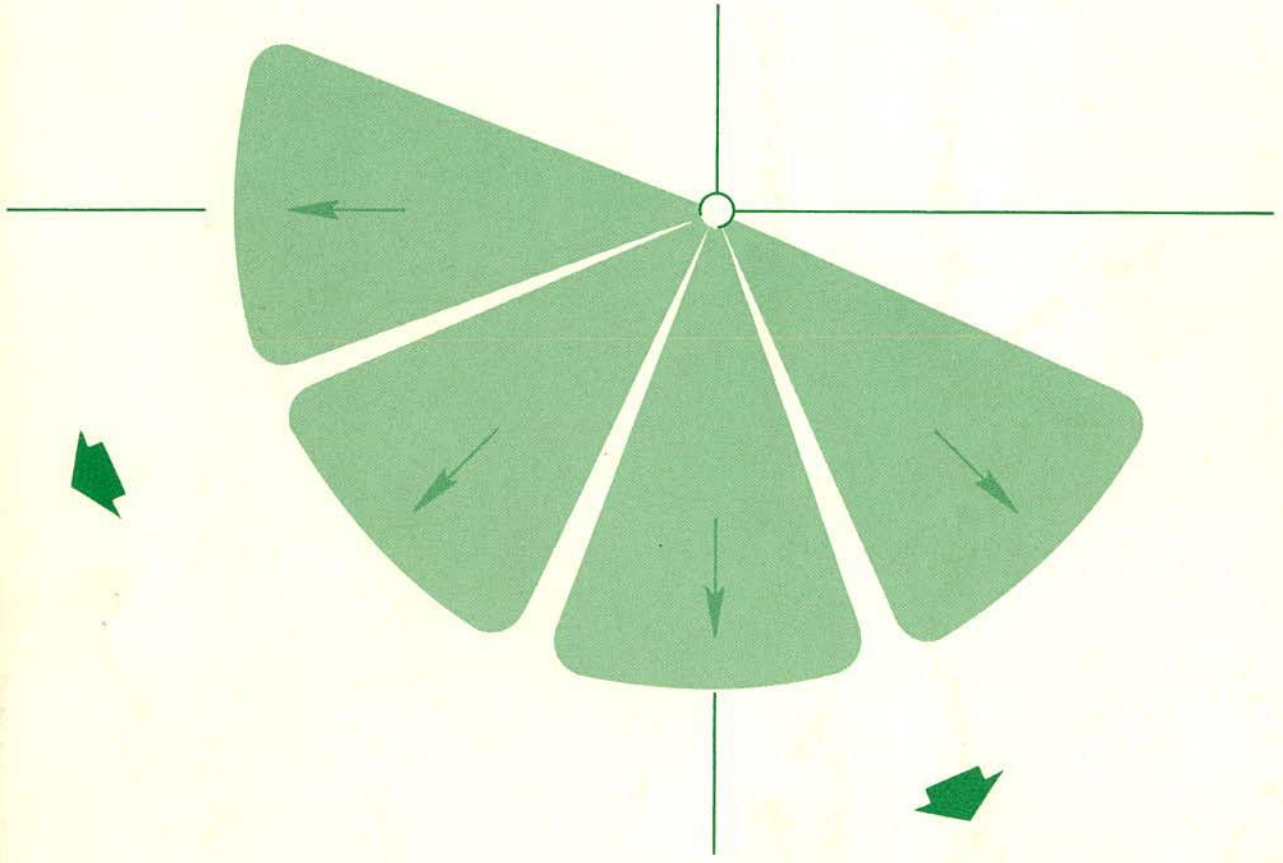
SPECIAL REPORT 190

Transportation System Management in 1980

STATE OF THE ART AND FUTURE DIRECTIONS



TRANSPORTATION RESEARCH BOARD
NATIONAL ACADEMY OF SCIENCES

The Transportation Research Board is an agency of the National Research Council, which serves the National Academy of Sciences and the National Academy of Engineering. The Board's purpose is to stimulate research concerning the nature and performance of transportation systems, to disseminate information that the research produces, and to encourage the application of appropriate research findings. The Board's program is carried out by more than 250 committees, task forces, and panels composed of more than 3100 administrators, engineers, social scientists, attorneys, educators, and others concerned with transportation; they serve without compensation. The program is supported by state transportation and highway departments, the modal administrations of the U.S. Department of Transportation, the Association of American Railroads, and other organizations and individuals interested in the development of transportation.

The Transportation Research Board operates within the Commission on Sociotechnical Systems of the National Research Council. The National Research Council was established by the National Academy of Sciences in 1916 to associate the board community of science and technology with the Academy's purposes of furthering knowledge and of advising the federal government. The Council operates in accordance with general policies determined by the Academy under the authority of its Congessional charter, which establishes the Academy as a private, nonprofit, self-governing membership corporation. The Council has been the principal operating agency of both the National Academy of Sciences and the National Academy of Engineering in the conduct of their services to the government, the public, and the scientific and engineering communities. It is administered jointly by both Academies and the Institute of Medicine.

The National Academy of Sciences was established in 1863 by Act of Congress as a private, nonprofit, self-governing membership corporation for the furtherance of science and technology, required to advise the federal government upon request within its fields of competence. Under its corporate charter, the Academy established the National Research Council in 1916, the National Academy of Engineering in 1964, and the Institute of Medicine in 1970.

Transportation System Management in 1980

STATE OF THE ART AND FUTURE DIRECTIONS

SPECIAL REPORT 190

This report contains the proceedings of a workshop sponsored by the Urban Mass Transportation Administration and the Federal Highway Administration, U.S. Department of Transportation, and conducted by the Transportation Research Board, November 26-29, 1979, in Arlington, Texas.

Transportation Research Board
Commission on Sociotechnical Systems
National Research Council

National Academy of Sciences
Washington, D.C., 1980

Transportation Research Board Special Report 190
Price $5.60
Edited for TRB by Frances R. Zwanzig

modes
1 highway transportation
2 public transit

subject areas
11 administration
12 planning
54 operations and traffic control

Transportation Research Board publications are available by ordering directly from TRB. They may also be obtained on a regular basis through organizational or individual affiliation with TRB; affiliates or library subscribers are eligible for substantial discounts. For further information, write to the Transportation Research Board, National Academy of Sciences, 2101 Constitution Avenue, N.W., Washington, DC 20418.

Library of Congress Cataloging in Publication Data
Conference on Transportation System Management, 2d, Arlington, Mass., 1979.
Transportation system management in 1980.

(Special report—Transportation Research Board, National Research Council; 190)

Proceedings of a workshop sponsored by the Urban Mass Transportation Administration and Federal Highway Administration, U.S. Dept. of Transportation, and conducted by the Transportation Research Board.

Includes bibliographical references.

1. Urban transportation policy—United States—Congresses. 2. Transportation—United States—Congresses. I. United States. Urban Mass Transportation Administration. II. United States. Federal Highway Administration. III. National Research Council. Transportation Research Board. IV. Title. V. Series: National Research Council. Transportation Research Board. Special report—Transportation Research Board, National Research Council; 190.
HE308.C653 1979 388.4'0973 80-18435
ISBN 0-309-02996-1 ISSN 0360-859X

Sponsorship of the Papers in This Transportation Research Board Special Report

Committee on Transportation System Management
David W. Gwynn, New Jersey Department of Transportation, chairman
Gary E. Maring, Federal Highway Administration, secretary
Paul N. Bay, William D. Berg, Alinda Burke, E. Wilson Campbell, Robert J. Conly, John P. Eicher, Ralph Gakenheimer, Charles A. Hedges, Harvey R. Joyner, David R. Koski, David A. Lee, David M. Levinsohn, James J. McLary, Michael D. Meyer, Mark R. Norman, Chester F. Phillips, John J. Roark, Morris J. Rothenberg, Warren O. Somerfeld, Edward F. Sullivan, Warren Travers, Herman Volk

Conference Subcommittee

John J. Roark, PAWA, Inc., chairman
Paul N. Bay, Tri-Met, Portland, Oregon
Milton L. Brooks, Urban Mass Transportation Administration
Alinda C. Burke, U.S. Department of Transportation
Robert J. Conly, U.S. Department of Energy
Ralph Gakenheimer, Massachusetts Institute of Technology
David W. Gwynn, New Jersey Department of Transportation
Harvey R. Joyner, Barton-Aschman Associates, Inc.
David R. Koski, city of Minneapolis
David A. Lee, Metropolitan Transit Commission, Minneapolis
David M. Levinsohn, U.S. Environmental Protection Agency
Gary E. Maring, Federal Highway Administration
Michael D. Meyer, Massachusetts Institute of Technology
Warren O. Somerfeld, Madison Transportation Department
Warren Travers, Travers Associates, Inc.

James A. Scott and David K. Witheford, Transportation Research Board staff

The organizational units and officers and members are as of December 31, 1979.

Contents

Introduction

Michael D. Meyer, Department of Civil Engineering, Massachusetts Institute of Technology, Cambridge
John J. Roark, PAWA, Inc., Dallas, Texas

Four years have passed since the Urban Mass Transportation Administration and the Federal Highway Administration issued the joint regulations that embody the concept known as transportation system management (TSM). What is TSM, aside from something in the category of "we know it when we see it"? One way to define it is to quote from the federal regulation:

> Automobiles, public transportation, taxis, pedestrians, and bicycles should be considered as elements of one single urban transportation system. The objective of urban transportation system management is to coordinate these individual elements through operating, regulatory and service policies so as to achieve maximum efficiency and productivity for the system as a whole.

The TSM policy formalized what, at that time, many transportation professionals were already beginning to realize—that the era of massive construction of highway and transit facilities was coming to an end and that more-effective use of the extensive transportation infrastructure already in existence in most U.S. cities was going to be necessary. The response to the TSM policy, however, was problematic and gave rise to a number of serious substantive and procedural questions at all levels of government. As a result, in 1976 the Transportation Research Board (TRB) sponsored a Conference on Transportation System Management that was designed to answer many of the questions relating to definitions, consequences, and future directions of TSM (1). The environment for transportation planning changes rapidly, however, and government policies and programs either respond to these environmental changes or are ignored in favor of other, more flexible, means of addressing new issues. Thus, the purposes of this, the second TRB Conference on TSM, were to identify what has happened in TSM planning since 1976 and to develop recommendations that should lead to better assimilation of the TSM concept in both the urban transportation planning process and the ongoing transportation programs of every urban community. To accomplish this, individuals representing private and public transportation agencies, universities, consulting firms, and federal agencies were brought together for two and a half days in Arlington, Texas, to examine the many dimensions of current TSM practice and to propose new directions for both TSM and transportation planning. These proceedings are a report of what occurred at this conference.

The conference was structured to address three major issues in TSM planning and implementation—the identification of organizational roles in TSM planning, programming, and implementation, including the roles of the private sector and the professional disciplines; an understanding of why certain high-achievement TSM actions have been neglected; and the relationship of TSM to major national goals and to the comprehensive transportation planning process in metropolitan areas. Each of these issues was assigned to a workshop where the participants discussed, debated, and produced a position paper presenting specific recommendations. Because these issues could not be addressed independently of each other, the workshop chairpersons presented the latest findings of the workshops in conference plenary sessions so that every participant was aware of the direction that each group was taking. These plenary sessions proved most useful in finding and establishing the themes that were common in all workshop discussions and in highlighting those areas where substantive agreement on underlying issues could not be obtained.

The organization of this report reflects the structure of the conference. The papers presented at the opening session, which provided background information on TSM, established a common point of departure for the workshop discussions, and identified topics in TSM that merit further attention, are found in the first section of this report. The next three sections are devoted to the activities of the three workshops; each includes the resource papers prepared by the workshop participants and a workshop summary. The conference summary presents the major conclusions and recommendations of each workshop (although the workshop summaries will provide the interested reader with a better sense of how these conclusions were reached).

This conference was held at a most propitious time for TSM planning specifically and for transportation planning in general. One month before the conference, the Comptroller General of the United States in a report to Congress (2) had concluded that the TSM regulations have not been as effective as they could have been because

> [1.] The two Federal agencies have not administered the regulations consistently,
> [2.] Urban areas have not been able to institute planning processes that result in unified plans, [and]
> [3.] Projects that have the most potential for improving the efficiency of existing transportation systems have not been widely adopted.

Thus, the conference, coming one month after publication of these conclusions, was the first gathering of transportation professionals that could make recommendations on policy actions that would alleviate some of the problems of TSM identified in the Comptroller's report.

Elements of the Surface Transportation Assistance Act of 1978 also provided an opportunity for this confer-

ence to influence transportation policy. Section 160 of this act required that the U.S. Department of Transportation undertake a study of those factors affecting the integration of rules and regulations concerning transportation, air quality, and energy-contingency planning. Because many of the concerns and the types of actions considered in these planning processes relate quite strongly to the concepts underlying TSM, it was apparent that this conference could contribute to a better understanding of how these many planning processes could be linked.

Finally, the potentially serious situation of gasoline shortages and their impacts on travel behavior and on the ability of the transportation system to respond to changing travel patterns had been of much interest in the months before the conference. TSM actions should not be viewed as a means of significantly reducing the level of fuel consumption but rather as a means of minimizing the amount of confusion during a crisis by having an in-place physical and institutional infrastructure capable of providing alternative forms of transportation. The uncertainty surrounding the supply of fuel thus provided added impetus for conference participants to establish policy guidance for TSM.

As can be seen in the conference summary, many of the original objectives were achieved but, because of the limited time available, not all of the issues raised were addressed and many suggestions on policy actions did not receive the level of debate needed to examine their feasibility in any detail. The number of issues raised and the importance they have on the future of transportation planning in this country indicate that further attention from the transportation community is needed.

REFERENCES

1. Transportation System Management. TRB, Special Rept. 172, 1977.
2. Comptroller General. Stronger Federal Direction Needed to Promote Better Use of Present Urban Transportation Systems. U.S. General Accounting Office, CED-79-126, Oct. 4, 1979.

Conference Summary and Findings

Michael D. Meyer, Department of Civil Engineering, Massachusetts Institute of Technology, Cambridge
John J. Roark, PAWA, Inc., Dallas, Texas

Throughout the conference, several recurring themes provided a common basis for the deliberations within and between the workshop groups. As is usual with a group this size, however, there were also several issues that eluded efforts at resolution. In this summary of the conference, we will attempt to describe in detail the underlying themes or agreements that are in many ways the most important results, while also highlighting those issues that are of significant concern to many individuals but that require further attention. (More detailed descriptions of the discussions and recommendations of each workshop will be given in the workshop summaries found in the following sections of this Special Report.)

CHANGING ENVIRONMENT OF TRANSPORTATION: THE ROLE FOR TSM

Whereas the Minneapolis Transportation System Management (TSM) Conference focused almost exclusively on the definition of TSM, both as a concept and as a program, this conference focused on the future of TSM and its institutional and methodological dimensions. Every participant shared the sense that significant change could be facing the entire transportation profession in the near future and thus focused on the role that TSM could most effectively play in a rapidly changing environment. Although many participants were most concerned about the serious impact of fuel shortages on travel behavior (and by implication on the transportation planning process), others argued that funding constraints, political considerations, and changing societal values will by themselves require fundamental changes in the way transportation decision making now occurs.

The themes that recurred throughout the conference and served as the basic points of departure for most of the workshop discussions clearly reflect this changing perspective on transportation decision making. They also have significant implications on the methodologies used, the type of skills needed by those individuals actively involved in TSM planning and implementation, and the institutional structure in which it occurs. These themes are described below.

Regional Versus Local Orientation

In each workshop, it was recognized that there is a clear distinction between regional TSM actions and metropolitan-level organizational responsibilities versus local-level TSM actions and impacts and implementation responsibilities. In the workshop on institutional roles, great importance was placed on developing the interests, skills, and opportunities in TSM at the local level. As stated by one workshop participant, focusing on individuals and the skills they need for effective TSM planning and implementation is simply recognizing that it takes people, not organizations, to get things done. The concept of an "entrepreneur" was developed by this group to illustrate the skills needed and the roles to be played by these individuals. (Because this concept was an important topic throughout the conference, it will be discussed in greater detail in a later section.)

In the other two workshops, the one examining high-achievement TSM actions and the other developing a methodological framework that can provide a prominent place for TSM, the importance of local-level TSM planning and implementation was accepted, but that there is an important role for a regional perspective was also acknowledged. Indeed, in the third workshop, a methodological framework was developed that explicitly recognizes the important contribution that subarea or local TSM efforts can make in the overall process and it was recommended that the level of analysis and the types of solutions should be scaled to the range and scope of the problems. There are thus problems that can be best dealt with at the regional scale, but there are also many others more appropriately handled by a wide variety of actors at the corridor or local level.

Focus on Management

One of the original objectives of the TSM policy was to encourage the more efficient use of existing facilities through operational and regulatory actions, i.e., the transportation system should be better managed. This focus on management, both by the traditional definition of orchestrating or guiding actions in an organizational context and by a new definition of coordinating policies and programs at a regional and subregional level to effectively manage the transportation system, was found throughout the conference. In the first case, the concept of an entrepreneur is very much based on the idea of project and program management, i.e., the ability to manage the progress of specific projects or programs through the many institutional barriers that hinder successful completion. In the second case, the conference participants recognized that coordination of the many TSM activities, not all of which are applicable in all situations, is necessary to improve the performance of the transportation system. Both the types of high-achievement actions considered during the conference and the overall planning methodology developed are affected by the interrelationships among different TSM ac-

tions and their impacts and thus require a management focus.

