defining Exposure Points

Revenue management should be guided by the adage that states "an ounce of prevention is worth a pound of cure." Extensive and continual efforts should be expended in the identification of potential points in the revenue stream at which "leakage" can occur.

Control weaknesses can never be completely eliminated from a financial cycle. However, through the use of various reconciliation reviews and consideration to segregation of duties among responsible parties, management can ensure that control problems can be averted, or at least detected when they occur.

In assessing a revenue system, it is prudent to chart each transaction type in order to clearly identify potential weaknesses which may exist in the process.

Each transaction flow should be carefully documented by objective individuals, with the intent of identifying every step of a specific transaction process. Charts should be created to reflect movement of actual cash as well as controls on storage devices, keys, revenue instruments and the recording of transactions.

Each point of responsibility transfer should be noted and assessed to ensure that the passage of responsibility is clearly controlled through documentation, approvals or miscellaneous control activities. Figure 1 presents a preliminary outline of such a flow review.

There are seven steps in the initiation and execution of every kind of revenue/sale transaction.(*2*) These steps, and the corresponding transit revenue activity, are highlighted next. Control analyses on each of these areas can assist in providing management with greater comfort levels on the adequacy of revenue protection.

Standard Transaction

- Receipt and acceptance of customer order
- Preparation of order form
- Confirmation of order
- Preparation of execution documents
- Physical execution: withdrawal from stock and delivery
- Completion of invoice and billing of customer
- Collection of invoice

Transit Sales Transaction

- Customer requests tokens
- Agent checks terms, prices, confirms availability
- Agent prepares receipt and sales report entry
- Agent gives tokens to customer
- Customer pays agent
- Agent completes sales report of cash

Control documents and approvals should be assessed to ascertain that complex and overbearing mechanisms are removed, since actions which are deemed difficult are often not performed on a regular basis, thus eliminating the usefulness of such processes.

These control analyses, which should enlist the assistance and expertise of internal or external auditors, should be a product of extensive consultations with the persons responsible for supervising and performing the tasks under review. The final product should be reviewed carefully with these individuals to ensure clarity and appropriateness of the program prior to implementation.

When an inadequate control point has been identified, management must determine the appropriate level of effort which should be applied to correct or minimize exposure. Many such weaknesses can be alleviated through investment in technology, reassignment of personnel or redesign of reports and processes. In other cases, compensating controls can be relied upon for revenue protection, particularly in situations where more aggressive protective efforts would require extensive cost or human capital. The listing below provides an example of compensating control elements.

Potential Control Weakness

- Did the customer receive the proper quantity of tokens for the cash tendered to a sales agent?

Possible Controls

- Cameras could view each transaction; an on-site supervisor could view each transaction; a token dispenser could be used to replace the sales agent.

Compensating Control

- The customer will complain to the sales agent in the event that an improper quantity of tokens is received. In the event that the customer is dissatisfied with the transaction, a complaint will be filed with management.

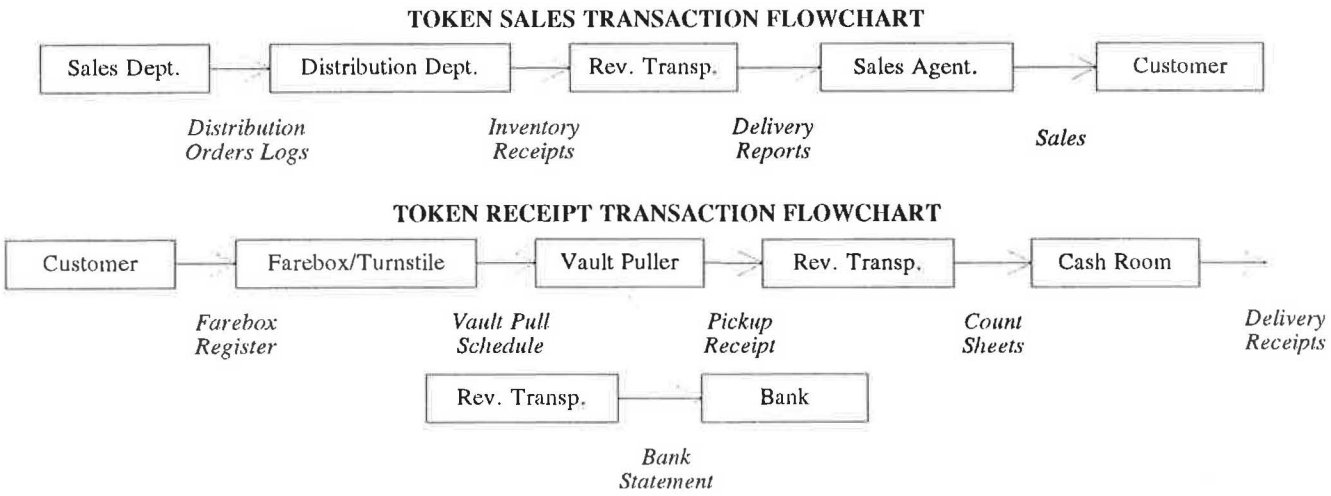

FIGURE 1 Token sales and receipt process.

Data and Information Issues

Senior management in revenue sensitive organizations must have access to data reflective of the performance of revenue operations and the level of service to passengers. Potential forms of management data requirements follow:

Administrative
- Cost per transaction by instrument
- Cost per delivery
- Cost per bank deposit

Control
- Receipts by location, date, time
- Type of receipt, bills/coin, tokens
- Daily token inventory report, by location
- Vandalism analysis, prevention
- Revenue received, by type, by location
- Revenue received compared to prior periods
- Ridership data vs. revenue received

Operations
- Number of distribution points
- Trouble calls
- Vehicle movement reports
- Headcount utilization
- Counting/processing errors

Maintenance
- Percentage of units in service
- Transactions between failures
- Farebox pullouts between failures
- Repeat repairs

Sales
- Number of outlets
- Number of machines
- Number of refunds
- Sales locations, by neighborhood
- Sales by location, by type

Among the most essential financial data which revenue management should receive on a daily basis are the receipts and inventory reports. These reports, which can take the simple format demonstrated below, should be generated through computer interface, secured to minimize the level of employee access to the data input process.

Daily cash receipts are usually determined from the following sources: Coinage can be reported directly from computer meters attached to the coin counting mechanisms. Dollar bill counts can be generated from metered bill counters.

Sales agent figures can be produced from a computerized reconciliation system which is used to reconcile the daily banks submitted by the sales agents.

All receipt figures should be reported into the reporting computer through secured computer modem, producing the consolidated report format shown in Tables 1 and 2. Inventory reporting, which should be performed daily for each type of revenue instrument can be generated through the data from sales reports, inventory journals and distribution logs.

Each day, the total token inventory should balance to the number of instruments purchased from the manufacturer.

Sensitivity to Corporate Perspective

The revenue function has changed in recent years. In the area of sales, the revenue agent transacting the sale of tokens, passes or tickets is perhaps the most direct point of communication between the customer and the firm. Accordingly, sensitivity to the customer's initial perception of the corporate appearance should be of paramount importance at the sales point.

TABLE 1 Daily Cash Receipts Report

	Coinage	Notes	Total Cash	Tokens
Rapid Rail Line 1				
Rapid Rail Line 2				
Subtotal - Rapid Rail				
Bus District 1				
Bus District 2				
Bus District 3				
Subtotal - Bus Districts				
Sales Agent Receipts				
District A				
District B				
Subtotal - Sales Agents				
Total Daily Receipts	_____	_____	_____	_____

TABLE 2 Sample Token Inventory Report

	10 Pack	Loose	Total
On-hand Stock:			
Vault room			
Reconciliation in process			
Distribution Center			
-in safe			
-in process			
-prepared for shipment			
Packaging plant			
Total in Hand			
Sales Locations			
Station agents			
Vending machines			
Sales offices			
Contractors			
Total Sales Locations			
Outstanding Tokens Purchased			
Total Token Inventory	_____ (should always be the same)	_____ (should always be the same)	_____ (should always be the same)

Revenue management should remember that although their function is the control and collection of funds provided by passengers, they also provide essential services to other departments within the agency. Interactions with the transportation department and the maintenance department through performance and training efforts as well as the impact of revenue activities on the firm's scheduling process create opportunities for revenue personnel to address the needs of their counterparts in other departments.

Revenue personnel should maintain responsibility for training all agency employees who deal in revenue issues, such as vehicle operators, cashiers, and rail conductors, in the appropriate revenue issues which the employee will face. Through training techniques such as role playing, employees can become sensitized to the needs of passengers and customers.

Training should be a recurring practice, with each employee receiving some form of reinstruction annually. New employees should receive some interaction with their instructors several months after entering full service, in order to relate specific concerns as well as to present inquiries on revenue issues. At least some portion of the costs associated with such training should be borne by revenue management.

Other needs of the agency, in the corporate sense, can be fulfilled through open accessibility to data generated through revenue systems, particularly those volumes of data available through the use of recent technologies, such as registering fareboxes or entry gates. The interchange of information should involve data pertaining to ridership and revenue data. The agency's budget personnel, traffic managers, rate department and schedule makers should be frequently provided with data created through revenue department technology. In this fashion, appropriate consideration can be given to revenue sensitive issues, as well as actual service demand levels at particular routes or time periods.

Managing Revenue Operations

To present the overall responsibility of a revenue manager's efforts, consider a bell curve. This curve (Figure 2) presents a hypothetical frequency distribution representing the probability that an individual within a population group would steal funds.

In general terms, the left end of the curve represents persons who will ALWAYS attempt to take funds, regardless of conditions, or circumstances. The right end of the curve represents those individuals who will NEVER take funds in any circumstances. The majority of the population of employees can be swayed in either direction by environment and circumstance.

The revenue manager's general function is to sway the population towards the NEVER take category, while using appropriate methods to reduce opportunity for the ALWAYS steal group. The manager's limited resources should be expended in positive efforts for the behalf of the vast majority of employees who are not inclined to misappropriate funds, with less managerial emphasis on the negative. In fact, when the correct atmosphere is created in the work place, the manager will be frequently assisted in the primary task by the employees themselves.

Human Resources Issues

The primary participants in the revenue collection process are the employees. Regardless of the capabilities and complexities of machinery and technological mechanisms used in the process, the entire program must rely on the competence and supporting roles of all assigned personnel to perform the revenue process properly.

Unfortunately, many weaknesses in any revenue system are related to the assigned personnel, who have the access and the capability to misappropriate funds through acts of commission or omission. The manager's function, as in any operating environment, is to maximize return from the employee's competence and capability, while minimizing the employee's exposure or incentive to act improperly.

Import of Employee Relations

Interaction with the appropriate bargaining unit representatives can offer great assistance in the implementation of a revenue management program. Rather than approaching the employee groups in an adversarial fashion, some success can be achieved in this arena through participation.

The nature of revenue protection task requires some confrontation with employees who do not perform their responsibilities in a proper fashion. However, managers should remember that the labor grievance process consumes energy and the resources of both the firm and the bargaining units which could be better used in a more positive effort. The pursuit of one grievance or judiciary process can cost the agency over $100,000 in management time, replacement labor costs and the costs incurred in the event that a grievance is upheld for labor. The bargaining unit also incurs costs. Accordingly, it is financially astute of both management and labor to avoid such activities through preventive efforts in the arena of personnel management.

It should be noted that the level of success related to necessary disciplinary proceedings can be greatly enhanced through thorough training of supervisors and managers in the specific legal requirements associated with proof of wrongdoing, custody of evidence and the vagaries of entrapment.