As noted by some participants, one important implication of this management focus is that TSM planning begins with the existing transportation system and then examines the types of improvements that could be made to improve system and program performance or to better achieve regional and local objectives. Given this focus, it becomes apparent that one of the pressing needs in future years will be maintenance, i.e., the physical rehabilitation of the transportation system. As one participant observed, some of the most controversial transportation decisions at the local level in recent years have related to the question of what level of resources should be allocated to maintenance versus other priorities. As maintenance projects begin to compete with other types of TSM actions for increasingly limited resources, this trade-off will most likely become even more controversial.

Relationship Between Professional Staff and Local Elected Officials

The success of a program such as TSM is greatly dependent on a continuing interface between TSM planners and implementors and local elected officials. Councilman Richard Smith of Dallas in his remarks before the conference, stressed the need for a partnership between professional staff and local elected officials in implementing TSM strategies. Smith suggested four actions on the part of a professional staff to improve the transportation decision-making process and transportation system management:

1. Professional staff should anticipate problems and discuss them with local elected officials rather than trying to hide them.
2. Professional staff should never assume that anything can be imposed on a community against the will of that community. Smith emphasized that local elected officials "must be a partner in an effort to clean up the air", but diamond lanes, toll booths, parking bans, growth restrictions, and such "cannot be imposed from above."
3. Professional staff should identify options for decisions by local elected officials. Smith emphasized that the total transportation program should be developed by local elected officials represented on the metropolitan planning organization after presentation to them in the form of options (rather than as predetermined staff decisions).
4. Professional staff should allow local elected officials to be constructive. Smith noted that "we need not be demagogues, we can work regionally, we can take the heat (and we do that better than anyone), we can work for long-range decisions, and we can support TSM rather than overcostly and flashy capital projects."

Relationship Between Planning and Implementation

There was general agreement among the participants that one of the critical problems facing effective transportation planning today is the often inconsequential link between planning and implementation. The conference participants noted that this link has been very difficult to develop because of the different organizations responsible for each activity, the varied staff skills necessary in each task, and problems of incompatability and nonexistence of funding programs.

In all three workshops, the planning-implementation relationship was explicitly considered in developing recommendations. The strongest stand on this issue was taken in the workshop on institutional roles, which recommended the entrepreneurial style of program and project management to foster the implementation of TSM actions. This entrepreneurial style was considered necessary to "fill the gap between planning and implementation" and requires professionals having the necessary skills "to build constituencies, bridge the gap between disciplines, involve the private sector, and respond to local publics and special interest groups." The concept of an entrepreneur is thus very much focused on the dynamics of the implementation process.

In the workshop on neglected high-achievement TSM actions, a wide variety of issues that hinder the implementation of TSM actions were examined, and it was concluded that to the extent possible the implementation process should stress positive incentives. In the third workshop, an overall framework for the planning process was developed in which characteristics of the TSM implementation process were explicitly considered. Monitoring of TSM actions was also considered a particularly important component of the methodology to provide feedback to the implementation process so that adjustments in project implementation could be made.

Role of the Private Sector

Many of the conference participants observed that the private sector is playing an increasingly important role in the initiation and implementation of TSM actions. Actions such as ride sharing, alternative work schedules, parking management strategies, urban goods movement strategies, and employer-subsidized transit programs require active participation and commitment from employers. As noted by Volk, the private sector can play a valuable role in TSM planning and implementation in that it can

1. Identify problem areas and potential solutions,
2. Provide data on current and future industrial expansion and travel demand,
3. Assist the public sector in making trade-offs among strategies and in packaging groups of projects,
4. Play a direct role in both inducements and actual implementation,
5. Promote or support public-sector projects (or both),
6. In selected situations, provide all or part of the funding for preliminary engineering, right-of-way acquisition, or construction, or combinations of these factors, and
7. Perform the function, along with the public sector, of monitoring progress and suggesting changes needed in projects, process, institutional structures or legislation.

Flexibility in Planning and Funding Programs

It became apparent early in the conference that one of the most important characteristics of a transportation planning process, and of the funding programs that support it, is the amount of flexibility that planners and other interested individuals have in undertaking different types of activities. In this regard, it was noted that there is not one TSM planning process in an urban area, but many different processes that look at a diverse group of TSM actions and involve a wide variety of actors. This multifaceted characteristic of a TSM program was considered in many discussions throughout the conference and was reflected in the workshop recommendations. In the workshop on planning methodology, for example, this flexibility was incorporated into the recommended framework by the provision of an important place for subarea or local TSM studies. These studies could be initiated by regional and local agencies or by local community groups and individuals. In the workshop on institutional

roles, the possibility of providing greater funding flexibility by combining various categorical programs and by changing some discretionary programs into formula-based programs was examined. Allowing this greater flexibility in planning and funding, however, was not considered by the conference participants to be synonymous with eliminating the need for a coordinating role in the region. Such a role was considered necessary, although there was significant disagreement as to how pervasive this influence should be.

These themes provide a useful basis for placing the workshop recommendations in context. Several opportunities were provided for interaction between workshops and, thus, these underlying concepts and ideas were discussed and, where appropriate, incorporated into the workshop findings.

INSTITUTIONAL ROLES IN TSM: THE ENTREPRENEUR

The emphasis on local-level participation in TSM was reflected most forcefully in the conference discussions on appropriate institutional roles in TSM planning and implementation. Many participants argued that the most-effective TSM institutional arrangement cannot be and should not be one that is prescribed from above, but rather should reflect the different styles, organizational arrangements, and levels of TSM planning and implementation found in the specific metropolitan area. What should be done, however, is to identify those institutional barriers that hinder effective TSM implementation and to encourage an entrepreneurial style of program management that recognizes the importance of the committed individual or group of individuals in successfully implementing a TSM action. As stated in the results of the workshop on the roles of organizations, public and private enterprise, and the professional disciplines in TSM planning, programming, and implementation, it is to be hoped that the future environment for TSM will include an increasing number of professionals who

[1.] Are comfortable serving multiple objectives,
[2.] Are able to cross the lines between the public and private sectors,
[3.] Are able to operate in complex political environments and build or catalyze political coalitions to achieve implementation,
[4.] Have the technical ability to identify and define problems and yet also can assess alternative options,
[5.] Can provide expertise in a politically acceptable way,
[6.] Can operate at different levels of problem scales and in response to different constituencies (sometimes simultaneously),
[7.] Can visualize the need for, and ensure the provision of, a variety of different services designed to meet different needs, [and]
[8.] Are able to accomplish all this quickly and effectively.

This emphasis on local-level initiative and participation in TSM planning and implementation created concern among some conference participants in that it is difficult to envision how these many different entrepreneurial programs can be related to one another, i.e., how, if at all, would these programs be coordinated? Implicit in this concern was the issue, What role will the metropolitan planning organization play in this locally based program? The need for leadership in project initiation and planning was deemed critical for a successful TSM program, but the entrepreneurial style suggests an approach to project development that is almost laissez-faire. The response to these concerns was that the entrepreneurial concept is not meant to replace the existing organizational structure, but rather to enhance the position of the entrepreneurs already in it. Leadership is indeed lacking in most urban areas, where what is needed is an atmosphere in which leadership can develop, individuals are willing to take risks, and the focus is on implementation. The entrepreneurial style of TSM planning and implementation creates such an atmosphere.

Although most of the participants agreed that the concept of an entrepreneur is a useful basis for TSM planning and implementation, it was recognized that, if it is to be carried out in any serious manner, some fundamental changes will be necessary. These changes related to federal-state-local red tape and funding inflexibility, agency and staff perceptions of their missions, inadequate communication channels between major TSM actors, and a more-flexible analysis framework that would allow a relevant and systematic evaluation of TSM options. The recommendations that resulted from the discussions in the workshop on institutional roles and in the plenary sessions suggested the first steps that would have to be taken to implement this new image of TSM planning. Specifically, the following major recommendations and statements on institutional change were made (see the workshop results for a more detailed list):

1. There should be a single, annual metropolitan planning process that has a clearly defined focus—to produce an agreed-on program to be used for all planning and implementation funds available to the locality for the next year. This would provide for an explicit annual decision point in formulating a strategy for transportation actions in a metropolitan region.
2. The federal and state processes should be streamlined so as to produce project approvals within six months of local program adoption. There was near-unanimous agreement that project-level certification should be eliminated and that certification acceptance procedures should be implemented at a much higher organizational level.
3. Funding programs should be modified to provide the flexibility needed to encourage the entrepreneurial style of TSM planning.
4. Transportation professionals should be encouraged to perceive transportation planning more broadly. This implies efforts at disseminating information, establishing a new focus in training and education programs, developing communication and coordination skills in local TSM actors, and creating an organizational environment in which TSM entrepreneurs can survive and indeed be rewarded for their efforts.
5. Transportation-related agencies such as the U.S. Department of Transportation and the Transportation Research Board should disseminate information on innovative projects in progress, the availability of funds for promising actions, and the process to be followed for project implementation. It was pointed out in conference discussion that three demonstration projects that embody the entrepreneur concept are under way in California, Florida, and Connecticut.

These recommendations do not reflect a conservative approach to bringing about desired changes. They suggest significant changes in legislation, major efforts to streamline certification procedures and, perhaps most difficult, a fundamental change in the attitudes of many transportation professionals. Most of the conference participants felt, however, that these changes will be necessary if we are to revitalize the transportation planning process and get projects implemented.

HIGH-ACHIEVEMENT TSM ACTIONS: WHY HAVE MANY BEEN NEGLECTED?

One of the major purposes of this conference was to identify those high-achievement TSM actions that have largely been ignored, investigate the reasons underlying

this lack of interest, and suggest factors that could increase local interest in such actions. As noted by Morin, lack of a constituency, the need for effective interagency coordination, intense competition for funding, and political sensitivity have all contributed to the slowness of implementation of many high-achievement TSM actions. The types of actions were grouped by the workshop participants into nine major categories (see the results of the workshop on neglected high-achievement TSM actions)—ride sharing, traffic control strategies, alternative work schedules, parking management, high-occupancy-vehicle (HOV) incentives, transit operations, urban goods movement, pricing, and bicycle and pedestrian incentives. Each of these categories was then examined for potential barriers that obstruct its implementation, e.g., political sensitivity, funding processes, agency biases, lack of enforcement, and then related to offsetting measures that could be used to bypass these barriers, e.g., community involvement, provision of funding and organizational flexibility, and incremental approaches to development.

The participants in the workshop on neglected actions agreed with the other groups in that the emphasis in implementation of TSM actions occurs at the local level and that the involvement of local officials in the process is critical to the success of TSM. They also concluded that (a) the metropolitan planning organization role relates best to coordinating functions, (b) effective communications (marketing) is essential in TSM implementation, (c) system operations management appears to be handled best through existing operating frameworks, (d) the implementation process should stress positive incentives, (e) contingency programs should be pursued aggressively against the event of serious disruption to system behavior, and (f) continuing research is needed to investigate the short- and long-term effects of selected TSM actions (e.g., flextime and shorter work weeks).

The types of neglected TSM strategies considered by the workshop (and in particular those not considered) sparked much debate among the conference participants. One participant noted that an entire set of TSM actions—taxis, other forms of paratransit, and alternative transit strategies—was missing from the workshop list. The importance of this missing set was found in the types of additional agencies that must be included in the TSM process if these actions are to be seriously considered, e.g., in the case of taxis, the public utilities commission would most likely be involved. Another important observation about the characteristics of the projects on the workshop list related to their orientation toward the work trip and that a potentially significant opportunity that has, up to now, been neglected is related to non-work-trip travel.

The most controversial issue in this area, one that was not satisfactorily resolved, was that of the provision of user subsidies to encourage changes in travel behavior. Preferential parking and pricing for carpools was used to illustrate the point that lower costs per vehicle do indeed provide incentives for carpools, but that they are in many ways cost-ineffective because (a) people are already carpooling, (b) encouraging additional carpooling aggravates the competition between carpools and transit, and (c) carpooling creates an administrative nightmare in monitoring compliance to the rules. The money used for this type of subsidy could be spent more effectively by subsidizing vanpools or bus passes. This discussion was expanded to a general debate on the desirability of government intervention in the transportation market, and some participants suggested that market forces should be allowed to operate so that the most cost-effective results would occur.

Other participants took issue with these statements by noting that travel behavior is not the same in every section of the country and that, although there may be large numbers of carpoolers in eastern U.S. cities, the same is not true in western cities. If ride sharing is to be successful in these areas of the country, some incentive must be provided to encourage HOV travel, or alternatively (and perhaps in combination), the cost of travel in non-HOV vehicles should be increased. One participant noted that, in both cases, the marketing of ride-sharing programs is absolutely critical if we are to convince the public that they will be better off if they participate.

The debate on high-achievement TSM actions underscores one very important observation—TSM actions, whether individually or strategically packaged, can result in high achievement only when designed to local circumstances. There are, however, important questions of concept (e.g., effects of subsidies) and implementation (e.g., increasing local support) that still need to be considered in greater detail.

AREA PLANNING FOR TSM: REGIONAL AND LOCAL CONTEXTS

Among the most vexing problems in TSM have been that of defining the limits of TSM as a planning process and the questions of its appropriate relationship to the broader comprehensive transportation planning process. In the course of examining these problems, the participants in the workshop on an areawide planning context for TSM proposed a reorientation of the urban transportation planning process that would result in TSM actions playing a more important role in the overall process. The characteristics of a comprehensive new planning process, one that reflects the changing environment of transportation planning, were identified as the recognition that

1. Attaining an important goal for transportation planning—to provide mobility—is subject to many constraints and that many times these originate in sources external to the metropolitan area (for example, air quality standards and fuel-conservation levels provide constraints on the level of mobility that can be provided in an urban area);
2. The scope of the process must be comprehensive, i.e., the planning and implementation of TSM actions should not be a separate process, but should be an integral part of a total, areawide transportation planning process;
3. TSM-type actions should be prominent among the options considered;
4. The process must not have a top-down orientation—operators, local officials, and private-sector interests should be encouraged to actively participate in the planning process;
5. The process must start with the existing system and its problems;
6. Solutions and levels of analysis must be scaled to the problem levels; and
7. Other federally sponsored transportation programs, e.g., those of the U.S. Departments of Energy and Housing and Urban Development and the U.S. Environmental Protection Agency, must be tied into the process.

The proposed transportation planning process attempts to unify regional, subarea, and local demands; long-range and short-range needs; and capital-intensive and low-cost improvements, actions, and policies. The three major activities in the process include (a) the establishment of a regional context; (b) the development of

subarea transportation policies, plans, and actions; and (c) the synthesis of an overall regional transportation plan from the policies and plans developed at the subarea-local level. In developing this proposal, the workshop participants realized that the implications of this process on programming, implementation, and monitoring were significant (see the results of the workshop on an areawide planning context for TSM).

One conference participant voiced concern over the apparent absence of a goals orientation in the overall process (or, more correctly, the focus on one major goal subject to constraints). In particular, he pointed to the absence of any discussion of two of the most important concerns of many transportation engineers—safety and maintenance. The most difficult task in current programming involves the consideration of projects having safety objectives, because oftentimes the available accident data are insufficient to gauge the likely effectiveness of particular projects. In the case of maintenance, there is likely to be significant pressure in the near future to put large amounts of resources into maintaining the existing transportation system (which will put maintenance into competition with traditional TSM actions).

The discussion on TSM goals stirred one participant to request that the conference adopt a definition of TSM that would be widely recognized by the profession and easily understandable by the community. The definition "to optimize the use of transportation resources" was not accepted by some because of the multiple interpretations of "optimize". Another definition, "to move, promote, and assist in the least-cost solution to transportation problems", was more readily accepted by some; however, others expressed concern about the definition of "least cost".

Another participant noted that the proposed planning process contravenes the direction set by the other workshop groups in that the process implicitly emphasizes a strong regional orientation while the other groups had focused almost exclusively on developing a TSM program based on grass-roots support. In support of his statement, he pointed to the goals orientation of the process, which ignores the fact that local officials and entrepreneurs might not have mobility as an objective and would most likely not place great weight on air quality and energy constraints, which are more regional in scope. Furthermore, the three major activities in the process—the establishment of a regional context, the development of subarea studies, and the synthesis of a regional plan—suggest a sequence of events that requires the establishment of the regional context before the other activities can be done. This clearly differs from the concept of a TSM program based on flexibility and entrepreneurial behavior.

These statements initiated a series of comments that indicated that there was still some disagreement over the relationship between entrepreneurial TSM activities and the need for some regional perspective. Several points were made. First, the process indeed implies a sequence of activities, and this sequence is appropriate. There was no intention of ignoring the fact that subarea and local TSM actions are occurring all of the time but, for an overall planning process in which TSM activities are but one component, it is indeed necessary to first set the regional context so that appropriate decisions are made. Second, subarea-local studies are a major element of the proposed process. The structure of the process allows entrepreneurs to seize opportunities and initiate actions that will be implemented quickly; however, it also allows these actions to be placed within a sense of regional priorities. In general, the process was developed to be robust enough to address all levels of transportation problems, but also sufficiently rigorous to allow a systematic appraisal of transportation options.

The recommended transportation planning process has important implications for the federal statutes and regulations that govern all aspects of transportation planning. Because there was insufficient time for the workshop participants to make specific recommendations, a series of questions was raised to pinpoint future research and policy directions (see the results of the workshop).

CONCLUSIONS

This conference provided an opportunity for lively discussion and debate on issues that are likely to face TSM planners and implementors in the near future. Most important, the conference participants focused on the future and did not dwell on such past issues as inappropriate focus of the TSM regulations, ineffective implementation strategies, and problems of compliance. There was a definite sense among the conference participants that the environment of transportation planning is changing rapidly and that changes must be made in the way our transportation systems are planned, so that projects and programs can be implenented and, in some cases, implemented quickly.

Although many issues were identified during this conference, two stand out as being critical for the future of TSM.

1. Everyone present agreed that an important actor in the TSM process is the local official, operator, or individual who initiates and guides the progress of TSM actions through the complicated institutional process of project development. There was a significant difference of opinion, however, on the relationship between these TSM entrepreneurs and the other, more established, transportation agencies found in a metropolitan area. Another facet of this issue was the link between these local TSM initiatives and the regional TSM program. An investigation should be made of the different types of relationships and the links that can exist and of the barriers to successful implementation they may involve. It is hoped that the current demonstrations in California, Florida, and Connecticut will provide useful insights into the entrepreneur concept, but much more will have to be done if this concept is to be accepted as the basis for transportation planning in urban areas.
2. The second issue arose from the general feeling that transportation planning has become an extremely complicated undertaking and will likely become even more complex as more concerns, issues, and problem definitions (oftentimes from sources external to the transportation field) are incorporated into the process. At this period in the history of transportation planning, we should be asking ourselves how we can make some sense out of a process that has been added to, modified, and molded to incorporate new concerns but has not benefited from a fundamental rethinking of its organizational structure. Perhaps this conference, in focusing on the future of TSM, will have begun a dialogue that can provide the impetus for such efforts. However, this is only a beginning. What should the transportation planning process be? How do we get there from where we are today? How do we balance the many interests in an urban area, both metropolitan and local, that were created over the past 20 years to guide transportation planning? How do we bridge the real and artificial gaps that exist between planning and implementation? planning and programming? and TSM planning and non-TSM planning?

This conference may have raised more questions about TSM and transportation planning than it has answered but, realistically, these were the questions that had to be asked. However, it would be a mistake to gloss over the anxieties and concerns felt by some of the participants about the conclusions and recommendations of this conference, because these concerns are probably felt by many in the transportation profession. It is hoped that this conference has provided some exciting new ideas that, if pursued, could lead to new directions for transportation planning in this country. As we begin the next decade, perhaps these new ideas and directions will provide us with a greater awareness of the opportunities that TSM can offer and of the contribution that transportation planning and investment can make in addressing the needs of an urban area.

The major conclusions and recommendations of this conference are found in the preceding discussions of the individual workshop results. Every conference participant felt that TSM as a process and a problem-solving approach is an important element of the transportation planning activities of each metropolitan area and, as such, deserves continued attention and support. Because the style and effectiveness of TSM planning is so heavily dependent on the characteristics of each metropolitan area, it is essential that information on TSM planning and implementation activities be available to provide the necessary link between concept and practice.

Overview Papers

Transportation System Management: Observations and Comments on Future Directions

C. Kenneth Orski, German Marshall Fund, Washington, D.C.

Almost exactly three years have elapsed since many of us here today met in Minneapolis to discuss the transportation system management (TSM) policy, then barely one year old. Now a little grayer and a little wiser, we have convened again to consider what has been accomplished since then and to compare the insights we have acquired in implementing TSM policy.

I have been away from the TSM scene for a while, and it would be presumptuous of me in these opening remarks to attempt to summarize the state of TSM today. I will leave this to Meyer and Deen who will follow me this morning, to the authors of the resource papers, and to all of you who have been in the front lines of TSM implementation for the past three years. Nor do I feel compelled to launch into the standard sermon I used to deliver as a federal official about the importance of TSM; I will leave that to my successors. Instead, secure in the knowledge that I can now offer advice without fear of having to act upon it, I propose to share with you some thoughts about TSM—thoughts in part stimulated by the papers prepared for this conference and in part based on reflections of the past year and a half, since my departure from the federal government.

What has struck me most in reading the resource papers, in reviewing recent planning literature, and in conversations with local officials around the country is how thoroughly the TSM concept has succeeded in becoming institutionalized in the transportation planning process. For a concept that strives to fundamentally restructure the planning process, this is no mean accomplishment. I do not mean to imply that the TSM policy has ceased to be controversial in all quarters or that the federal TSM requirement has been unquestioningly embraced by local agencies everywhere. But I do not think anyone would disagree that the concept of transportation system management has entered the mainstream of transportation thinking. The rationale for TSM is by now well understood and accepted—as are most of its techniques. What is more, numerous actions are being planned and executed in the name of TSM, and the term itself is becoming a permanent part of the vocabulary of the transportation planning and engineering professions. Indeed, the TSM acronym has crossed the Atlantic and is being used abroad—a supreme accolade to its universal acceptance.

What accounts for the rapid diffusion, acceptance, and appeal of the TSM concept? It is not enough to say that there was no choice but to embrace it once it became the object of a federal regulation. The Federal Register is replete with rules and regulations that have been given only token compliance. The explanation, I think, lies deeper. At the risk of sounding ponderous, I believe that the TSM concept has been embraced because it was an idea whose time had come. I mean by this that TSM had come to reflect a set of values and concerns that independently have gained wide currency in the United States. These values include the emerging conservation ethic, the growing fiscal conservatism, a new emphasis on reusing the old rather than throwing it away, and a newfound awareness that the age of cheap, unlimited energy is over. TSM happened to be at once an expression of these new values and an instrument for their realization. It was, in other words, a policy fundamentally in tune with the mood of the times—a concept that, I daresay, would have to be invented today if it did not already exist.

And so, while we may—indeed should—continue to refine the TSM concept and seek its politically acceptable forms, we should do so secure in the knowledge that its foundations rest on firm ground. Thus, I suggest that we can spend our time here more productively if we concentrate on the question of how to make TSM work rather than on debating whether it is needed.

As we get down to the business of discussing the practical aspects of TSM implementation, I would leave you with these thoughts and a few unanswered questions.

First of all, how important is it that TSM be conducted as a system planning activity at the regional level? Frankly—and here I join the thoughts expressed in Jones' paper—I have always entertained serious doubts about the need for a comprehensive, top-to-bottom approach to TSM. Somehow the type of actions that TSM evokes in my mind—small-scale, low-cost, quick-turnaround, incremental actions whose effects and beneficiaries are often confined to the scale of a community or even a neighborhood—seem to be more suitable to local initiative and implementation than to an areawide approach. Planning institutions at the regional level may be too far removed—temperamentally as well as geographically—to be capable of building an effective political consensus and coalition for TSM improvements. Planning a residential parking permit program or organizing a neighborhood transit service, and garnering political support for it, are not the type of activities at which the staffs of regional planning agencies necessarily excel.

I do not wish to denigrate the importance of system-wide planning or the role of the metropolitan planning organization. Long-range stategic planning is important in providing localities with a blueprint for the future. But we need to reexamine our blind allegiance to the concept of systemic planning and consider whether we might not be better off with a different institutional division of labor, i.e., greater decentralization of planning

and implementation functions and a greater sharing of power among regional, municipal, and even submunicipal (neighborhood) institutions.

The second thought I would leave with you is the need to take greater account of the role of the private sector in TSM implementation. Many TSM initiatives—flexible work hours, vanpooling, off-street parking management, and pedestrian malls, for example—are significantly dependent on the initiative, support, and good will of private enterprise. It makes good sense, therefore, to welcome the private sector as a partner in the TSM coalition. From what I see happening around the country, the role of the private sector in delivery of public transportation services is going to grow. As the cost of gasoline continues to climb, more and more private employers, shopping center operators, developers of new communities, and resort owners will turn to public transportation to ensure continued access to their facilities and to protect their investments. In time, many large employment centers, regional shopping malls, amusement parks, and such may find it necessary to institute their own neighborhood transit systems in order to retain their increasingly fuel-conservation-conscious clientele.

Some early manifestations of this trend are already visible in California, where several regional shopping centers set up their own private transit services during the recent fuel shortage. There is also a growing trend nationally among suburban employers to provide company-sponsored-and-financed bus and vanpool services for their employees—a fringe benefit that is already quite common in Europe. All this increased activity argues in my view for a closer integration of private efforts in TSM planning and implementation—an idea that is reflected in the paper by Volk, who sees the private sector as a potentially valuable constituency for TSM.

Third, I would draw your attention to the less visible although highly beneficial TSM-type actions that can be introduced—and are being introduced in growing numbers—at the local level. These include residential parking permit programs, traffic diversion, commuter parking bans, street closures, and other small-scale attempts to manage automobile use at the community or neighborhood level. These actions may be less glamorous and less eye-catching than corridor-level improvements such as diamond lanes, but they are no less important as tools for environmental betterment and fuel conservation.

Finally, I would add to the list of neglected TSM options discussed in the paper by Morin the practice of track sharing. By and large, those concerned with rail planning have failed to embrace the philosophy of transportation system management—the need to fully exploit the facilities already in place before embarking on costly programs of new construction. Many of our metropolitan areas possess well-developed rail networks that are grossly underused. In my judgment, more attention should be given to placing these facilities—often used only occasionally for freight or Amtrak trains—at the service of commuters through various kinds of track-sharing arrangements. Joint use of rail facilities by freight and commuter services is a potentially high-payoff TSM option that has not been given adequate attention in the past. Now, with the city of San Diego in the lead role, track sharing is receiving increased scrutiny and will be the subject of special hearings by the House Subcommittee on Cities under Congressman Henry Reuss in the near future.

Let me conclude by saying how much I appreciate your invitation to join you here today. It is good to be back among old friends, and I look forward to sharing with you two days of stimulating and productive discussions.

Four Years Later: The Status and Prospects of TSM

David A. Lee, American Public Transit Association, Washington, D.C.*
Michael D. Meyer, Department of Civil Engineering, Massachusetts Institute of Technology, Cambridge

Since its introduction in the joint Urban Mass Transportation Administration (UMTA)-Federal Highway Administration (FHWA) planning regulations in September 1975, the concept of transportation system management (TSM) has received much attention. Initially, this attention focused on the implications of TSM for existing planning processes and on the different institutional strategies and frameworks with which individual communities were responding to the new requirement (1-4). During the past four years, TSM has evolved in a variety of ways, each reflective of the communities in which it has occurred. In some areas, for example, TSM has simply given a new nomenclature to existing planning activities. Elsewhere, however, it has led to fundamentally restructured planning processes and the development of new opportunities for intermodal transportation management.

We are now in a position to examine the evolution of TSM during these past four years and ask ourselves some questions: What has been accomplished? Why has TSM evolved in different ways in different settings and at different rates? What can be done to encourage more serious attention to the objectives and strategies that are represented by TSM?

When we attempt to answer these questions, it is necessary to begin with a common background on the purpose of TSM, why it was deemed necessary, and the dimensions of its current application. This discussion can hardly present the definitive statement on TSM—such a task would be impossible given the varied interpretations the concept has acquired as a planning process, as an action agenda for transportation system improvement, and as a federal requirement—but perhaps the following can serve as a basic point of departure for the remainder of this conference.

UMTA-FHWA PLANNING REGULATIONS

During the mid-1970s, conservation—of fiscal resources, of declining central city areas, of energy, and of environmental quality—emerged as a central theme of national urban policy. In the area of transportation, this theme surfaced in several major policy initiatives from the U.S. Department of Transportation (DOT) that involved attempts to shift the focus of planning toward actions that are service-oriented (rather than facility-oriented), that emphasize low-capital solutions, and that prefer the more efficient use of existing resources to the construction of new facilities. Above all, these new policies embraced a concept of urban transportation as a single, intermodal system in which both transit and highway resources could be managed together for improved overall system performance.

Perhaps the most important policy statement in this regard is that found in the joint UMTA-FHWA planning regulations of September 17, 1975, which advanced the following key elements:

1. Incorporating into the transportation plan of a metropolitan region an element (the TSM element) that would address the short-range transportation problems of the area and
2. Programming of highway and transit projects into a single, areawide transportation improvement program (TIP) designed to facilitate the concept of federal funds as transportation resources and to maximize the complementary nature of transit and highway improvements on the overall transportation system.

As such, TSM reconciled and redirected what had been formerly separate planning processes for transit and highway programs. Its emphasis on management reflected concern for both increasing system efficiency (rather than expanding the system to accommodate more vehicles) and improving performance through low-capital actions, more-efficient use of resources, and coordination. That transit service is an integral part of managing the highway network (and vice versa) and that regional transportation management must address both demand and supply are fundamental principles of TSM.

One year after the joint planning regulations were issued, a national Conference on Transportation System Management was held in Minneapolis, Minnesota, to identify and discuss the many issues surrounding the new policy (5). It was apparent throughout the conference that one of the most important issues to be resolved was the very definition of TSM. Not only was there an institutional dimension to this question (i.e., who should be responsible for TSM and what roles should other agencies assume?), but there were technological and methodological dimensions as well (i.e., what constitutes a TSM action? how are its impacts to be evaluated?). As stated by then UMTA Administrator Robert E. Patricelli, however, the future of TSM would rest not in the hands of those who initiated the policy but rather with those who were to carry it out:

> I hope [these brief remarks] have helped to clarify the meaning and some of the implications of transportation system management. If you are still not sure what it means, then I can only leave you with this thought that—whatever it is—it is the most important program direction UMTA is emphasizing. You, more than I, will define its precise meaning over time with your programs and your performance.

The last few years have provided a rich experience of TSM programs and performance, and it is the evolution and the definition that experience has given to the concept of TSM that most concerns us now.

Although there are many analysts who have their own opinions of the origins and intent of TSM, the major objectives of the policy can be summarized as follows:

1. To coordinate all of the individual elements in an urban transportation system—automobiles, public transit, paratransit, pedestrians, and bicycles—through a program of managed, systemwide operating, regulatory, pricing, and service policies;
2. To establish a process in which short-range low-capital planning activities can effectively compete with long-range capital-intensive planning;
3. To encourage more-judicious use of existing facilities by reorienting the planning process and emphasizing techniques that can improve system performance;
4. To relate the programming process to planning by requiring a link between TSM and the project implementation agenda for the area;
5. To strengthen the role of the metropolitan planning organization (MPO) in the programming and budgeting of federal funds and in the coordination of planning and

service functions; and

6. To reconcile and redirect the formerly separate planning processes for transit and highway development into one systemic process.

How closely does existing TSM planning correspond to the model implicit in these policy objectives? Let us turn to this issue next.

TSM TODAY

In a summary of the conclusions of a recent series of regional conferences on TSM sponsored by the American Public Transit Association (APTA), it was noted that "One striking, overall impression is the great variety that exists from region to region and from city to city regarding TSM" (6). As a process, a program of projects, and a federal requirement, TSM today appears to represent a ubiquitous but still often-misunderstood element of the urban transportation planning process.

Translating the concept of TSM into a regional planning framework and a program of systemwide transportation management strategies has proven particularly difficult. As has been noted elsewhere, the TSM process confronts deeply rooted problems of compatibility among agency missions, skills, and constituencies (1). Although there are a few significant exceptions, MPOs have not often overcome the conflict between their mandated role as coordinator of the regional TSM process and their usual lack of influence over the actions of local operating agencies. Consequently, a regionally based, intermodal, goal-oriented, strategic TSM approach has been difficult to develop and implement, and the few exemplary models that exist have proved equally difficult to replicate.

To generalize about the current status of TSM is a nearly impossible task, given the widespread differences that exist in terms of institutional structure, policies and objectives, and types of transportation problems confronted. However, an indication of how TSM has been implemented in some urbanized areas and how it is currently being defined can be obtained from two basic sources of information: TSM documents submitted during the past year and the results of the recent APTA-sponsored conference series.

The following statements are quoted directly from recently submitted TSM elements: From Denver (7),

> The TSM plan element is a continuing process which focuses on immediate needs which can be met by various types of management practices.... The nature of TSM as a management tool implies TSM is a process and not an end-state design for the transportation system.

From Indianapolis (8),

> Much of the short-range planning process will be quite familiar to planners and engineers in the agencies that operate or implement transportation improvements.... The aim of the TSM is to make this process explicit, to improve the systematic character of these actions and to strengthen their relationship to long-range planning.

From Baltimore (9),

> The function of a separate TSM element in the regional transportation plan is to describe current and recommended system management improvements and to establish a process whereby these and new improvements can be identified, studied, selected, implemented and evaluated.

From St. Louis (10),

> First, TSM must be an integral part of some overall scheme or approach to transportation planning in the region. Second, in order to be successful, TSM planning must conform to a key set of attributes or requirements. Third, and most important, the process itself is not the end product. TSM planning must produce projects designed to meet preconceived goals and objectives in the most cost-effective and publicly acceptable manner.

Two aspects of these statements should be noted. First, all four emphasize that a TSM process has been established to address the short-range transportation problems of the region. This closely conforms to the emphasis originally placed on the concept of a "process" by federal officials and indicates that the systemic, intermodal planning approach encouraged by the joint planning regulations has been adopted.

Second, the term "management" is used to describe not only control of the supply of transportation service but also control of the process itself. That is, TSM is considered to be a truly continuous management process, not simply the design of a one-time-only transportation development plan.

These observations support some optimism that localities are conforming to the basic intent of the TSM regulations. At the same time, however, one must be careful about drawing any conclusions from a few limited examples. During the recent APTA conferences, for example, many local representatives stated that TSM had had few significant effects on regional planning or the integration of transit and highway improvement programs (6).