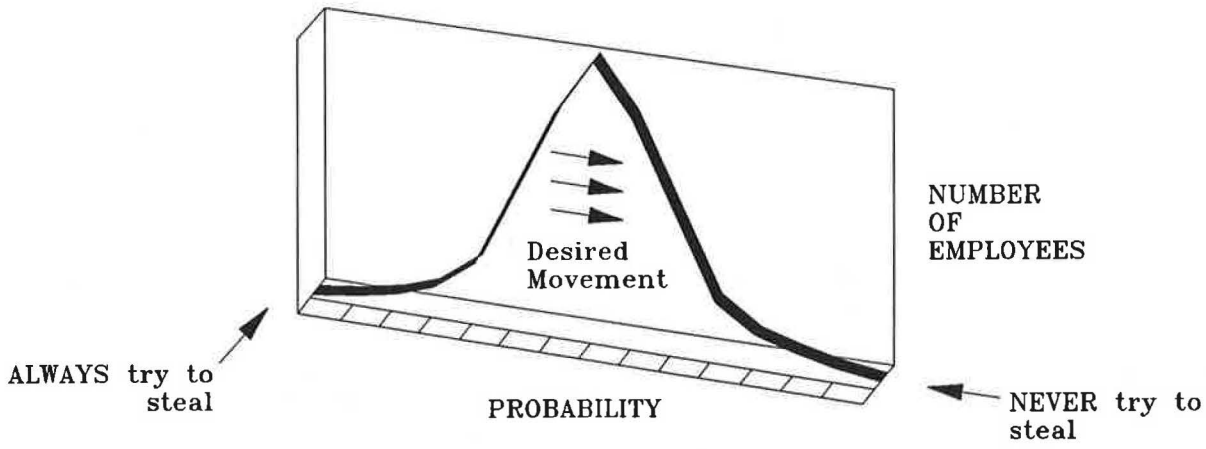

FIGURE 2 Propensity to misappropriate revenue.

Although many transit supervisors assume that each employee will attempt to misappropriate funds, consideration should be given to alternative positions, such as the possibility that the individuals are appearing at the worksite to perform their tasks in return for their wages. Every effort should be made to encourage this line of thinking, since the alternative is management through fear with the implementation of an aggressive and expensive police program designed to capture, prosecute and punish the workforce.

Through the development of a positive relationship with revenue employees and their bargaining unit representatives, significant progress can be achieved in the general attitudes affecting the business.

Through the formation of employee/management programs, the efforts of both personnel and supervision can be recognized and applied to the overall improvement of revenue operations.

Programs such as intra-departmental contests, with a schedule of pre-defined parameters, such as those noted next, and *de minimus* awards, such as gift certificates, can be developed with labor, in such areas as productivity, attendance and general performance among peer groups. A contest may award points for such items as reduced sick days or reduced equipment failures. Another program may solicit comments from the department's customers, such as the transportation department or the vehicle maintenance department. Favorable ratings might then be used in an award program.

Performance
- Productivity—on schedule, volume
- Safety—injuries
- Equipment handling—breakages per volume
- Equipment performance (maintainers)

Paperwork
- Completeness
- Accuracy
- Legibility

Uniforms
- Appearance
- Completeness

Customer Satisfaction (from Operating Depts)
- Timeliness
- Cooperative Attitude
- Accuracy, Quality

Facility
- Appearance
- Security
- Safety

Attendance
- Latenesses
- Unscheduled Leave

Suggestion programs have also been found helpful in several instances. Through such programs, the technical expertise of employees at every level can be tapped for the purpose of improving the overall activities of the revenue function.

With the involvement of union representatives, as well as other employees and first-line supervisors, such programs can be very helpful in improving employee relations, while providing the company with needed improvements in productivity or cost reduction.

Import of Overall Working Conditions

Managers often place the blame for revenue loss or "shrinkage" on the employees. However, in order to understand cause more fully, a manager should first

consider the employees' position in ascertaining the reason for a theft or loss.

The manager must honestly determine what can be expected to occur if an employee is placed into an inhospitable, often dangerous environment, with little support, frequent confrontation with customers, risk of personal financial exposure for unintentional or unrelated shortages, risk to personal safety due to robbery, and constant pressure or abuse from supervision.

To this picture, add an undeserved stereotypical reputation of corruption or laziness that is frequently ascribed to the employees in revenue positions. Now place this employee into a position in which they are in direct contact with clearly uncounted, unproved cash for even a short period of time.

Over time, most people who are placed into such circumstances for eight hours or more daily for a period of months or years, will be tempted to "borrow" some of the cash for personal use, such as lunch, with the full intent to replace the funds at a later time. Unfortunately, the intention to repay becomes forgotten over time, particularly with continued success in avoiding detection or suspicion.

The result is a revenue loss. In such instances as those described, revenue loss can be prevented through a concerted effort by the firm's management to address each of the issues that created the situation.

Causes of Internal Theft and Remedies

The basic causes of internal theft are ". . . need, greed, revenge or challenge."(*1*) In most instances such conditions exist through management's failure to address employee needs or basic quality of life standards which are expected to exist in any work place. In order to correct this environment, managers must exert sincere efforts to improve the conditions. Some of the actions which can be taken include those items are noted below.

- Provide employees with information of the revenue control process in its entirety. "No man is an island," nor is any revenue employee a free agent. Many mechanisms are in place to identify loss or misappropriation. All employees should be aware of this fact, and should be encouraged to offer improvements to the process. Such knowledge of control systems may be sufficient to discourage attempts at theft.
- Ensure that the employees' specific responsibilities and duties are clearly stated and understood by all parties, including direct supervisors.
- Ensure that the employees' duties are commensurate with the individual's educational skills. (i.e., does a sales agent with only a grade school education understand what a reconciliation is?)
- Provide continual training to employees and supervisors in all aspects of their duties. Training should address not only the technical aspects of the position, such as fare types, machine operation and weapons handling, but also issues such as basic negotiation skills involving customers, or basic management training in areas such as stress management.
- Improve the quality of work facilities in minor ways, such as painting work areas, correcting HVAC problems or providing clean chairs and work tables.
- With the participation of bargaining units, redefine employee job descriptions to ensure that the employee's time is fully utilized, in order to prevent boredom. As an example, a vault puller may become involved in quality control or preventative maintenance issues involving fareboxes.
- Develop employee sensitivity to revenue control as an important aspect of the company's activities. The more money collected by the revenue department means more funds for the firm, with resulting benefits to the employees.
- If applicable, eliminate the reputation of some revenue jobs as last chance, dead-end jobs. In fact, corporate culture should be amended to cure this condition, if it exists, since it is not prudent to place the fiscal health of a firm with the last chance crowd.
- Enhance the self-esteem of the employees through intra-departmental contests or posting of departmental performance statistics.