Several other observations made during the APTA conferences may also shed light on the current status of TSM planning. First, among the current problems, the most important are still those that pertain to the planning and implementation of intermodal TSM actions and require the cooperation and active support of several agencies or political jurisdictions. Consequently, the most successful TSM examples reflect either unique institutional arrangements that have facilitated intermodal programming or intramodal actions requiring only minimal cooperative support.

Second, the federal agencies responsible for promoting TSM are frequently perceived as holding inconsistent or conflicting perspectives. Separate programming procedures for transit and highway projects may discourage localities from visualizing federal funds as transportation resources and from effectively using the TIP as an action agenda for intermodal TSM strategies. The separate funding provided for air quality and energy-contingency planning is also seen as a potential obstacle to more effective integration between TSM and related urban-conservation strategies. Moreover, the TIP process itself may discourage certain types of TSM actions by emphasizing funded grant projects over no-cost management actions or actions performed within the private sector (e.g., improved transit scheduling techniques or voluntary employer staggering of work hours). Finally, the facts that only UMTA performs a formal review of TSM compliance and that sanctions for insufficient follow-through on previously programmed TSM projects are imposed only on transit operators is viewed as a disincentive to more ambitious, intermodal TSM planning.

A third concern focused on the general ability of MPOs to provide leadership in TSM planning and implementation. Given the conclusions of the TSM conference of three years ago, these concerns are already familiar: lack of leverage over plan implementation by local agencies, lack of a political constituency for TSM, and the distractions resulting from the increased paperwork requirements imposed on MPOs.

In summarizing the current status of TSM, it may be useful to draw a distinction between strategic and tactical

TSM planning. Thus, "strategic" planning can be defined as that characterized by a focus on systemic, intermodal effects and the achievement of regional goals and objectives. "Tactical" planning is that characterized by the solution of localized, intramodal transportation problems.

The APTA conferences revealed few successful examples of strategic TSM, although, as shown by the quotations cited above, it would appear that several areas are attempting to develop frameworks for such planning. Nevertheless, it was clear that "such [strategic] approaches are most prone to goal conflict and most susceptible to the problems of leadership and linkage to transportation investment policy" (6). On the other hand, there are numerous examples of reasonably effective tactical TSM. In some instances, representatives of the transit operator, city traffic engineer, and police department meet periodically to solve transportation bottlenecks through actions that fall within the rubric of tactical TSM. In other examples, teams from UMTA, FHWA, and the U.S. Environmental Protection Agency jointly review local opportunities for cooperative TSM efforts.

Yet, tactical TSM techniques lack both the systematic approach and the analytical methodology that was originally envisioned for TSM. Concentrating on the worst bottleneck conditions or using internal management controls to improve transit and highway performance are not by themselves sufficient to constitute the systemic, strategic approach intended by the joint planning regulations of 1975.

In this context, one of the most promising developments is a growing emphasis on corridor-study approaches to TSM planning. In several cities, e.g., Dayton, San Antonio, Pittsburgh, and San Diego, reducing the scale of the TSM process to the corridor level has allowed planners to consider intermodal approaches that more easily achieve political support and interagency cooperation.

Ultimately, it would appear that the status of TSM today is characterized by lingering problems of institutional and goal conflicts. Although the basic intent of TSM has evidently been adopted within the local planning process, the problem that remains is that implementation and follow-through are weakest where TSM is most vital—in terms of intermodal actions and strategic planning. At the same time, corridor techniques appear to offer one approach that can reconcile political and procedural realities with the spirit of TSM as it was originally envisioned.

FUTURE FORCES ON TSM

It would be wrong to conclude either that TSM has been diluted by the diversity of its applications among cities or that the concept is hopelessly mired by institutional and policy conflicts. That TSM has now entered the planner's vocabulary to describe a wide range of transportation improvement actions suggests its potential use in improved strategic planning.

In addition, the conservation theme that was fundamental to the origins of TSM has now been underscored by federal directives to conserve liquid fuels used in transportation and to improve urban air quality. It is significant that TSM is frequently cited among the local actions for response in both cases. Certainly in the future, an important challenge to TSM will be the requirements to combine conventional transportation planning with regional strategies to reduce energy consumption and air pollution.

Stated another way, TSM has become a conceptual touchstone for many different processes, ranging from the tactical component of transportation management to the transportation component of urban conservation strategy. In the future, TSM will increase in importance as a technique for building a transportation component into the achievement of regional and national urban policies. Concurrently, the forces that originally led to the TSM concept—the needs for intermodal coordination, for low-capital solutions, and for increased system efficiency in an era of scarce resources—will not abate.

CONCLUSIONS

Let us conclude this paper by responding directly to three questions that can provide a common background for the further discussions at this conference. What is TSM? Why was it deemed necessary? and What are some of its current dimensions?

What Is TSM?

TSM is a short-range element of a regional transportation planning process that addresses ways to improve overall transportation system performance through various low-capital or no-capital management actions. Such actions can be intramodal (e.g., improved transit scheduling techniques, bikeway or pedestrian facilities, express bus operations), intermodal (e.g., bus priorities on streets, parking restrictions, relocation of bus stops that impede traffic flow), or extramodal (e.g., staggered work hours, pricing strategies to discourage long-term parking, employer incentives for ride sharing). The heart of TSM is a concept in which the urban transportation system is a single entity and federal funds are transportation resources. The goal of TSM is to increase the systemwide efficiency of people and goods movement without significant new infrastructure investment, rather than to simply accommodate increasing vehicle travel.

Ideally, TSM is regional in scope, goal-oriented, and intermodal and has its principal leadership and coordination provided through the MPO. In practice, such strategic approaches are rare; TSM is most commonly of a tactical nature involving site-specific actions that have marginal effects on systemwide performance. The recent corridor-study approaches, however, are a potential way to reconcile the practical advantages of tactical TSM with a basic thrust toward strategic planning, particularly to achieve air quality and energy-conservation goals.

Why Was TSM Deemed Necessary?

The joint planning regulations (and, of course, TSM itself) were products of several pressures felt by the DOT during the early 1970s. When demands outstripped federal resources, the need for more-effective multimodal planning and improved transportation system management became evident. To satisfy that need, it was essential that short-range transit and highway planning be focused on low-capital solutions (rather than on justification of new facilities) and on actions that could improve overall system performance and efficiency (rather than on the accommodation of increasing vehicle travel).

Also, TSM reflected an emerging recognition of the potential for complementary transit and highway management. Ample evidence had made obvious the need for more-effective allocation of road space among types of users, increasing vehicle occupancy, complementing new types of transportation service, private-sector involvement, and coordinating the many modal elements of an overall urban transportation system. TSM included all these techniques in a new process for analyz-

ing, selecting, implementing, and monitoring short-range transportation improvement actions.

What Are the Current Dimensions of TSM?

TSM today clearly reflects the variety of strategic and tactical approaches that have created not one, but many, TSM processes throughout the United States. Much of the strategic character of TSM has been subsumed by air quality planning and potentially will be by new efforts at energy-contingency planning. Although a great deal of research and support material has been sponsored by DOT, most of the results have emphasized the tactical focus of TSM planning. Thus, except in those cases where strong agency leadership has been exerted to forge a regional TSM process or where a TSM approach based on corridor planning has been adopted, in many cities, TSM remains what it was three years ago—a collection of independent actions by modal agencies with limited successful coordination.

REFERENCES

1. R. Gakenheimer and M. Meyer. Urban Transportation Planning in Transition: The Sources and Prospects of TSM. Journal of the American Planners Association, Vol. 45, No. 1, Jan. 1979, pp. 28-35.
2. D. Jones, W. L. Garrison, and A. D. May. Transportation System Management: Promise, Performance, and Prognosis. Research and Special Programs Administration, U.S. Department of Transportation, Rept. DOT/RSPA/EPB-50/78/30, Dec. 1978, 43 pp. NTIS: PB 292 447/0SL
3. D. Jones and E. Sullivan. TSM: Tinkering Superficially at the Margin? Journal of the Transportation Engineering Division, Proc., ASCE, Vol. 104, No. TE 6, Nov. 1978, pp. 817-834.
4. M. Meyer. Organizational Response to a Federal Policy Initiative in the Public Transportation Sector: A Study of Implementation and Compliance. Department of Civil Engineering, Massachusetts Institute of Technology, Cambridge, Ph.D. dissertation, May 1978.
5. Transportation System Management. TRB, Special Rept. 172, 1977.
6. D. Lee. APTA's Conference Series on TSM: A Summary of Observations and Conclusions. Transit Journal, Vol. 5, No. 3, Summer 1979, pp. 25-36.
7. Transportation System Management in the Denver Region. Regional Council of Governments, Denver, CO, Draft Rept., April 1979.
8. Transportation System Management Process Report: A Short-Range Plan for the Indianapolis Region. Department of Metropolitan Development, Indianapolis, IN, 1978.
9. Baltimore Region Transportation System Management. Regional Planning Council, Baltimore, Nov. 1978.
10. St. Louis Transportation System Management Element. East-West Gateway Coordinating Council, St. Louis, March 1979.

D.A. Lee is now with the Metropolitan Transit Commission, Minneapolis, Minnesota.

Relationships Between Major National Goals and TSM

Thomas B. Deen, Alan M. Voorhees and Associates, McLean, Virginia

Transportation system management (TSM) has been a major element of transportation improvement programming in U.S. urban areas for the past four years. As such, it has evolved slowly: Thus, although no one can be sure of its current status, it appears that many actions are being planned and implemented in its name and that even the name itself—TSM—is becoming part of the jargon of those concerned with urban transportation improvement. It also appears, however, that such actions have rather consistently failed to develop and organize their actions as explicit responses to major transportation goals (as discussed by Lee and Meyer in the preceding paper in this special report). From the start of the program, local agencies have shown the capability to prepare substantial lists of management actions designed to improve the system but, at the same time, they have been unable or unwilling to demonstrate that the actions were prepared in response to specific goals or to indicate what the impacts might be on the attainment of these goals. The early problems in this regard were attributed to the novelty of the program, and great hopes were still expressed for early improvement (1). However, it is not at all clear that we are in a better position now than at the beginning. TSM programs continue to consist, in the main, of lists of tactical actions that have no apparent relationship to larger strategic goals. What are the reasons for this? Are TSM analytical processes inadequate? Is it simply inattention to the problem? Or is there some attribute of TSM that makes linking planning efforts to goals particularly intractable?

The purpose of this paper is to begin answering these questions so that the important link between TSM planning and national and regional goals can be made. I will begin by looking at transportation goals themselves—their sources, nature, and intrinsic internal conflicts—and then ask questions about the true effects of TSM; i.e., if we assume a perfect TSM planning process, what achievement of transportation goals can reasonably be expected from management actions? Finally, I will end by examining the role of TSM in an environment where goal priorities may be changing.

MAJOR NATIONAL GOALS RELATED TO TRANSPORTATION

Before we look at the goals related to transportation themselves, it will be useful to note two facts that are usually suggested in discussions of normative TSM planning processes. These are (a) that the goals should be explicitly established at the outset so that responsive action packages can be developed and (b) that, after implementation, it is then equally important (as a guide to future planning) to evaluate the effects of the TSM actions and the degree to which the goals have been satisfied (2). Clearly, in either case, an explicit statement of goals is needed.

The first thing that can be said about national transportation goals is that they are elusive. There is no single person, location, or document that can articulate them. A comprehensive goals statement in a very large and pluralist society such as ours is extremely difficult, perhaps even impossible, to develop, given that the responsibilities for transportation are so decentralized and scattered. Even within urban areas, transportation is the responsibility of numerous government agencies and an even larger number of private companies and individuals of varying functions and interests. Goals development must thus be an evolving process that reflects and builds on the existing laws, precedents, and programs of the many actors found in the transportation arena.

When one examines statements of national transportation policy, legislative histories of major transportation acts in Congress, policy statements, regulations and guidelines published in the Federal Register, and speeches of U.S. Department of Transportation (DOT) officials, a substantial commonality of major goals expressed as a general intent or direction can be found (3-7). Those that can be identified as relevant to TSM are related to the following:

1. Mobility,
2. Economic efficiency,
3. Environmental conditions,
4. Energy use,
5. Urban economics and land use, and
6. Transportation for the disadvantaged.

[Safety and security are obvious omissions from this list, but these issues at the local level more often involve tactical (intramodal, intrajurisdictional, or intra-agency) actions rather than strategic ones.]

At the federal level, these goals are translated into the programs and administrative regulations executed in various agencies. At the local level, the goals are often translated into objectives—quantified statements of intent—that lead to primary goal satisfaction. A typical objective might be to shift a specific percentage of travel from automobiles to public transit within a specific time period. Clearly, this objective has no intrinsic merit; however, it is seen as a means to achieve energy conservation, environmental improvement, or some other primary goal.

What we would all like, and what the planning process seeks in the first instance, are those actions that have a positive effect on the satisfaction of one or more of the goals while having little or no negative effect on the others. A supersize bus, for example, put into service on a route that has a high passenger volume has the potential for positive effects on mobility (fewer buses needed and thus less traffic congestion), on the environment (fewer buses mean less noise and fumes), and on economic efficiency (fewer drivers mean lower costs). The negative effects would appear to be negligible, and a decision for implementation is easily taken if the required conditions are met. Similarly, carpool matching and promotion programs, improved bus service and marketing programs, or provision of bicycle paths are programs that have positive effects that most communities endorse (except for some marginal effects on the goal of economic efficiency in some cases).

Unfortunately, many of the more-effective TSM actions cannot be implemented without negative effects on important goals. Take-a-lane bus-priority schemes, road tolls, parking pricing, large automobile-free zones, and fuel taxes are effective in reducing environmental pollution and increasing fuel conservation, but to the detriment of personal mobility. Not surprisingly, few such schemes have been adopted. In fact, there are relatively few instances where schemes that seriously impinge on personal mobility have been accepted.

Table 1. Alternative goal hierarchies of different groups.

Emphasis	Metropolitan-Area Residents (1)	Residents of an Environmentally Sensitive Area (2)	Local Residents in a Neighborhood Traffic Study (3)	Local Officials in a CBD Study (4)	EPA Officials (5)	U.S. DOT Regulations (6)	Citizens after Additional Fuel-Supply Interruptions (7)
More	Mobility	Mobility	Environment	Mobility	Environment	Mobility and other goals	Mobility and energy
		Environment	Mobility	Economic revitalization	Other goals		Other goals
	Environment	Other goals	Other goals	Other goals			
Less	Other goals						

This suggests that there is an implicit hierarchy among major transportation goals as reflected in the attitudes of urban residents and that, not surprisingly, mobility tops the priority list. The nature of this goals relationship is illustrated in Table 1. The first column suggests that mobility is the dominant goal of most urban residents, with environmental considerations secondary, and other goals generally lower than that. The willingness to improve automobile accessibility through traffic engineering, new signal improvements, and selected street improvements continues unabated despite the potential for increasing automobile use that these actions imply. Congress has been unable to take any actions that inhibit mobility, despite the almost unanimous official agreement on the need for fuel conservation. A good illustration of this constraint occurred in the unsuccessful attempt by the U.S. Environmental Protection Agency (EPA) to trade off ease of personal mobility for improved air quality (8). And perhaps the most dramatic demonstration of goals ambivalence has been the unwillingness until very recently at DOT to increase parking charges for its employees in Washington, D.C., while advocating such programs for others nationwide.

In some environmentally sensitive and politically active areas (e.g., Portland, Oregon, and Denver), there is greater acceptance of marginal subordination of mobility for the sake of the environment—at least officials are willing to consider it. This is illustrated by column 2 of Table 1 as a slightly modified goals hierarchy that reflects an increased emphasis on environmental considerations. Note, however, that mobility is still the most important goal.

In small subareas, i.e., local neighborhoods, mobility is sometimes displaced by environmental considerations (see column 3 of Table 1). Several neighborhood-traffic-circulation studies have occurred solely in response to a local citizenry upset by the environmental degradation caused by through traffic in the neighborhood. In some cases, traffic restraints and regulations that reduce mobility have been implemented. It is important to note, however, that in reality this represents a triumph of a local us over an areawide them, rather than a willingness of an entire constituency to favor environmental improvements over mobility. The neighborhood is willing to reduce the mobility of people who live elsewhere in order to improve its own environment.

Another goal that has become important in recent years is the economic revitalization of central cities (see column 4 of Table 1). Many central business district (CBD) studies have focused on this goal—sometimes even to the extent of encroaching on mobility. Although the use of automobile-free zones and malls is evidence of this, the importance of accessibility (i.e., mobility) is not lost on the economic planners.

The fifth column in Table 1 illustrates the goals of EPA officials and of some environmental legislation. Special-interest politics, widely practiced by many groups on the current U.S. scene, is able to obtain passage of legislation that has unknown effects on other values that become known only on implementation. Although environmental advocates might fault TSM as impotent or irrelevant from their perspective, the problem is not in the program or analysis methods nor in the lack of effective potential actions. The problem is that their goals do not reflect those of much of the citizenry. (This statement stands independent of whether the environmentalists are, in the end, right or wrong. Decreased mobility is immediately perceived, whereas the incidence of disease and the costs of health care due to environmental pollution are not fully understood and are, in any case, deferred. Thus, health-care disbenefits tend to be discounted except by people who have lung cancer or emphysema.)

The DOT regulations, including those requiring TSM, stress the evaluation of actions against goals achievement (see column 6 in Table 1). Disillusionment and criticism begin when actions favoring mobility at the expense of other goals seem to win. Fault is sought in the planning process, in institutional arrangements, or in official timidity. In fact, the same results might occur if the process were perfect, organized ideally and headed by heroic officials, so long as the goals hierarchy remained the same.