Through implementation of basic management tools, such as training, communication and job enrichment, a firm can achieve extensive returns through enhanced employee morale. In light of the importance of the employees to the success of a revenue operation, costs incurred in the development and implementation of such activities can create extensive benefits.

Treatment of employees with distrust and abusive management tactics can only create a breeding ground for mishandling of revenue. Conversely, by implementing a cooperative effort with employees to improve the revenue process with mutual respect and mature interaction with the firm's adult employees an atmosphere will be created in which individual will think before stealing—that will sway the vast majority of the population bell curve.

Organizational Structures

In order to assist in the focusing of corporate attention and resources on the revenue issues, a goal for every transit property should be the formation of a segregated revenue department, which should have full and sole responsibility related to this important area.

Responsibility Centers

The location of revenue responsibilities within a transit organization structure is an essential ingredient to successful achievement of revenue control goals.

An inability of revenue supervision to capture the attention of management in an atmosphere where revenue issues must compete with transportation or vehicle maintenance issues can create serious morale problems at all levels of revenue personnel. One method to develop a level of necessary specialization, expertise and management focus on revenue within a transit organization is through the creation of a centralized revenue department, segregated from all other operational responsibilities, with sole responsibility for all revenue issues.

Figure 3 presents one form of a revenue department, which holds responsibility for a variety of areas.

Some recommended duties for each branch of the revenue department are presented below. It should be noted that the sales department is well suited to serve as the agency's central clearing house for all customer transactions, including the training of customer service agents and other employees who may have interaction with the customers on a regular basis.

Sales

- Station management of rapid rail stations, light rail stations and commuter rail stations, including management of collectors and station agents.
- Third party sales program oversight, including management of distribution and reconciliation functions as well as policy formulation and expansion of all third party sales activities.
- Management of on-board sale and collection of revenue instruments.
- System wide revenue training of all employees and third party contractor employees, including vehicle operators in issues related to fare collection and control.

Revenue Control

- Development of revenue control sensitive practices for handling cash resources and revenue instruments.
- Control over all revenue system security, including access locks and key control.
- Ongoing analytical reviews of receipts to identify potential anomalies in the levels of receipts.
- Design and servicing of revenue sales machines, including fareboxes, token, transfer and ticket dispensers.

Revenue Operations

- Transport and reconciliation of pass, token and railroad ticket inventory to all sales points.
- Farebox vault pulling at bus and light rail districts.
- Turnstile pulling at rapid rail locations.
- Transportation of receipts from collection points to central cash room and from central cash room to bank.
- Maintenance of all revenue sales and collection equipment, including sales machines, fareboxes, turnstiles and cash room equipment.
- Operation and maintenance of parking lot facilities, including fee collection and control measures.

Cash Room Operation

- Distribution and reconciliation of pass, token and railroad ticket inventory to all sales points.
- Operation of central cash facility.
- Preparation of bank deposits and sales agent banks.

Control Considerations

In forming a revenue department, basic consideration must be given to the presence of internal controls in the structure. Through installation of a pattern of segregation of duties between parties involved in a transaction, adequate protection of revenue can be installed into the transaction flow.

Each transaction should be carefully evaluated to ascertain the applicable control points in the process. As the example presented in Figure 4 demonstrates, a sales transaction involves an inventory control feature, a sales reporting feature and a bank deposit feature. Persons performing these functions should be located in different departments or sections, when possible. Accordingly, in the proposed organization, Revenue Operations personnel would be responsible for the inventory of passes, sales department personnel would perform sales and produce sales reports, and Cash Room personnel would perform revenue counting and bank deposits.

The Control department would assess the various documents produced during these steps of the process to ensure that the figures reported are in agreement.

Many agencies do not have sufficient resources to implement a complete system as defined. In these cases, great care must be taken to create some form of independent verification of relevant documentation on a regular basis. Where available, data produced from automated sales or collection equipment can be used to confirm the accuracy and completeness of bank deposits.

Interaction with Operating Departments

In managing a specialized revenue department, the development of mutually beneficial interactions with the operating departments is essential to the success of the organization's efforts.