What, then, is the future of TSM? Is it forever doomed to be simply the compilation of lists of actions that would have taken place anyway, to have only a marginal effect on the way we use and operate the system, or at best be a watchword or banner under which the use of tactical actions favoring mobility can be promoted during periods of fiscal austerity? The best answer to this would appear to be "no". Barring new technological solutions, the energy problem will perturb the transportation system in ways that will make management of the system ever more essential. Automotive fuel will be rationed either by price (whether permitted or prohibited by government action), coupons, occasional short-term supply interruptions, or combinations of these factors. In the event of price or coupon rationing, the need for high-occupancy vehicle (HOV) programs will be significant and the need to expand the capacity of our transit systems rapidly will be great. Supply interruptions will bring into play the energy contingency plans now being prepared in each urban area and the term "management" in the context of the urban transportation system will take on a new meaning. All of these factors have the potential for shifting the goals hierarchy (see column 7 of Table 1) such that the possibility of difficult, perhaps even agonizing, trade-offs between conflicting TSM actions may be required. In the event of this occurring, the fact that TSM is known—that a program has

been established, that research has started and results are partially available, that transportation professionals are trained, and some technical analysis processes are available—will be of enormous help. TSM will then be an idea whose time has truly come.

POTENTIAL FOR SATISFACTION OF GOALS THROUGH TSM ACTIONS

None of this discussion of goal conflicts and hierarchies will have any significance if TSM is, as some have alleged, simply a tinkering with the system, a marginal manipulation that, in the end, is too small to matter. If TSM actions have, in the aggregate, effects that are too small to significantly affect goal satisfaction, or if it is possible to satisfy some goals but not others, then we should recognize this now and not strive for trade-offs and evaluations that are intrinsically irrelevant. This section of the paper deals with TSM effects, their nature and size, and how they could relate to the satisfaction of major goals if we were of a mind to implement TSM without reservation.

As noted above, perhaps the three most important goals to which TSM is relevant are mobility, energy conservation, and reduced air pollution due to emissions. Both energy-conservation and emissions-reduction goals are favorably affected by a reduction in vehicle travel (VT) in an urban area. Thus, although other variables also affect energy use and emissions, this variable (VT) will be used as a surrogate for them in the discussion below.

The percentage changes in travel time (a measure of the satisfaction of the mobility goal) and VT (a measure of the satisfaction of energy-conservation and emissions goals) of four different TSM strategies (involving packages of diverse TSM actions) for work, nonwork, and all trips in a typical city of one million population are given in Table 2. The four strategies are different in the way in which they affect the demand for vehicle travel on highways and those in which they affect the quality or speed of travel on the system (i.e., affect the quality of the supply of transportation). [Details of the methodology and the many assumptions necessary to make this analysis can be found elsewhere (9).] These effects were calculated by assuming a significantly higher commitment to TSM improvements than is generally accepted at present and further assuming that, for most TSM actions, only partial implementation has so far been achieved. (One can, for example, upgrade the signal system by using current technology only once; after that, that TSM action is no longer available to a given area.)

The first thing to be said about the results shown for worktrips in Table 2 is that the potential effects of combined actions are very large. Travel-time reductions on a regional basis of the order of 20 percent are simply enormous. Class B actions alone (e.g., traffic engineering improvements, freeway traffic management) have the potential for almost 10 percent travel-time reductions, while class C and class A actions have the potential for about 5 percent reductions.

The potential effects on VT are not as great, but are still large—a total of more than 10 percent VT reduction appears possible. About half of this comes from efforts to encourage HOV use through ride-sharing programs and transit improvements, while the other half comes from actions affecting HOV use through restrictions on regular automobile use (e.g., take-a-lane HOV priority schemes, automobile-restricted zones).

Class A actions tend to favorably affect mobility goals as well as energy-conservation and emission-reduction goals and are being implemented in many areas throughout the country with little controversy. Their use is limited largely by the extent to which improvements can be affected without unreasonably large financial costs (thus unfavorably affecting economic-efficiency goals). Class B strategies, on the other hand, tend to achieve mobility goals (by reducing travel time), while adversely affecting energy-conservation and emission-reduction goals (by increasing VT). It is interesting to note that class B actions are also being implemented in many locations, giving further weight to the contention that mobility goals are generally dominant at the local decision-making level. In addition to class A actions (which also improve mobility), the most favorable effects on VT are achieved by road-user pricing and class C actions. Both of these actions, however, are perceived as having adverse effects on mobility and thus tend to be the most difficult to implement. (Pricing actions can be shown to reduce travel time and thus improve mobility for those willing to pay the price, but are perceived to reduce the mobility of those unwilling to pay the price.)

Table 2. Effects of TSM strategies: prototypical city of one million population.

Type of TSM Strategy		Change (%)					
		Work Trips		Nonwork Trips		All Trips	
Description	Class	Travel Time	VT	Travel Time	VT	Travel Time	VT
Actions that reduce demand for vehicle travel							
Ride-sharing programs, transit marketing, express bus services, park-and-ride lots, local transit route and schedule improvements, paratransit services, bicycle and pedestrian facility improvements	A	-5.1 to -5.5	-5.1 to -5.5	0.2	1.1	-2.0	-1.5
Road-use pricing	A'	-2.3 to -2.4	-2.3 to -2.4	-1.2	-6.1	-1.7	-4.6
Actions that enhance highway supply: traffic engineering improvements, freeway traffic management, truck restrictions	B	-9.1 to -9.7	+0.2 to +0.9	-7.0	1.0 to 3.4	-8.0	0.7 to 2.4
Actions that reduce demand for vehicle travel and degrade highway supply: preferential treatment for HOVs, automobile-restricted zones, reductions in off-street parking	C	-4.7 to -5.1	-5.8 to -6.2	0.4	1.9	-1.7	-1.3
Actions that reduce demand for vehicle travel and enhance highway supply: preferential treatment for HOVs, on-street parking restrictions	D	-1.3 to -1.5	-0.6	0	0.2	-0.6	-0.1
Actions that improve mobility	A + B + D	-15.5 to -16.7	-4.8 to -5.9	-6.8	2.4 to 4.7	-10.6	-0.9 to +0.9
Actions that favorably affect energy-conservation and emission-reduction goals	A + C + D	-11.1 to -12.1	-11.5 to -12.3	0.6	3.3	-3.8	-2.7
All actions (except road-use pricing) combined	A + B + C + D	-20.2 to -21.8	-10.6 to -12.3	-6.7	4.4 to 6.6	-12.1	-0.3 to -2.2

The potential effects of these same strategy classes on nonwork trips are much less than those for work trips. This is due to the fact that most TSM strategies are directed toward relieving congestion (and thus primarily affect work trips) or apply only to daily or highly repetitive travel (e.g., ride sharing). Thus, travel-time reductions approaching only 7 percent appear possible. The real problem is the adverse effect on VT. All strategies except pricing actually increase VT. This is explained by the increased use of the family automobile that is now available at home. This extra VT also adversely affects fulfillment of energy-conservation and environmental goals. Overall travel-time improvements of about 10 percent seem possible for TSM strategies for work and nonwork trips, surprisingly high considering that potential travel-time reductions for nonwork travel are intrinsically limited because most such travel occurs at noncongested periods.

Our ability to reduce VT appears very limited unless we are prepared to use pricing strategies. Without the use of pricing strategies, VT reductions of about 3 percent appear to be the upper limit. As urban transportation is responsible for about 25 percent of all petroleum consumed in the United States, this means that nonpricing TSM strategies have the potential for saving less than 1 percent of U.S. oil use. This, however, may understate the longer-term effects of families selling the car released from travel to work when HOV strategies are employed. Little is known about this type of effect.

All of the results shown above are for a prototypical city of one million within the current goals-acceptance context. Smaller cities could expect results of less magnitude, and larger cities could expect greater results; many priority HOV treatments, carpool and vanpool encouragement programs, and transit improvements have larger effects where trips are longer, congestion is greater, and costs are higher. In a rationing or fuel-supply-interruption context, however, the effects among different types of cities might be more equally distributed.

We should agree that effects of 3-5 percent are significant. Even very large, expensive, and highly visible transportation projects in urban areas rarely affect more than 5 percent of all urban travel. For example, a 16-km (10-mile), eight-lane section of urban freeway carrying 100 000 vehicles/day in a city of two million population will likely carry less than 5 percent of the VT for that area. The Bay Area Rapid Transit System carries less than 2 percent of all trips in the Bay Area. Because of the ubiquitous use of energy in all aspects of human activity, reductions in any single area will likely have only a small effect on overall energy use. Success must necessarily be achieved by small reductions in a large number of different types of activities. Part of our problem may be that we as professionals do not ourselves understand the importance of changes of these dimensions. The larger capital-intensive systems tend to be oversold and have popular perceptions of effects larger than warranted. Our own perceptions may be similarly distorted.

TSM IN AN ALTERED GOALS CONTEXT

As a group, we have grown accustomed to the evaluation of transportation improvement projects not only for their effectiveness in improving mobility, but also in terms of their effects on other national (and related local) goals. Although mobility is still considered of highest priority, we are at least comfortable with the concept of trading off among conflicting values associated with many of the potential improvements developed for any particular problem. Such evaluations are almost always at the local neighborhood or metropolitan scale, and it is accepted that the total of projects that survive such local evaluations will, in the aggregate, move us in the direction of goals satisfaction. Such notions, although satisfactory to most in the past, may be quite insufficient in the coming years, when energy conservation or other social goals may justify a much more rigorous system intervention. This insufficiency springs from the very dominance of mobility, its impact on the American lifestyle, and its supporting economic and social structure. Any serious manipulation that has adverse impacts on mobility will likely have social and economic impacts so pervasive that they can be evaluated only at the level of national policy and long-range planning (rather than at the local or short-range level that is our custom).

Wachs (10) describes these impacts as follows:

> In the U.S., employment related in some way to vehicles and highways totals almost 15 million jobs. This means that about one-fifth of all jobs held by Americans in all fields are related to building, repairing, driving, or selling vehicles, roads, and related facilities. Just the retailing of automobiles and auto equipment and supplies required nearly two million employees and produced annual receipts exceeding 119 billion dollars. Industries other than motor vehicle manufacturers themselves produce more than 16 billion dollars annually in auto parts. Vehicle rental, parking, repair, and related services generated annual receipts of more than 12 billion dollars and payrolls of more than 2.5 billion dollars. Nationally, 70 percent of all fruits and vegetables travel by truck, and virtually 100 percent of all livestock reaches major markets in trucks. Given this setting, it is clear that any national policies or cumulation of local policies impacting mobility will have pervasive social and economic impacts.
>
> Among the most dramatic of social changes which have been facilitated by the evolution of personal mobility are those related to recreational travel. Tourism is now considered to be the second ranking source of retail expenditure within the U.S., surpassed only by the marketing of food. In 1974, the U.S. Travel Service reported that expenditures for travel within the United States were 61 billion dollars annually and that more than ninety percent of this total was automobile oriented. Only two years later, by 1976, this annual total had grown to more than 72 billion dollars. There are now more than 55,000 motels in the United States, grossing 7.5 billion dollars per year and all depending upon continued freedom of personal mobility.
>
> Mobility and expectations regarding mobility are such an intrinsic part of American social life, that changes in national policies regarding the economy, energy, environment, and transportation can and will have major social impacts related to mobility. It has been estimated, for example, that the national decision to close gas stations on Sundays during the fuel shortage of 1973-74 caused a temporary loss of jobs to 90,000 people, and that losses to the tourism and travel businesses over a four month period amounted to three-quarters of a billion dollars. In the last full year before the oil embargo, Americans purchased 752,000 campers, pickup truck covers, travel trailers, camping trailers, and motor homes. In response to the oil embargo and the recession, this annual total dropped by one-third. After the embargo was lifted and the supply of fuel returned to the more usual levels, sales in this area climbed upward again. Such trends indicate more than the economic dependence of certain industries upon expectations of continued mobility. The economic facts, of course, mirror choices which have been made by a hundred million families and are indicators of the role of mobility in modern America. These facts and figures also imply the kind of readjustment which would be required to cope with major changes in policy which might lead to reductions in mobility during the coming decade.

Consideration of such broad impacts has been beyond the range of all but a few national policy planners. However, it is clear from recent events that decisions being made at the state and local levels also have impacts beyond those we normally evaluate. Odd-even gasoline sales, intrastate fuel-allocation decisions, gasoline-less weekends, and other conservation measures depending on site-specific contexts can spell economic ruin (or windfall) for thousands of Americans and social readjustment for millions. To discuss the relationships between TSM actions and national goals thus requires considering these broader implications under conditions where radical system manipulation is required.

SUMMARY

It has been noted that one of the major criticisms of TSM has been its failure to develop action strategies that are appropriately responsive to specified goals. Many TSM actions have favorable effects on some goals while unfavorably affecting others. The need for analysis and evaluation of the trade-offs of these effects is particularly important if major goals are viewed as having equal or nearly equal value. The fact that such evaluation and analysis does not occur appears to be a natural result of a goals hierarchy that strongly and rather consistently favors mobility over other goals. Fuel rationing, energy supply interruptions, or national economic difficulty, however, have the potential to alter this hierarchy and introduce an era where TSM can function in its originally conceived manner.

TSM strategies, if applied without reservation (but excluding fuel rationing or pricing strategies), can have significant effects on major goals. Travel-time reductions for work travel of 15-20 percent are possible. Favorable effects on energy-conservation and emissions-reduction goals are more limited—probably not more than 3 percent VT reduction for all trips (but more than 10 percent VT reductions for work travel). Pricing seems to be the only significant TSM strategy that reduces VT for nonwork trips; thus, the need for acceptable TSM strategies that could accomplish this goal is a crucial weakness in TSM as currently practiced. However, effects of even 3-5 percent are significant when compared with the effects of some highly visible and costly transportation improvements.

The strategies that include more radical conservation measures (such as fuel allocation, rationing, and pricing) have, because of the pervasiveness of personal mobility and its influence on the American life-style, more far-reaching impacts than those usually considered by planners. Under such conditions, the cumulative effects of local TSM actions could have a significant impact on the satisfaction of national goals such as economic growth, economic equity, and social diversity and choice.

REFERENCES

1. Transportation System Management Review: Current Status and Future Guidance. Federal Highway Administration and Urban Mass Transportation Administration, Aug. 1976.
2. Transportation System Management. TRB, Special Rept. 172, 1977, p. 100.
3. B. Adams. Transportation for a Changing America. Office of the Secretary, U.S. Department of Transportation, Feb. 6, 1978.
4. W. N. Coleman. Statement of National Policy. Office of the Secretary, U.S. Department of Transportation, Sept. 17, 1975.
5. W. N. Coleman. National Transportation: Trends and Choices (to the year 2000). Office of the Secretary, U.S. Department of Transportation, Jan. 12, 1977.
6. Transportation in the United States: Summary Appraisal. Mitre Corporation, McLean, VA, July 1975.
7. APTA's Transportation Policy: A Proposal. Transit Journal, Vol. 1, No. 1, Feb. 1975.
8. L. E. Keefer. Transportation Control Plans: The Next Round. ITE Journal, June 1978, p. 19.
9. F. A. Wagner and A. K. Gilbert; Alan M. Voorhees and Associates. TSM (Transportation System Management): An Assessment of Impacts. Office of Policy and Program Development, Urban Mass Transportation Administration; Office of Highway Planning, Federal Highway Administration; and Office of Transportation and Land Use Policy, U.S. Environmental Protection Agency, Rept. UMTA-VA-06-0047-79-1, Nov. 1978, 188 pp. NTIS: PB 294 986/5SL.
10. M. Wachs. Resource Paper on Social Issues. Paper presented at Conference on the Future of Personal Travel in the United States. Aspen, CO, 1979.

Roles of Organizations, Public and Private Enterprise, and the Professional Disciplines in TSM Planning, Programming, and Implementation

TSM: Alternative Institutional Roles

Gordon A. Shunk, De Leuw, Cather and Company, San Francisco*

The purpose of this paper is to develop a basis for a discussion of the roles and responsibilities of the various institutional participants in the transportation system management (TSM) process. I will begin by presenting a brief summary of the current institutional structure to serve as a frame of reference and will then describe in more detail an alternative perspective of the TSM process. The institutional roles in this perspective are viewed as a reasonable proposal for how the TSM process could and should work. I will conclude by discussing the steps necessary to actually achieve this alternative posture.

TSM TODAY

To many, TSM is simply a set of federal requirements or a type of project whose consideration these requirements mandate. The federal transportation agencies, the Urban Mass Transportation Administration (UMTA) and the Federal Highway Administration (FHWA), are now attempting to induce planning and implementing agencies to at least consider, and preferably to implement, low-cost alternatives in place of capital-intensive projects. Few would argue with the economic reasoning that underlies these attempts, but I take issue with the manner in which it is being administered. Going one step further, if the process were properly organized, this heavy federal hand would be unnecessary because local agencies would conduct their affairs according to this same economic reasoning. That is the basis of the argument I will develop in this paper.

Today, state and local agencies are trying to obtain as much federal highway and transit money as possible. Their considerable needs could justify such efforts, but there is also the feeling that they should get their fair share before it is too late. If they do not get theirs now, someone else will. An additional aspect of this behavior is to obtain the funds while there are still some available and before inflation further erodes their purchasing power. As a result, one can see agencies throughout the country working feverishly to show that TSM solutions are not as satisfactory as major capital-intensive projects.

In contrast to the behavior described above, FHWA and UMTA continue to force state and local agencies to shift their emphasis to TSM solutions. Most of these efforts are product oriented, i.e., implement TSM projects, prepare TSM plans, or consider TSM project alternatives. It may be more appropriate to examine the process, i.e., to consider how changes in the transportation planning process could effect a reorientation of priorities. A major part of this change could be effected by redefining the responsibilities of participating agencies. Let us examine a hypothetical reorientation and reorganization of the TSM process. This will help to define and understand appropriate roles and responsibilities of participating institutions.

THE MANAGING PROCESS

To begin, let us consider TSM as the process of managing the transportation system. The purpose of this process is to provide transportation services to travelers and haulers. The managers' objective is thus to provide service in the most effective and efficient manner possible. In simplified terms, this would seem to be the process actually followed by most transportation agencies. It is in fact the modus operandi of most transit operators, primarily because they both own the facilities and operate the services. It is, however, not the approach or attitude of most street and highway agencies because, although they control the facilities, they have little control over individual driver behavior.

The goal of every participant in the transportation management process should be to provide the most and best service, given available resources. The transportation manager will assess the needs and problems and allocate the resources in the manner that will most efficiently and effectively satisfy those needs and solve those problems. This will require making trade-offs about the best way to allocate resources, and such trade-offs imply making the most of operational improvements in order to allocate or preserve resources for needed capital improvements. For this discussion, it is important to emphasize that these trade-offs should be made by the transportation manager. These decisions require knowing the needs and resources of the system or service. Therefore, the individual making such trade-offs should be familiar with the operating system in order to properly appreciate all aspects of these trade-offs.

ALTERNATIVE ORGANIZATION FOR MANAGING TRANSPORTATION

This organization for managing transportation would be quite similar to a typical business management hierarchy. There would be operating managers responsible for providing various types of service to the public, e.g., transit operators, airport operators, street departments, and highway departments. There would be several successive levels of supervising management, provided in turn by city, county, regional, and state transportation agencies and the U.S. Department of Transportation. Obviously, not every agency of a particular type would have the same responsibilities, but the basic hierarchy would be the same.

The operators (i.e., operating agencies) would collect

revenue for services provided. Some of this revenue would be from fares or tolls; some would be from taxes. It is very important, however, that the relationship between services and revenue be carefully defined and preserved. One important reason why current financing structures produce less service than they might is that there are too many people, too many rules, and too many decisions between the users (who pay) and the producers (the operators). Therefore, the producer is more responsive to the fund-allocating agencies (and their criteria) than to the users.

The operating managers would be responsible for the allocation of resources among transportation services in the limited local area for which they were responsible. The revenue collected would pay for operations (bus drivers and train operators, traffic police, and toll takers); some would pay for maintenance, some would purchase new facilities and equipment, and some would pay for management. The operating managers would oversee and administer operations and would plan the design and financing of needed improvements. The operating agencies and their managers would be directly responsible to the users and the taxpayers (who pay taxes directly to the operators) for providing service and for trade-offs among operating expenses and capital improvements.

A portion of the revenue allocated for management would be passed up to supervising managers (this will be recognized as overhead). Supervising managers would usually not be directly responsible for providing transportation services but rather would oversee the activities of several operating managers, each having service responsibilities for one operating system or one local area. A city or county transportation agency could supervise operators of several modes in one jurisdiction; a regional agency could supervise operators of the same mode in several jurisdictions in the region. The role of the supervising managers would be to ensure adequacy of performance of lower-level managers, primarily operating managers. The supervising managers would also be responsible for ensuring coordination among the systems operated or supervised by the agencies for which they were responsible. State transportation agencies would be supervising managers for several regional supervising managers and for operating and supervising managers in counties and cities. (State agencies would also be operating managers for rural highways.) Federal transportation agencies would be supervising managers overseeing state managers.

One problem with this organizational arrangement is that of the responsibility for policymaking. The analogy to corporate management is somewhat difficult. Operating managers would have principal responsibility for policies on the services for their systems (they are directly responsible to the users and the electorate), and supervising managers would set policy for coordination among the services for which they were responsible. The question is, How much responsibility should supervising managers have for policies within individual systems? It seems reasonable to assume that policy input from supervising management to all operating systems under their supervision would be necessary. Some consistency among systems must be maintained because travelers and haulers often use transportation services outside their local areas. This same rationale also argues for interarea fund allocation, which would provide the needed influence to ensure compliance to the policies of supervising management.

INSTITUTIONAL ROLES

The hypothetical organization described above permits an analysis and comparison of the roles and responsibilities of the various institutions or agencies in the transportation management process. The principal responsibility for TSM decisions should reside in the operating agency whose service is affected; that agency is, after all, closest to the service, the needs, and the users. In the hypothetical organization, the operating agency is also closest to the financing source and thus should be responsible for resource allocation and its associated trade-offs. This agency understands, better than any other, the needs of its system and the demands of its user constituency. The manner in which each operating agency makes its decisions on services in its system would be reviewed by the supervising agencies, but the supervisors' involvement would be limited to advising operators on appropriate considerations and approaches in such decisions.

The supervising agencies would be lead agencies for decisions requiring coordination among the individual systems that they supervise. Such decisions should include active participation by each operating agency whose system will be directly affected by the decision. Except in extreme cases, however, the agreement of all participants in such coordination decisions should be obtained before implementation. Higher-level supervising agencies should be responsible for the review of lower-level supervising agency performance, except in the case where they are either coordinators or operators. This means that the federal and state agencies should not be deeply involved in the management process.

It is unlikely that this hypothetical organizational structure will ever be implemented, but even within existing regulations and especially with a few administrative changes, the general principles that it implies could be incorporated into the existing TSM process. This would require two major changes in the existing TSM process:

1. All participants in the process must agree on a redefinition of responsibilities. Each agency must carefully define what it will and will not do. Supervising agencies must be identified and their responsibilities defined. Above all, system users must know who is responsible for deciding how their money is spent.
2. Transportation professionals should be trained in management skills. In a few cases, little adjustment beyond role definition will be necessary. In the majority of cases, however, major retraining efforts would be necessary. The major focus of such training would be on managing resources and making trade-offs. Some short- and long-term financial planning and techniques for evaluating performance should also be taught.

How can we initiate this metamorphosis? This conference can take the first step. Recommendations for change and precise definitions of roles from a group of this stature could be the catalyst. Once the need to change and the likely benefits of change have been recognized by the funding agencies, the process can begin. It would seem appropriate for this group to prepare concrete recommendations for change as the first step in such a process.

ROOTS OF THE PROBLEM

Notwithstanding the potential benefits that such changes can offer, the roots of the problem are much deeper than described above. Given the existing incentives in federal funding programs, local agencies cannot make the kinds of reasonable management trade-offs that the federal agencies are encouraging. In the simplest terms, federal and state funding is awarded on the basis of ap-

parent need; the more need you show, the more money you get. This approach puts a premium on high-capital-project solutions rather than on encouraging cost-effective trade-offs among operating and capital improvements. Under the guise that there is so much capital need, the funding agencies have earmarked funds for capital projects.

As a result, local agencies (and states) have tremendous incentives to develop the largest-capital projects possible, so that they will receive a larger allocation. Because of this capital-project orientation, implementing agencies have no incentive to make cost-effective trade-offs. The local and state staffs concentrate on developing plans for large projects, which leaves little time for operations improvements and other managing efforts.

It seems incongruous for federal and state agencies to attempt to force local agencies to implement TSM improvements. The funding incentives are currently against such an orientation; if they were not, the TSM requirement would not be needed. Operating managers would be able to make reasonable management decisions if they were responsible for expenditures. In the face of this, the federal agencies are seemingly unwilling to revise the existing funding mechanisms.

This situation will not change easily or soon, but recognizing the problem is the first step toward solving it. Knowing that counterincentives exist and that responsibilities are misplaced, we should be able to work out a strategy to circumvent the problem and accomplish what we all know needs to be done. That job is to bring management and funding decisions closer to the market so that services can respond to the user. This conference can be the first step. If we can prepare a reasonable agenda and timetable for improving the funding process, a giant step will have been taken. If we can assign some responsibilities and identify follow-up activities, that step may be the first on the journey out of the TSM organizational morass.

*G. A. Shunk was with the Metropolitan Transportation Commission, San Francisco, when this paper was prepared.

Institutional Dimension of Transportation System Management: A Bottoms-Up Approach

David W. Jones, Jr., Institute of Transportation Studies, University of California, Berkeley

When federal rule makers speak of institutional arrangements, they are thinking of formal and orderly procedures to implement policy objectives. When local policymakers speak of institutional arrangements, they are thinking of practical ways to capture federal funds, satisfy local constituents, and exert community leadership. These two views of institutional arrangements—the top down and the bottom up—do not coincide. The usual result is ritual compliance—dressing up opportunistic local decision making in the clothing of federal mandate and the language of systems planning.

Local response to the transportation system management (TSM) regulations of September 1975 is a classic case of ritual compliance at work—at least in many metropolitan areas. Most areawide TSM plans have been pieced together by reporting projects that have been planned at the local level and then sorting them into the official categories [40 Federal Register 42 976 - 42 984 (1975)]: actions to make more efficient use of existing roadspace, actions to reduce vehicle use in congested areas, actions to improve transit service, and actions to increase internal transit management efficiency. Thus, as it has been practiced by most regional agencies, TSM has been a list-making and documentation exercise. Planning has occurred at the local level; stapling has occurred at the regional level (1-4).

Federal transit and highway officials had something different in mind when they first promulgated the TSM regulations. Federal officials believed, as expressed in guidance for TSM planners prepared jointly by the West Coast regional offices of the Federal Highway Administration and the Urban Mass Transportation Administration (UMTA) and distributed at workshops in TSM hosted by the California Department of Transportation in 1978, that

> TSM planning should take place within a region-wide context. Area transportation goals should be formulated or restated, existing conditions and problems assessed, alternative strategies developed and evaluated, and a preferred priority set of improvements identified. This regional perspective is essential to avoid duplicative or conflicting TSM projects and to avoid TSM strategies which might contravene other established goals.

A similar view of TSM was expressed by C. Kenneth Orski:

> The TSM requirement is much more than individual low-capital, short-range actions being taken to manage each component of the system or even the set of all those actions. More significantly, it is the mechanism established to set objectives for managing the system, the process of selecting specific goals and implementing strategies, and the technical planning activities undertaken to inform that process. This concept of TSM leads to definition of three functional components of TSM:
>
> (a) institutional arrangements for getting all the relevant actors together and producing viable TSM plans, since no single actor can be given responsibility for all of the pieces;
> (b) technical planning activities to monitor system performance, identify problems and opportunities, identify optimal packages of actions associated with possible goals and assess their feasibility, and determine the points of trade-off or complementarity between different goals and actions; and
> (c) implementation and evaluation activities that determine and carry out the detailed design and planning for actual installation or initiation of each planned action and that measure the response in order to insure optimal performance with respect to its goals.

This view of TSM and the appropriate organization for the TSM planning process has led federal officials to view the TSM plans developed to date as inadequate, cosmetic, and unresponsive. Such an assessment was inevitable, given the questions federal representatives ask when they evaluate TSM elements (TSMEs) and TSM plans:

1. What was the process or procedure for developing the TSM strategies?
2. Does the TSME reflect overall area goals and objectives, policies, and strategies, as well as more-specific TSM objectives against which TSM improvements can be judged?
3. What was the range of TSM strategies evaluated and proposed?
4. Was there areawide assessment of the effectiveness of a combination of TSM strategies?
5. Were preproject planning studies conducted or proposed to evaluate the effects of individual strategies?
6. Do mechanisms for monitoring improvements exist?
7. What was the involvement of transit operators, state and local jurisdictions, regulatory agencies, private businesses, and citizens?
8. Was there coordination with the U.S. Environmental Protection Agency transportation control plans where applicable?
9. Was there endorsement of the TSME by the policy committee?
10. Are the recommended TSM strategies compatible with the long-range transportation plan?

Assessed against these questions, the TSM planning process looks like what we have called it: ritual compliance. This, of course, annoys the architects of TSM in UMTA. But it does not trouble me.

The real dilemma in TSM planning is not local compliance, but the expectations of federal officials—expectations that are unrealistic and inappropriate. The federal rules embody a textbook version of systems planning. But textbook-style systems planning has very little to do with the way decisions are actually reached in metropolitan areas. Nor has it historically had much to do with planning that leads to successful implementation (5).

Planning has always been most effective when it is conducted by people who

1. Know from practical experience what works and what does not work,
2. Have developed the trust of political leadership,
3. Understand the in's and out's of financing implementation,
4. Are sensitive to community values and can communicate plans in the language of interest groups and community needs, and
5. Are responsible for accomplishing implementation and accountable for its impacts.

In short, TSM planning will be as effective as the people involved in it. Their technical expertise, their communication skills, and their sensitivity to the values

of their community will make or break TSM.

If you accept this view of what makes for effective planning, the institutional arrangements necessary for successful transportation system management follow logically. TSM should attempt subvention of planning funds so as to

1. Upgrade the traffic-operations expertise of transit agencies and highway departments;
2. Engage major employers in traffic mitigation;
3. Allow local communities to develop plans to protect residential neighborhoods and areas of heavy pedestrian activity from traffic intrusion; and
4. Cultivate a concern with traffic mitigation in the local agencies that plan urban development, issue building permits, and review environmental impact reports.

In this conception of TSM, regional agencies would be involved in the procurement of planning from agencies that have implementation powers and are responsible for living with the results of implementation. It would not involve an elaborate exercise in regional goal setting, the convening of areawide task forces, or an active role in operational planning for the metropolitan planning organization (MPO). MPOs would procure planning by subvention of funds to action agencies—or a consortium of action agencies. They would plan for planning, rather than develop plans themselves.

This approach posits that the key to successful TSM is the commitment of the implementing agencies and the involvement of the community constituency with which they are engaged. Community involvement and agency commitment are not likely to occur if TSM planning is conducted as a systems planning activity at the regional level. The systems planning game is simply too distant, too abstract, and too heavily overlayed with the heritage of modeling to produce the consensus necessary for implementation.

Let me anticipate the reaction of federal rule makers to this line of argument. Many would say, I suspect, that an areawide approach is necessary to coordinate TSM planning with energy-conservation and air quality planning. Therefore, it is critical that TSM, transportation control planning, and energy-contingency planning be lodged in the same regional agency so that efforts are not duplicated.

The answer to this line of argument is that TSM measures will not have consequential impacts on fuel consumption and air quality. Estimates of the energy-conservation and air quality impacts of aggressive implementation of the full menu of TSM actions usually indicate reductions of one or two percent of total regionwide vehicle travel (6-9). And when affordability and acceptability constraints are added to the analysis, the fuel savings and pollutant reductions that can be achieved through TSM are reduced to negligible.

There is no merit in coordinating TSM with air quality and energy-conservation plans if coordination cannot deliver significant results.

Let me anticipate a second reaction from federal rule makers: that TSM should be coordinated with long-range planning and therefore should be lodged with the agency responsible for long-range planning. This argument has merit. But coordination can be accomplished from the bottom up as well as from the top down. As MPOs procure TSM planning and implementation from action agencies, they can adjust their assessment of long-range needs accordingly. Thus, local accomplishment in TSM would lead to the lessening of regional investment needs.

A third federal concern can also be anticipated—that TSM must be an essential element of planning for fixed-guideway transit and must therefore be located in the regional agency that is engaged in alternatives analysis. One of the origins of federal commitment to TSM was the judgment that priority treatment of buses and carpools on freeways may offer a cost-effective alternative to rail transit on exclusive rights-of-way. Thus, as Orski noted in his opening remarks at the 1976 Transportation Research Board Conference on Alternatives Analysis, Hunt Valley, Maryland, alternatives analysis posits that making more efficient use of existing road space should be evaluated as an option to major investments in right-of-way and rail transit. The dilemma with this argument is that few urban corridors have sufficient transit service or transit demand to support exclusive bus ways, much less rail transit. In most metropolitan areas, priority entry at metered freeway ramps is the strategy best suited to the level of transit service that can be anticipated, even in the future. This means that corridors in which a trade-off between rail transit and exclusive bus way is germane can be treated as unique cases. The institutional arrangements for TSM should not be organized around the exceptional case, but rather based on the routine demands of traffic management, parking management, and employer-based traffic-mitigation planning.

Finally, a fourth federal concern can be anticipated—that a bottoms-up process driven by no explicit regional objectives cannot be easily monitored and evaluated. Without well-defined objectives, the cost-effectiveness of competing projects cannot be assessed and programmed optimally. This argument is difficult to rebut because formal measures of cost and benefit have never played a large role in transportation planning and programming (2, 10). Rather, planning decisions have been guided by sensitivity to community wants and budget tolerances. And programming has been guided by balancing the competing claims of competing jurisdictions. Thus, the calculation of costs and benefits has been more instinctive and political than systematic and formal. This being the case, it has been viewed as appropriate to give decision-making authority to elected officials who are accountable and whose reelection depends on their sensitivity in interpreting what their communities want and can afford. [This philosophy of governance is embedded in the official TSM regulations, but local has been interpreted to mean local officials assembled in a regional forum. It is the responsiveness, constituent composition, and equity of regional forum arrangements that are the issue (1).] Unless the planning and programming process is changed radically, it should remain the responsibility of those closest to community needs.