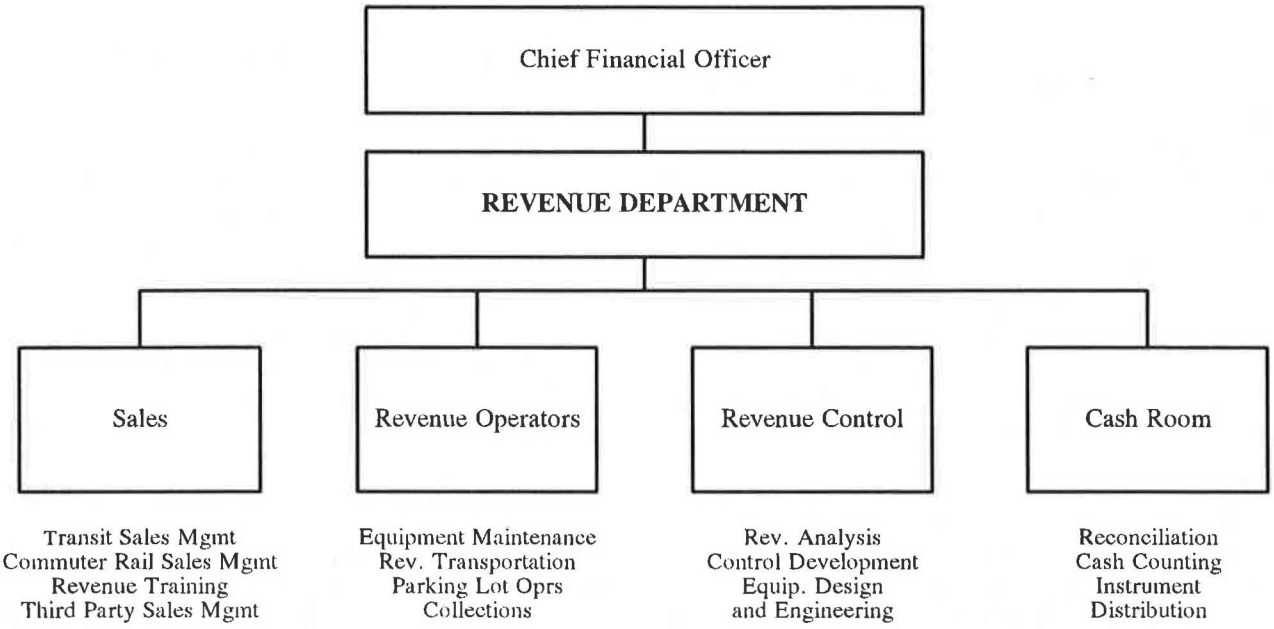

FIGURE 3 Specialized revenue department organization structure.

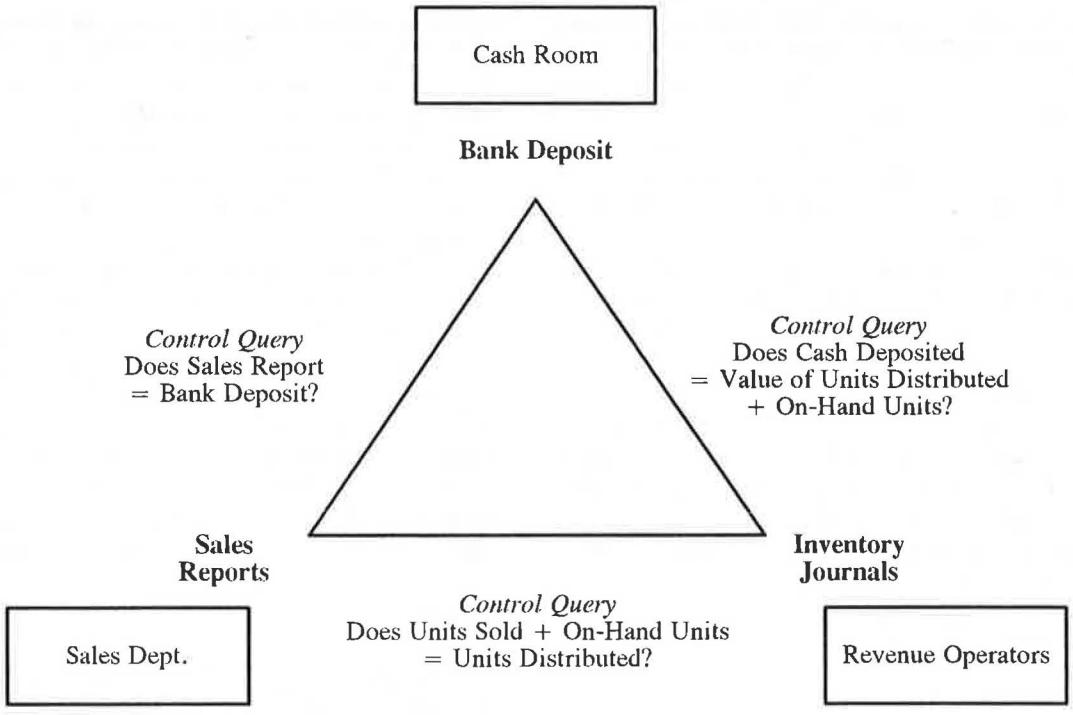

FIGURE 4 Sample control analysis sales transaction controls.

In the area of training, the revenue department should play an important role in the development and implementation of ongoing revenue training programs for the benefit of those operating personnel who are included in the revenue stream.

Personnel such as bus drivers and rail vehicle crews should be frequently reminded of their responsibilities concerning the collection of revenue from passengers. These employees should receive continuing instruction and assistance in issues related to the fare structures of the company, as well as in developments of new fare systems.

Due to the variety of their daily experiences, vehicle personnel can often provide more accurate information regarding passenger concerns involving fares than any number of analysts, supervisors or passenger focus groups. Such information should be sought and acknowledged by the revenue department.

Operating management and supervision should be consulted in the development of revenue schedules for activities such as vault pulling and farebox maintenance. Their comments should also be solicited in the evaluation of revenue personnel performance within the operating environment, particularly in areas directly related to the provision of service to the firm's passengers.

Transaction Structures

Transaction Types

Two basic types of transactions exist in the transit environment—those that can be reconciled and those which cannot be reconciled. Clearly, the efforts of revenue management should be focused on the formation of the former and the elimination of the latter.

Reconciled transactions are those which are related to the sale of an inventory of product, with pre-defined quantity and value. Through control of access to the product inventory and through comparison of bank deposits and distribution logs to reported sales, the amount of expected receipts can be clearly identified and adequately protected.

Unreconciled transactions, which unfortunately are a major part of the transit revenue business, are related to the sale of a product or service in a quantity which can not be pre-defined. Accordingly, the level of expected receipts can not be identified with certainty, thus precluding the ability to protect them with confidence.

Revenue Modals

Among the controls which can be used to protect unreconciled receipts is the development of a revenue modal to be used in identifying variances from the norm. Using standard statistical techniques, a control analyst should develop trend analyses, by instrument, location, date and transaction type which can be used to detect aberrations. Such aberrations can then be investigated fully to ascertain the propriety of the variance. Factors which would be considered in the formation and evaluation of revenue modal data include:

- Holidays
- School holidays
- Weather conditions
- Equipment conditions
- Traffic conditions

Control Standards

Prior to the development and evaluation of revenue transaction processes, management should develop baseline control standards which should be evidenced at each step of a procedure. Such standards should reflect the fare policies and service requirements of the particular agency. Potential baseline standards include:

- Cash handling must be minimized throughout the chain of transactions; cash should be handled in a "sealed pathway" from the customer to bank.
- The use of "reconcilable" transactions should be maximized.
- Revenue instruments must be treated in the sales stream as cash; passes, transfer, tokens and tickets should be handled in a "sealed pathway" from printer/manufacturer to cash room to seller to customer.
- Fare structures should be simplified to avoid customer confusion and to reduce the level of subjectivity at the collector level.
- The particular responsibility for sales shortages should be ascertained at each transfer point through activities such as field sales reconciliations performed by properly trained supervisors.
- The number of unreconciled transactions should be minimized through the use of discount pricing and expanded availability of pre-paid revenue instruments.

Sales Collection and Control Equipment Issues

Equipment failure can be demonstrative of a wide spectrum of related system weaknesses, such as inadequate maintenance due to poor workmanship, inadequate training, inadequate facilities or lack of parts. Such failures create a host of problems, such as revenue loss from passenger "free fares," travel delays, theft due to frequent access to failed equipment and poorly controlled cash vaults. Passenger annoyance at difficulties encountered with unreliable fareboxes or entry gates can adversely affect ridership over time.

Equipment management is a major issue facing all revenue managers as new computer technologies become increasingly available to transit fare applications. Although these technologies can greatly enhance the levels of control by providing expanded reconciliation capabilities, as well as extensive data on revenue and ridership, managers must assess the cost of the equipment and the associated operating costs in the context of potential revenue loss.

New types of equipment can be designed in a fashion which can greatly reduce overall incident maintenance expense, however, preventive maintenance becomes increasingly important as the delicacy of the technology is tested by the harshness of most transit environments. Furthermore, in order to derive the full benefits of data collection and control which these machines can provide, it is necessary to assign extensive analytical resources to the process. Otherwise, the extensive volumes of reporting and control features, for which the agency has paid, will quickly overwhelm management.

Understanding these issues, it remains clear that the application of new technology is a desired long term goal for the industry. In order to maximize the benefits available from existing and newly acquired equipment, several areas should be of concern to revenue management.

Preventive Maintenance and Controls

The maximum return from an agency's investment in equipment can only be achieved through the performance of a thorough preventive maintenance (PM) program. Such programs in the revenue context are unique, in that technological issues must be applied within the constraints of revenue control and security.

Different levels of PM activity should be developed by management, with assignment of individual tasks to employees at the appropriate level of expertise. In this way, a PM farebox cleaning could be performed by a third-class maintainer or vault puller, while more complex electronic component replacements can be assigned to a specialist or first-class maintainer. The varying levels of expertise can also serve as a *de-facto* apprenticeship program.

A PM program should provide for the replacement of parts before they fail, in order to minimize service disruptions to the passengers. Assessment of failure incident data, such as primary cause, life of failed unit, repeat repairs and service conditions should be performed in order to generate a PM replacement policy for each individual part. Appropriate unit scheduling can then be developed.

Installation of quality control programs and continual shop enhancements should be a part of the overall program. Statistics such as "pullouts between failures" or "transactions between failures" should be developed and continually monitored by management to ascertain levels of quality control and shop performance. Problematic conditions should generate manufacturer assistance, as appropriate.

Control issues involving any revenue sensitive maintenance activity, particularly in the field, should be developed in the design phase of the equipment acquisition. However, such considerations as access control and inventory control can be implemented at any time in the life cycle.

For proper security over the maintenance function, it is essential that control be maintained over tools, keys and equipment parts. Documents such as manuals, designs and programs should also be stored and accessed in controlled fashion.

Each component of equipment, should be cataloged by serial number, and the movement and specific assigned location of each component should be carefully monitored through a data base system. Security sensitive devices, such as farebox vaults should be repaired or maintained only in a secured environment, such as the cash room, where appropriate keys should be secured. No vault keys, such as "teardrop devices" should ever be allowed to leave secured areas.

Access to the equipment in the field by maintenance personnel should be carefully monitored, as well. Through development of strict scheduling of equipment maintenance, entry into units can be restricted through daily key assignments, parts inventory usage or tool target systems. Perhaps a cleaning assignment requires no keys, whereas a feeder belt replacement action may necessitate access only to the top of a unit. The most secure arrangement might entail the movement of the entire unit from the field into a secured facility with no on-site access needed, however, this type of control process may generate greater costs that the funds protected.

Of course, with the implementation of new technologies, card access controls can identify each entry into a unit for the most effective control on this area.

Security and Alarm Processes

The security of revenue equipment is another issue which can be best addressed at the design stage of the equipment's life cycle, however, many concepts can be implemented at any time.

Security of revenue equipment must be viewed not only from the perspective of protecting the revenue from internal mishandling, but also from the aspect of vandalism, burglary and robbery.

Internal mishandling of revenue is primarily addressed in hardware terms through control over access to the machine itself as well as to the vault component, in place or in transit. Processes as discussed earlier, such as

scheduling and tool and part inventories can assist in this effort. Key security, even under the most controlled systems, can hinder but not prevent improper access through key loss or duplication, particularly by technically competent personnel.

Issues such as vandalism and burglary can be addressed with the assistance of police personnel, as well as with the installation of covered hinges and locks, sloped machine tops and graffiti resistant surfaces. The prospects of robbery of servicing personnel must be carefully considered by management in decisions related to the placement and positioning of equipment, as well as in the scheduling of maintenance and revenue servicing activities. The use of teams for performing such duties may be a valuable option.