Let me summarize the arguments made here:

1. The TSM plans developed by MPOs have disappointed federal reviewers and rule makers.
2. The federal view of TSM is at variance with the planning practices and decision processes of metropolitan areas.
3. Successful TSM planning does not require an elaborate areawide process based on texbook-style systems planning.
4. The key to successful TSM planning is the people involved: their expertise, their access to the political process, and their sensitivity to community values and needs.
5. MPOs can foster TSM by subvention of planning funds and procurement of project design from action agencies.
6. TSM cannot deliver consequential energy savings or pollutant reductions; therefore, the planning process

for TSM should not be structured around these objectives.

7. TSM should be coordinated with long-range planning, but this can be accomplished by adjusting long-range investment plans in light of local-level TSM accomplishments.

8. The number of regions and corridors that face trade-offs between rail transit and exclusive bus lanes is limited. The TSM process should not be structured around these exceptional cases but rather around the routine requirements of traffic management, parking management, and traffic mitigation.

9. Given the TSM measures most likely to be effective and command community support, the institutional objectives of TSM should be to (a) upgrade the traffic-operations expertise of transit agencies and state highway departments, (b) engage major employers in traffic mitigation (ride sharing, parking management, and work-hour rescheduling), (c) allow local communities to develop plans to protect neighborhoods and pedestrian areas from traffic intrusion, and (d) cultivate a concern with traffic mitigation in local land use planning and the environmental impact report process.

10. These objectives can be most effectively accomplished if MPOs procure planning from action agencies, rather than develop TSM plans at the systems level.

REFERENCES

1. Comptroller General. Report to the Congress of the United States: Stronger Federal Direction Needed to Promote Better Use of Present Urban Transportation Systems. U.S. General Accounting Office, CED-79-126, Oct. 4, 1979.
2. D. W. Jones, Jr. The Politics of Metropolitan Transportation Planning and Programming. Institute of Transportation Studies, Univ. of California, Berkeley, 1977.
3. E. Deakin and others. Transportation Systems Management: A Review of Current Activities. Center for Transportation Studies, Massachusetts Institute of Technology, Cambridge, Dec. 1976.
4. M. Meyer and R. Gakenheimer. Options Chosen in TSM Plans. Center for Transportation Studies, Massachusetts Institute of Technology, Cambridge, Feb. 1977.
5. D. W. Jones, Jr., and E. C. Sullivan. TSM: Tinkering Superficially at the Margin? Journal of the Transportation Engineering Division, Proc., ASCE, Vol. 104, No. TE 6, Nov. 1978, pp. 817-834.
6. A. A. Altshuler, J. P. Womack, and J. Pucher. The Urban Transportation System: Politics and Policy Innovation. Massachusetts Institute of Technology Press, Cambridge, 1979.
7. D. C. Kendall. Carpooling: Status and Potential. Transportation Systems Center, U.S. Department of Transportation, Cambridge, MA, June 1975. NTIS: PB 244 609/4SL.
8. G. S. Cohen. TSM Actions: A Study of Energy Costs. Planning Division, New York State Department of Transportation, Albany, 1979.
9. W. L. Garrison and D. W. Jones, Jr. Energy Conservation in Urban Transportation. Institute of Transportation Studies, Univ. of California, Berkeley, 1979.
10. D. W. Jones, Jr. Caltrans: The Road to Transition Is Paved with Uncertainty. California Commission on Government Economy and Efficiency, Sacramento, 1977.

Role of Private Enterprise in TSM: Can Interest Be Generated and Maintained?

Herman Volk, Middlesex County Planning Board, Belle Mead, New Jersey

It is in the interest of the public sector to encourage private enterprise to participate in the planning, programming, and implementation of transportation system management (TSM) strategies, as well as in the processes by which these functions are managed. This view is based on my experiences in working with a variety of employers and other groups in Middlesex County, New Jersey, in developing public- and private-sector transportation strategies offering the potential for quick implementation. (Middlesex County has a population of about 600 000 and is located midway between New York and Philadelphia.) It is also based on similar experiences of staff working on major capital projects in which a partnership between private and public sectors played an important role. An examination of these mutual interests will be one of the themes presented here.

HISTORY OF TSM IN MIDDLESEX COUNTY

The important role that the private sector has played in preparing and implementing locally based, comprehensive TSM strategies in Middlesex County is a useful starting point for this discussion. The first-year phase of the county TSM work program, initiated with Urban Mass Transportation Administration (UMTA) prototype study funds, involved an open and continuous dialogue with representatives from local business and industry. This dialogue was conducted under the auspices of four local chambers of commerce, representing the subareas of the travel corridors chosen for study. The overall TSM concept and categories of strategies were presented by transportation planning and engineering staff to the chamber representatives, who were then asked to identify known transportation-related problems within the study corridors. This activity generated an enthusiastic response, even though no promises were made that public agencies would deliver improvements quickly. A long list of problem areas was identified by industry representatives, as well as primarily positive reactions to the types of TSM strategies presented. A number of capital-intensive solutions were also identified. This information was the basis for identifying a list of the TSM strategies that offered the potential for quick implementation.

It was not expected that any of the projects identified during this first phase would be implemented. However, as a direct result of the chamber meetings, a significant transportation and labor-force problem was solved for one major employer. In this case, planners provided a brokerage function by arranging transportation to one employment center for more than 500 previously unemployed people. This took place as the result of a transportation pilot project within the county that was funded by the New Jersey Department of Labor and Industry. Two vans were purchased for the purpose of transporting underemployed and unemployed people from central pickup points within two downtown areas to job training sites, job interviews, and actual jobs (for a 10-week period). The major employer needed employees capable of assembly-line work. Because this work required little training, interested individuals were provided with immediate employment. In pure transportation terms, the net effect continues to be increased mobility and peak-hour traffic. The job retention rate is 85 percent and, according to the employer, the primary mode of travel to work after the 10-week period is private automobile with a larger-than-average fraction of carpooling.

The second 12-month phase, funded under an UMTA grant, is designed to identify the barriers and incentives to TSM program implementation and to answer the question, Does the TSM concept have any validity in practice? Although final analysis of the private- and public-sector (primarily county and state) involvement in TSM implementation has not yet been conducted, some general observations can be made. These observations form the basis for the specific comments in this paper concerning the building of a private-enterprise TSM constituency.

The first set of observations pertains to those employers who have been most interested in TSM. Private-sector interest and support for TSM strategies is greatest when there is a mutual perception of a significant transportation-related problem that can be observed close to the job destination and that directly affects daily work operations. Although this interest may be stronger when major employers are located close together (e.g., in an industrial park), local government officials must still agree with the private-sector perception of the problem. Additional interest is generated, or at least maintained, when a locally based participation mechanism (i.e., a task force, or a committee) is formed to examine the problem. Under these conditions, interest tends to increase when there is no apparent action being undertaken to solve the problem or when no real progress is made in implementing any public-sector improvement that is perceived as capable of improving conditions. Thus, it appears that most employers are more interested in TSM when the problem is literally on the doorstep.

The second set of observations pertains to those employers who are interested in TSM-type projects, but only from time to time as a specific need arises. For example, energy concerns in 1979 resulted in requests for county and state staff assistance on a variety of topics. These included the state computerized ride-sharing matching service, federal funds for vanpooling programmed by the county, and transportation and vanpool workshops. The staff visited several firms and developed local interest in (a) ride sharing within the firm and coordinated activities among adjacent businesses, (b) access to and improvements in park-and-ride lots, (c) staggered work hours, and (d) minor road improvements.

The third set of observations relates to the benefits of a locally based organization. A 61-member transportation coordinating committee has been in existence for more than four years in Middlesex County. This body consists of 25 mayors (or their designees) of the municipalities in the county; representatives of business, industry, and labor, of local transit operators and of social service organizations; and citizens. Its primary function is to advise the county governing body on the spending of federal funds for transportation. The work of

this committee is well publicized. There are regular monthly meetings, minutes, press releases, fliers on special topics, quarterly newsletters, and occasional speeches by committee members and staff relating to the work of the committee. This committee has been, in general, very useful in establishing a background for comprehensive transportation management and for developing an understanding of the need for specific transportation strategies. The technical, administrative, and coordinating role of the county transportation planning and engineering staff has also proved extremely important in maintaining this direct input into the transportation improvement process and in identifying potential trade-offs.

With this background of how Middlesex County developed strong local interest in TSM, we can now look at the role of private enterprise in TSM and what it takes to build a TSM constituency.

THE MAKING OF A TSM CONSTITUENCY: A LISTING OF NEEDS

Need for a Locally Based TSM Coordinating Group and Transportation Process

A subarea or corridor study group composed of representatives from business, industry, various levels of government (i.e., local, county, and state), transit operators, and citizens is a necessary part of the process of building a private-sector constituency for TSM. It is useful, but not necessary, to provide the group with ex officio status by institutionalizing it within an existing umbrella organization that is directly responsible for carrying out the local transportation process. The group could be officially convened by the governing body and charged with a set of responsibilities designed to provide advice and guidance relating to TSM planning and implementation. One specific task of the group might be the preparation or updating or both of a TSM plan.

The alternative to an officially convened special group is the participation of an existing group, such as a transportation (or related activity) committee of a chamber of commerce or an industrial park association. No matter what group, however, it is essential that there be technical staff support for dealing with the transportation planning process and that its member organizations and local government officials be invited to participate in the undertaking. Federal assistance in developing technical capabilities on the local level will aid the area in providing professional assistance to private industry and therefore improve local government credibility.

Existence of a locally based comprehensive transportation planning process is also important to ensure proper planning, programming, and implementation coordination. This emphasis on a local process is made to emphasize the need for the active involvement of those elected officials and staff representing the jurisdiction within which the problem is located. This provides the potential for greater accountability and also permits trade-offs to be made in funding and projects.

With regard to state support, there is usually no guarantee that the state will use its funds for local implementation. State support will depend on the extent of state representation and active participation in local planning and also on the extent of competing priorities.

Need to Establish an Agenda of Items to Reinforce a Public-Private Partnership

A TSM coordinating group such as that described above provides a framework for a public-private partnership in decision making and helps achieve rapid implementation of a variety of low-cost, reinforcing, demand-and-supply TSM strategies. Among the points regarding the role of the private sector in TSM implementation (including incentives to encourage participation) are that this sector could

1. Identify problem areas and potential solutions;
2. Provide data on current and future industrial expansion and travel demand;
3. Assist the public sector in making trade-offs among strategies and in packaging groups of projects;
4. Play a direct role in both inducements and actual implementation;
5. Promote or support public-sector projects (or both);
6. In selected situations, provide all or part of the funding for preliminary engineering, right-of-way acquisition, or construction (or combinations of these factors) (the circumstances under which this might be considered by the private sector could include instances where there is a particular urgent need that cannot be rectified quickly by the public sector because of funding limitations, policy restrictions, or red tape); and
7. Perform the function, along with public sector, of monitoring progress and suggesting changes needed in projects, processes, institutional structures, or legislation.

Need for a Central Coordination Staff

A locally based staff is important in order to analyze problems and potential solutions, to maintain the variety of mechanisms necessary for communication, and to manage the whole process (specifically keeping an account of project status). This local staff's close proximity to system problems and users will aid in establishing and maintaining credibility with the private sector and will therefore be helpful in generating enthusiasm and results. In addition, local officials will more likely support the recommendations of a staff that is locally based.

Need to Target Improvements

A TSM strategy should consist of a set of reinforcing projects. Theoretically, such a package of projects could be developed for any area. In practice, it would appear prudent to target a variety of complementary projects to carefully selected problem areas. This targeting of improvements offers the potential to generate a greater degree of association with, and involvement from, adjacent businesses and industries. Targeting, however, has the disadvantage of not providing improvements to groups outside the area. Obviously, every effort should be made to provide assistance to these also.

Need to Ensure Rapid Implementation

Quick implementation of public-sector projects offers the greatest potential to generate, maintain, and increase private-sector interest in TSM. It also encourages employers to consider TSM-type actions in their own operations. Examples include high-

occupancy-vehicle lanes in combination with employer-based ride-sharing efforts, bus route realignments to work sites in combination with partial employer subsidies, signal interconnections and related improvements in combination with staggered-work-hour programs, moderately expensive public-sector capital projects in combination with land dedication or private-sector capital-fund outlays or provisions for off-street parking improvements and such.

A good organizational structure and a well-established process supported by competent technical staff are not substitutes for implementation. Progress must be made in implementing at least a few projects. The business and industry representatives who stay at the discussion table must see their time and effort result in physical improvements. Improvements in the process, increased study funds, or more plans will at some point prove counterproductive if system changes are not made.

With respect to implementation, particularly as it relates to the traditional roles of counties and states, there is an increasing need to examine a variety of incentives that could encourage local jurisdictions to assume more implementation responsibility, especially for TSM projects. It is the area of implementation that will, in the final analysis, keep the private sector at the discussion table and actively participating. In the absence of implementation, private-sector interest will wane and the potentially effective support for TSM will be lost.

ACKNOWLEDGMENT

This paper is based on experiences in managing the development of TSM strategies and programs for the Middlesex County Planning Board. The views expressed are my own and do not necessarily represent those of Middlesex County officials.

Results of the Workshop

Cochairpersons: Alinda C. Burke, Office of the Secretary, U.S. Department of Transportation, and David R. Koski, City of Minneapolis
Recorder: Linda Samuelsen, Office of Planning Management, Urban Mass Transportation Administration

The purpose of this workshop was to discuss appropriate organizational roles for transportation system management (TSM) planning, programming, implementation, and operation and ways of developing a constituency at the local level for TSM programs. The composition of the workshop was excellent for such a purpose; all levels of government, including the metropolitan planning organization (MPO) and the local practitioner were represented, as were educational institutions, private industry, and consultants. We began by discussing the four resource papers that had been prepared for the conference—those by Jones, Shunk, and Volk in this Special Report and an unpublished paper by Brooks. These discussions covered a wide range of topics, and seeds were planted that eventually set the direction and conclusions of the workshop. A variety of observations were made: "I see our role as problem solving not planning" and "the MPO is a political reality, it exists, the planning is going on—to argue about the MPO is abstract. How do you actually make something happen?" "Those that have direct accountability have the most interest in implementation", "the person most likely to benefit is the person that must manage", and "we shouldn't be arguing over top-down, bottom-up approaches. Every locale in the United States is a unique setup that works politically. The real problem is how to increase management of enterpreneurial effort expended in urban areas." "Entrepreneurship includes the identification of attainable priorities", "entrepreneurship should be developed at all levels of all agencies", and "an organizational entreprenuer begins to become that when a number of people within that organization begin to act like entrepreneurs." All these helped to focus our efforts on the major topics that surfaced in this workshop.

Considerable discussion was given to the term "entrepreneur." This is a term that seems to stray from the traditional transportation system management terminology. Nevertheless, we kept returning to it to describe a person in any organization or any position in that organization, public or private, who accepts responsibility for implementation of a transportation plan, project, or program; identifies attainable priorities; and understands and accepts the risks involved. It was decided that the real issue in TSM is not what role the institution plays or how to help various professional disciplines to understand their role, or such factors, but the timely implementation of transportation services. To accomplish true TSM, implementation responsibility must be accepted by the individual (or organization) to whom (or which) it is most applicable. Entrepreneurs must therefore be developed in all organizations that deal with the transportation system.

Thus, we concluded that there is no one planning process or organizational arrangement that fits the diversity of metropolitan areas in the United States. No institutional arrangement for effective TSM can or should be prescribed from above. The most-effective arrangement will vary from region to region. And, within regions, different planning styles and organizational arrangements are appropriate for the TSM planning and implementation that occurs at the level of the workplace, the neighborhood, the activity center, the corridor, and the region. Federal rules and federal funding should be sufficiently flexible to reflect this diversity and to ensure the timely subvention of funds in a variety of channels to a variety of organizations.

It is possible, however, to identify the institutional and financial barriers that have hindered effective TSM implementation and an entrepreneurial style of program management that would foster implementation. An entrepreneurial style of program management is necessary to bridge the gap between planning and implementation. Cultivating professionals who have these entrepreneurial skills is necessary for building constituencies, combining the expertise of various disciplines, involving the private sector, and responding to local public and special-interest groups. Each of these skills is an important ingredient of TSM. The entrepreneur may be employed by either a planning agency, an operating agency, or a private enterprise.

OBJECTIVE (IDEAL) FOR FIVE YEARS IN THE FUTURE

We see, as a broad general goal for the five-year future, a TSM environment in which there will be a large number of actors involved in implementation and in which there are an increasing number of professionals who have the following characteristics:

1. They are comfortable serving multiple objectives.
2. They are able to cross the lines between the public and the private sectors.
3. They are able to operate in complex political environments and build or catalyze political coalitions to achieve implementation.
4. They have the technical ability to identify and define problems and yet can also assess alternative options.
5. They can provide expertise in a politically acceptable way.
6. They can operate at different levels of problem scales and in response to different constituencies (sometimes simultaneously).
7. They can visualize the need for, and ensure the provision of, a variety of different services designed to meet different needs.
8. They are able to accomplish all of this quickly and effectively.

(It is this package of professional skills and implied roles that we have characterized as entrepreneurship; other words that describe the same qualities and style could be "broker" or "manager".)

As complements to this entrepreneurial style in our general vision of a five-year goal, there are two necessary changes in the mechanism for delivering funds to assist in TSM implementation:

1. There should be a single, annual metropolitan process that has a clearly defined focus—to produce an agreed-on program to be used for all planning and implementation funds available to the locality for the next year and
2. The federal and state processes must be streamlined so as to produce project approvals within six months of local program adoption. (As an even longer-term goal, we also see some merit in increasing fund

flexibility through combining various categorical programs and perhaps formalizing some discretionary programs.)