Equipment alarm systems, whether for security or for servicing needs, are only useful if response to a call is achieved in a prompt fashion. On-site alarms and sirens are of minimal use, except in those locations where employee reaction can occur. Computer generated alarms are also useless unless police or appropriate operating personnel have immediate notice of the alarm in order to assign response. One solution to this requirement is the placement of a revenue control center in close proximity to operation and police control units. Through this mechanism, immediate response to standard and emergency maintenance, inventory or police requirements can be assigned quickly.

A revenue control center can also address the needs of any revenue servicing vehicles which may be in service. Continued radio communication with each vehicle is helpful in addressing assignment, schedule and security issues. Mechanical breakdowns or security problems can be immediately communicated by radio to the center, with appropriate response provided efficiently.

Equipment Acquisition Considerations

In formulating any revenue equipment acquisition project, control concerns should be of paramount concern. All aspects of the design should address security, and reporting requirements, as well as operational concerns. A primary concern of the designers should be the requirements of the customers, who in many instances are unable to communicate in common fashion, due to language barriers or illiteracy. Equipment operation procedures should be developed to ensure simplicity in operation and ease of use. For employee safety, door opening processes and ease of access to components by servicing personnel should be designed to prevent injury and deter robbery.

For security and control purposes, access and involvement in all design activities should be carefully monitored and controlled. Control of keys, alarm codes and security passwords in the possession of the manufacturer should be monitored continually, both during the project implementation as well as continually through system operations. In the implementation of the procurement, it is also imperative that all programs and manuals related to the equipment be provided to the transit operator in the early stages of the project.

In the interest of project efficiency and warranty concerns, the manufacturer should be held responsible for installing the equipment as a primary task within the procurement.

Dramatic cost savings and improvements in performance can be achieved through the use of existing equipment designs, which have been proven in similar applications. In addition, opportunities may exist to work with the manufacturer in a joint Research & Development project, in which the cost of the equipment is significantly reduced in return for installing test equipment which the manufacturer may be developing for its general product lines.

The quality and security of communication links are particularly important in the use of newer technologies which provide reporting capabilities. The transit agency should consider the opportunity to upgrade its telecommunications network in the context of a revenue equipment project, with potential assistance and mutual benefits from local telephone or cable television firms in the event that fiber optics technology can be useful to the purpose.

Reporting systems for equipment systems should be designed in a fashion which allows security and consistency in all applications, with the intent of consolidating reporting programs for all sales, collection and counting equipment to fully automate the reconciliation and control processes of the agency.

Financing Activities

Revenue management can use private sector financing mechanisms to assist in the acquisition of technological improvements to the revenue process. Virtually any capital equipment, such as fareboxes, dispensing machines or turnstiles can be funded on a "pay as you go" basis rather than on a pay at delivery basis through leasing transactions or vendor financing. In this way, transit operators can leverage the use of scarce capital grant resources by disbursing only small periodic payments each year, rather than larger acquisition payments in the year of delivery of these rather expensive systems.

Another alternative to consider involves the formation of partnerships with third party firms, such as banking institutions, to participate in the acquisition of capital equipment. Several examples of such transactions have occurred, in which banking institutions have acquired automated teller machines, converted the equipment to sell transit passes or tickets and placed the equipment into

transit sales points. In return for a commission on sales, the bank maintains and services the machines with transit revenue instruments. The bank's customers may also use the machines to obtain cash withdrawals as in standard ATM machinery. In a transaction of this nature, the transit operator receives the benefits of a dispensing machine without incurring capital costs of acquisition.

Privatization Opportunities

In transit circles today, many efforts are underway to identify methods for private sector firms to assist in the delivery of transit services. Revenue activities can offer many such opportunities for public transit operators to benefit from the administrative and management mechanisms employed by private firms in the performance of similar activities.

Private, for-profit entities clearly have the expertise to capture and collect revenue in a controlled environment on behalf of the transit operator.

Through development of partnerships or service contract arrangements with private entities, the public transit industry can gain valuable knowledge as well as operating cost savings.

Private-Public partnerships can be used to implement "turnkey" design and build programs to acquire new revenue sales or collection equipment. Such partnerships can address financing issues as well. In addition, many opportunities exist for the use of private firms in the performance of revenue duties. The privatization opportunities for consideration by transit operators—many of which are already in practice at public agencies in the United States—include:

Sales

- Off-site pass/ticket/token sales offices
- Rapid rail station management
- Commuter rail station management
- Pass/token/ticket vending machine mgmt.
- Pass/ticket/token mail sales programs

Revenue Operations

- Currency processing
- Revenue equipment maintenance
- Revenue instrument distribution
- Transportation services
- Vault pulling and cash room operations

Control

- System engineering and equipment design
- Analytical reviews

Conclusions

The management of revenue in the transit industry has become a growing concern of operating agencies. The need to develop sales programs, implement new technologies and collect greater levels of fare revenue to meet spiraling operating costs are issues faced by every transit firm.

Only through the use of private sector management techniques involving marketing, accounting controls, finance, statistics and personnel management, can public transit operators achieve the levels of revenue development and protection which are the lifeblood of every private company.

With enhanced sensitivity to customer needs, responsible treatment of personnel issues, and application of basic operating methods involving inventory and access control, the revenue streams of transit entities can become a reliable factor in the funding of mass transportation.

Potential Research Issues

Among the areas of revenue management which should be considered as review issues, the following recommendations are presented:

Assess psychological studies related to theft and tendencies to steal, as affected by the transit work environment.

Develop a uniform mechanism to assess appropriate and recommended educational levels of employees involved in the revenue process.

Develop a uniform mechanism for assessing the educational levels of passenger customers within the service area, for use in the development of revenue policies and equipment designs.

Develop a standardized system for reconciliation and revenue instrument inventory control.

Identify features of banking institution control systems which may be directly applicable to transit revenue processing.

Evaluate the costs and benefits of vehicle journey "transfer" fare structures, with consideration to control issues.

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Transit Cooperative Research Project Update

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Transit Cooperative Research Program Project A-1 Fare Policies, Structures, and Technologies

This study is part of the new Transit Cooperative Research Program (TCRP) being administered by the Transportation Research Board. As you may know, problem statements developed by a number of sources, including TRB Committees, have provided the basis for the first set of research projects for the TCRP. This project—Fare Policies, Structures, and Technologies—represents the combination of numerous research issues and problem statements, including several identified by the TRB Committee on Fares and Marketing.

Joseph Simonetti, from the Chicago Transit Authority, is the Panel Chair for the project. The research team on the study is comprised of Multisystems, Inc., J. W. Leas & Associates, R. L. Oram & Associates, and Applied Systems Institute. I would like to review the main elements of the study and the current status of different activities. Also, I hope we will have the opportunity over the course of the Workshop to discuss ideas and issues you would like to see addressed in the project.

The study is very broad in scope. It is based on the realization that transit agencies currently use a wide range of fare policies and structures in response to fiscal constraints, operating needs, and the changing demands of the market. Further, new approaches to fare collection and media distribution are becoming available through the application of advanced technologies. At present, there appears to be little systematic evaluation of the relationships among fare policies, fare structures, and emerging fare collection and distribution technologies.

One of the major purposes of the project is to examine and evaluate how fare policy objectives can be addressed through current and emerging practices and technologies. This should provide transit agencies and other interested groups with a better understanding of the costs, benefits, and trade-offs in adapting evolving technologies to address local needs and conditions. Thus, the main objective of the research study is to provide guidance for all sizes of transit agencies in evaluating appropriate fare structures and technologies and making fare policy decisions.

The project is divided into four phases. The first phase will provide a state-of-the-art review of current practices and develop a framework and methodology for evaluating the interrelationships among fare policies, structures, and technologies. A preliminary analysis and evaluation will also be conducted in the first phase using this framework and methodology. An interim report will be prepared detailing the results from the first phase.

The project was just initiated a few months ago. It is scheduled to be accomplished over a 27 month time period, with completion in June of 1995. Phase I of the project is currently underway. Information from members of the research team, relevant literature, industry databases, and discussions with transit professionals are all being used to identify the current state-of-the-art practices related to fare policies, fare structures, and fare collection and distribution techniques. The results from this will be used to develop and apply a framework and methodology for analyzing and evaluating the interrelationships among these three parameters.

A variety of fare policy issues have been identified already from the preliminary review. As you know, transit agencies currently utilize a wide range of fare policy goals. Fare policies often attempt to address customer-related, financial, management-related, and political issues. The importance of these goals and concerns vary between systems in response to local needs and issues. Further, fare policies may change over time in response to changing priorities. In addition, many fare-related goals are competing and resolving conflicts among goals is not easy.

Phase I will also examine the generic types of fare structures being used throughout the country. Fare structures currently in use include flat fares, consumer-based fares, distanced-based fares, and service-based fares. Pre-paid fare options are currently very popular. According to the American Public Transit Association (APTA), 75 percent of the systems, including 85 percent of the rail systems, offer passes. Further, 45 percent of the reporting transit systems offer discounted tickets or tokens. Fare differentials based on time of day and distance appear to be less common, with 37 percent of the systems reporting the use of distance-based fares and only 5 percent utilizing time-of-day differentials.

Fare payment methods are also being examined in the first phase. Current fare media and payment methods include cash, tokens, paper tickets or time-based passes, magnetic cards, smart cards or memory cards, and credit or debit cards. The type of fare media used is often related to the fare collection strategy, the type of fare structure, and the policy goals. The fare collection and media distribution strategies are also being documented. A summary of current techniques is being compiled.

The next activity in the first phase is to develop an evaluation framework and methodology. This includes the identification of the key decision points and the questions that should be addressed in making fare-related decisions. Three generic approaches to fare-related decision-making have been identified at this point. One is a policy approach, one is a technology-driven approach, and the third is a service-oriented approach.

The study is beginning to examine the development of the framework and methodology. This is one area we would like to get feedback on from the participants at this Workshop. The nature of the interrelationships is very complex and developing a practical structure that can be applied by a variety of operators will be a challenging task. This portion of the first phase will also identify the advantages and disadvantages of different technologies, develop possible evaluation criteria appropriate for different sized transit systems, and produce evaluation matrices to help analyze how well alternative fare structures and technologies address various policy goals. Further, it is anticipated that the study will identify and rank appropriate combinations of fare structures, fare media, collection strategies, and equipment by different sizes of transit systems and different modes.

The first phase is scheduled to take six months. A revised work program will be developed and submitted to the Panel at the end of Phase I. Based on approval from the Panel and authorization from TRB, the next phases will then be initiated. At this point, it is anticipated that a case study approach will be used in Phase II to conduct a detailed analysis and evaluation of the interrelationships among fare policies, structures, and technologies. The case studies will be selected based on systems that either have made or are planning to make significant fare-related changes. The case studies will address a range of system sizes and modes, fare structures, and technologies. A cross-cutting analysis of the case study results will also be conducted to evaluate the relative advantages and disadvantages, the costs and benefits, and any additional issues associated with different combinations of fare structures and technologies.

Phase III will focus on fare-related technology developments and the potential application of emerging technologies from other fields to public transit. Key trends will be identified and analyzed, and possible applications will be discussed. An interim report will be prepared documenting the results of this phase.

Phase IV will focus on the development of a set of procedures and guidelines for use in making decisions regarding fare policies, fare structures, and fare technologies. These will be designed to address the needs of a range of transit agencies and operators. Thus, the outcome of the project is intended to produce a practical set of guidelines for use by technical staff and decision makers. The final report, which will document all aspects of the study, will also be prepared in this phase.

Thank you again for the opportunity to present a brief summary of this very interesting and exciting research project. I would be happy to discuss the study further with you, and I welcome any comments or suggestions you might have on elements that should be examined in the study.

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