BARRIERS TO EFFECTIVE EXERCISE OF ENTREPRENEURSHIP

Federal, State, and Local Red Tape and Funding Inflexibility

Project development procedures (red tape) constrain timely exercise of the entrepreneurial style, and funding inflexibility in program categories, suballocation of funds, and eligibility limitations constrain innovative and timely program implementation.

1. The programming step is a key point in the implementation process. Thus, we recommend that an annual program plan be developed in each metropolitan area to open up the selection process and ensure that TSM options are considered along with major projects. The main feature of the annual program plan is that all funding sources and all significant actions (capital and noncapital), studies as well as projects, should be included. The projects should be capable of implementation, federal and state program requirements should be met, and there should be an explicit annual decision point.

It is recognized that such program plans will be developed from programs in the various jurisdictions and operating agencies in the metropolitan area during the year. But it is important that there be a metropolitan-level annual decision point when commitments are made to the significant projects to be implemented in the region.

2. We also recommend that federal and state project development procedures be streamlined: The U.S. Department of Transportation should establish a task force (including state and local representatives) to review and streamline delivery procedures, and state and local agencies should minimize the number of procedural requirements beyond federal requirements.
3. It is strongly recommended that each state implement certification acceptance procedures for federal-aid highway act (23 U.S. Code) projects to help streamline delivery.
4. The Urban Mass Transportation Administration should adopt procedures comparable to certification acceptance to eliminate individual project requirements.
5. There should be maximum flexibility in allocation and use of federal, state, and local funds.

Lack of Knowledge of Role Models and Employer Acceptance and Reward

The way agencies and staff conceive and execute missions creates an artificial separation of the elements of the transportation system and artificial distinctions among activities such as planning, persuasion, implementation, and management. Thus, we recommend that agencies

1. Encourage staff to conceive transportation problems broadly and multimodally, even though their individual roles may be more specialized;
2. Encourage employees to feel and act like system managers;
3. Tolerate failure;
4. Describe the behavior expected;
5. Establish incentives and reward for such behavior;
6. Help employees to feel part of the whole system; and
7. Establish training or activities to develop skills—(a) develop intern or apprenticeship programs, (b) allow release time for professional development, and (c) allow participation in transportation-oriented forums.

Many transportation professionals have a narrow view of the transportation system, often defined by the mode or discipline in which they work. This often results in a single-goal orientation. Transportation education and professional development should

1. Encourage broadening of education to expand professional scope;
2. Build more-effective and more-varied relationships at the local level;
3. Propagate changes in one's discipline, emphasizing the new state of the art and changing values and objectives through professional journals and contacts;
4. Foster mixing of professional associations and interdisciplinary approaches;
5. Support and reinforce the value of using coordination skills to do the job; and
6. Emphasize the need to communicate effectively as one of the necessary TSM job skills.

Underdeveloped Communication Channels

The interagency communication channels necessary for cooperative problem solving are not well developed. Many practitioners work in isolation or have contact with others only through formal channels such as committee arrangements. Professionals are often discouraged from developing informal communication networks that could link agencies together and allow entrepreneurs to develop constituencies. Thus, we recommend that agencies

1. Encourage staff to develop informal communication networks by encouraging staff participation in workshops, training seminars, meetings, and professional organizations of topical interest and by making available publications featuring both topics and individuals that have entrepreneurial characteristics;
2. Provide opportunities for promising staff to be exposed to and gain knowledge of extant communication channels throughout the transportation funding and service delivery systems;
3. Identify available information sources, both written and personal, for developing entrepreneurs;
4. Equip developing entrepreneurs with the skills involved in mass media communication, including knowledge of press releases, news conferences, and public meetings; and
5. Sanction and encourage the development of an informal network of contacts in the community and in other agencies.

Information on the planning, design, and funding of TSM actions is not readily accessible to the many actors in the TSM process. Therefore, we recommend that

1. Both the Transportation Research Board and the federal government should disseminate timely information in the following neglected categories: innovative projects in progress, actions where significant impacts have been achieved and those where results have been lower or counter to expectations, and innovative projects initiated by state or local agencies without federal assistance (federal evaluation funds might be made available to particularly promising programs, even though federal funds were not involved in implementation);
2. Federal program specialists should be identified as a hot-line resource for local implementors;
3. The transportation research information service

(TRIS) and highway research information service (HRIS) capabilities should be readily available to a larger clientele—many TSM activities involve quick implementation, so the updating and maintenance of the TRIS and HRIS files on TSM should be given priority attention;

4. Because local agency professionals are frequently unable to attend distant conferences, a series of regional conferences and workshops should be held to disseminate information;

5. Information on closely related or readily combined TSM activities should be available in package format—federal program managers in closely related program areas should communicate frequently to improve the information they can make available to state and local practitioners;

6. A systematic procedure should be developed to accumulate, digest, and disseminate information on the state of the art, the performance of programs, and the identity of TSM innovators—articles in professional and trade journals should become a major information-sharing vehicle; and

7. Much of the performance data routinely collected and analyzed by operating agencies can be critical for effective TSM planning—advances in the choice, collection, analysis, and application of operating and performance data should be shared.

Relevant and Systematic Analysis of Options

The traditional comprehensive, continuing, and cooperative methodology is long range in scope and not generally applicable to TSM, and a range of methodological techniques for TSM is not readily available to the general practitioner. Thus, we recommend that

1. There be greater emphasis on professional judgment and reporting of experimentation (i.e., demonstration projects),

2. The comparative assessment of options—often unlike options—be part of the planning process,

3. Methods reflect project cost and complexity,

4. Encouragement and financial support be available to evaluate TSM projects and that there be a timely dissemination network for this information, and

5. There be better appreciation of the cause-and-effect relationships that are involved in the impacts of TSM measures.

Neglected High-Achievement TSM Actions

Neglected High-Achievement TSM Actions

Donald A. Morin, Transit and Traffic Engineering Branch, Federal Highway Administration

The purpose of this paper is to discuss ways in which we can promote implementation of high-achievement transportation system management (TSM) actions that have been neglected. If we can identify the reasons for this neglect, we may be able to develop effective ways to overcome it.

Perhaps it is best to begin by defining what I mean by neglected high-achievement TSM actions. I consider neglected high-achievement TSM actions to be those operational and policy actions that, although they have been shown, through actual experience or analytical work, to be capable of significantly improving transportation system performance, have not been widely implemented. Note that purely physical improvements to the system are not included in this definition. Actions such as channelization, new signal installations, construction of bus and carpool facilities, and so on certainly have their place in a well-designed TSM plan, but they cannot be thought of as neglected. These types of TSM actions have been accepted by the transportation profession and are found in every TSM plan. In this discussion, I will deal only with those transportation management policies and actions that have not received significant attention in existing TSM implementation programs but offer the possibility of high payoffs toward attaining mobility, air-quality, and energy-conservation goals.

PRINCIPAL ACTIONS BEING NEGLECTED

Ride Sharing

Although it is true that carpooling and vanpooling have received much attention in recent years, I argue that, in many localities, much more could be done to make these programs more effective. Ride-sharing programs generally do not have the active endorsement of high-level elected officials or major employers and are rarely based on providing incentives for ride sharing. Most such programs consist only of providing matching services. Thus, such actions as identifying ride-sharing coordinators in major companies, developing incentives, and removing institutional obstacles to ride sharing could greatly increase the effectiveness of an area program.

There have been few studies of the impacts of ride-sharing programs. One study (1), however, has estimated that doubling the expenditures for a typical ride-sharing program (from $200 000 to $400 000) could reduce the areawide vehicle travel (VT) by 1 percent, compared with a 0.2 percent VT reduction for the original program. This translates to a cost of 0.6 cent/vehicle-km (1 cent/vehicle mile) reduced (based on the VT levels in a hypothetical urban area of 1 million population), a very cost-effective strategy. In addition, the capability of a ride-sharing program to provide alternative means of transportation in the event of an energy contingency, as well as the important role such a program plays in energy-conservation programs, makes it a significant transportation action that should be implemented in most metropolitan areas.

Traffic Control Strategies

There are several types of actions that significantly improve the operation of existing signal systems and the overall efficiency of street movement. One of the most effective actions in this category is signal timing optimization, a neglected facet of signal operation that requires periodic readjustment of signals after they are first programed. The "set it and forget it" approach should be abandoned. It is estimated (1) that a region-wide program of signal optimization can result in a 6 percent reduction in overall travel time at a cost of about 2 cents/vehicle-h saved. More advanced strategies such as signal interconnection, progression, and computerized networks offer incremental benefit above simple retiming, but a significant improvement to a system that is not monitored and adjusted regularly can result from simple timing changes (see Table 1).

Other traffic control strategies include improved freeway surveillance and incident detection, which improves response times to incidents (which in turn minimizes the impact of the incident on traffic) and can be instituted at relatively low cost. Sophisticated detectors and closed-circuit television systems are only one way of doing this. Improved communications among agencies and vehicles responding to freeway incidents can do much to reduce the impact of disruptions on traffic flow (4).

Traffic control strategies also include traffic restraint measures such as pedestrian and transit malls and neighborhood traffic restrictions. These types of actions address issues of congestion, encourage transit use, reduce transit delays, improve schedule reliability, and complement downtown revitalization efforts.

Alternative Work Schedules

By removing time constraints on working hours, many employers have encouraged employees to join carpools or vanpools or to match their workday to the schedule of the transit that serves their home and work locations, thereby easing site-specific congestion points while also improving employee morale. Greater acceptance of alternative work hours by employers could not only help to alleviate the transportation problems of specific

Table 1. Improvements in average speed due to changes in traffic signal timing.

Location	Type of Area	No. of Intersections	Time of Day	Avg Speed (km/h)		Increase in Avg Speed (%)
				Before	After	
San Jose, California	Central business district	46	4:00-6:00 p.m.	24.6	25.1	1.9
Los Angeles, California	Innercity					
	Broadway-Figueroa	26	3:00-4:00 and 5:30-6:00 p.m.	27.8	33.0	21.1
			4:00-5:30 p.m.	24.6	30.2	22.7
	Pico Boulevard	6	2:30-3:30 p.m.	33.8	39.8	18.0
			4:30-5:30 p.m.	32.3	34.4	6.4
	Wilshire Boulevard	45	Morning peak	21.0	23.0	9.9
Macon, Georgia	Central business district	54	7:45-8:45 a.m.	20.3	23.0	13.4
			4:45-5:45 p.m.	18.7	21.9	17.1
Inglewood, California	Citywide	60	7:00-10:00 a.m.	36.6	49.4	35.0
			3:00-6:00 p.m.	35.2	48.0	36.0
Montgomery, Alabama	Central business district	50	Morning peak	26.10	32.38	24.1
			Off peak	30.54	32.42	6.1
			Afternoon peak	28.70	31.79	10.8
Charlotte, North Carolina	Central business district fringe	10	5:00-6:00 p.m.	12.29	14.18	25.8
Washington, D.C.	Central business district	40	Off peak	19.15	21.15	14.4
Fort Worth, Texas		130	Morning peak			1.9
			Off peak			13.8
			Afternoon peak			19.7
Santa Barbara, California			Morning peak			15.0
			Afternoon peak			7.0
Unweighted avg (all locations, all time periods)						15.8

Notes: 1 km = 0.62 mile.
Derived from data given by Wagner (2) and Pinnell-Anderson-Wilshire and Associates (3).

individuals but could also address congestion problems in the overall transportation system. However, employers frequently are slow to implement alternative work schedules. One reason for this is the scarcity of information on how to implement such programs and the confusion surrounding the differences between the two major types of alternative work hour programs—staggered hours and flextime. Staggered hours have been shown to benefit transit when the problem is one of insufficient capacity to handle the peak-period demand but may negatively affect ride-sharing efforts. Flextime can be complementary to both (5, 6).

Parking Management

Effective management of the supply, location, and operational policies of downtown parking has great potential as a TSM action. Control of convenient, inexpensive parking for the 1 person/automobile commuter could be successfully used to encourage modal shift. The federal government is now attempting to face this issue by phasing out subsidized employee parking (7).

Enforcement of curb parking restrictions, especially during peak periods, can significantly improve the flow of vehicles, particularly transit vehicles that operate in the curb lane. Strong enforcement of parking restrictions is thus essential to the success of any parking program. The District of Columbia Department of Transportation has recently adopted an extensive program that includes a large civilian ticket-issuing corps, a towing program, booting of ticket scofflaws, simplified parking adjudication, and residential parking permits.

Parking rates can be structured to favor the short-term shopping trip downtown over the all-day commuter trip. Preferential parking locations for high-occupancy vehicles (HOVs) can also encourage more-energy-conscious trip making and can increase the person-carrying capacity of the system.

High-Occupancy-Vehicle Incentives

Although large-scale HOV treatments are not applicable to smaller metropolitan areas, there are several HOV actions that can be used in many areas. Park-and-ride lots have recently received interest, both as transit pickup points and as staging areas for carpool formation. Leasing arrangements with shopping centers or churches have proved a very cost-effective way to provide these lots. HOV preference on arterials in the downtown area can also be effective. Ramp metering combined with HOV bypass and HOV bypass of bottlenecks on mainline facilities could also be more widely implemented. In many instances, the effort is focused on how to provide a continuous HOV lane when the need is only to find a way for HOVs to bypass a short, congested bottleneck point. One of the important points to consider in examining HOV alternatives is, therefore, adjusting the scale of the solution to the scale of the problem.

Transit Operations

Efforts to improve transit operations, management, and service planning (such as improved scheduling, marketing, maintenance, public relations, fare collection, and routing) have too often become lost in arguments over financing. Simple actions such as monitoring and adjusting service and operations can significantly contribute to maintaining a high level of service and transit patronage. For example, the application of the run cutting and scheduling program to improve route scheduling can result in direct savings in system operating cost of 2-4 percent (8). Provisions for rehabilitation and stockpiling of buses are also now being emphasized as an important way to prepare for future energy contingencies. Although a number of unique, specialized transit services have been developed that demonstrate a capability to capture automobile commuters, for the most part metropolitan planning organizations and transit operators have not taken advantage of the results and expanded such services to other areas.

Urban Goods Movement

Planning for the movement of goods and for facilities for

trucks has generally been neglected in the traditional urban transportation planning process. Lack of facilities for truck loading and unloading can cause bottlenecks and severe disruptions to traffic flow in the central business district area. Simple regulatory, policy, or enforcement changes to ensure that truck-loading-zone areas are available for their intended use can lead to significant improvements, although longer-range actions such as truck-oriented streets and underground loading areas could also be considered (9). Improving the position of urban trucking in the overall transportation system will require close coordination, cooperation, and support from elected officials, administrators, and private-sector executives. Fleet operators should be encouraged and assisted in improving the efficiency of local pickup and delivery operations. Reductions in VT of more than 20 percent have been achieved where route efficiency has been analyzed and changes made (10).

Pricing

Pricing actions to encourage HOV use, reduce congestion, and restrict commuter parking have not been implemented to any degree in this country, although studies have shown such actions capable of some of the highest payoffs available (11). Area licensing schemes and road pricing in general are quickly labeled as politically infeasible. Parking surcharges are frequently discussed as a particularly effective TSM action and, indeed, analysis has shown them to have significant potential impacts on VT, but there are many problems in instituting such increased charges. Parking facilities are most often privately controlled and run completely separate from other transportation services and policies (12). Fear of possible adverse economic effects on downtown merchants also clouds any serious study of the institution of pricing actions. When one realizes that nationwide more than 90 percent of automobile work-trip commuters park free and that even in large downtown areas such as Washington, D.C., or Manhattan significant percentages park free (13), it is evident that considerable underpricing of automobile commuting exists. Emphasis should therefore be directed at encouraging employers to eliminate employee parking subsidies and at reducing the amount of free or low-cost street parking for commuters. An example of the potential impact of such efforts can be found in Ottawa, Canada, where, when federal employee parking rates increased from free to $20/month, there was a 23 percent decrease in automobile work trips ($1.00 Canadian = $0.85 1979 U.S.) and transit ridership of such employees increased by 16 percent (14).

WHY ARE THESE ACTIONS NEGLECTED?

In examining these actions and asking why they have not been implemented to any significant degree, I note several common points.

First, many of the actions are politically sensitive. The highest payoff actions are those that restrict individual automobile mobility in some way, either by physical restrictions or by pricing increases. These include parking management, traffic restraint, some HOV incentives, pricing, and goods movement to a degree. Most elected officials, corporation executives, and agency administrators are wary of supporting such actions and, without their support, the actions will generally not succeed. This is the most important single reason why transportation supply-limiting actions are not being actively implemented.

Second, the visibility of these projects to the public in general is quite low. Traffic control adjustments, transit planning, some ride-sharing activities, and programs for alternative work schedules are not generally considered glamorous projects. This disinterest can also lead to a lack of high-level support; decision makers generally like to be associated with visible improvement projects, such as highways and transit capital purchases.

Third, most of the actions are labor intensive. They are not projects that can be constructed once and then forgotten, but require a continuing commitment of local funds, usually at a higher local-matching level, even if federal money is available. The frequent unavailability of federal support puts these projects at a distinct disadvantage in competition with highway and transit capital-facility projects. This is especially significant in the current era of fiscal conservation at all levels of government.

Fourth, many of these actions require extensive interface and cooperation between public agencies and private entities. Local business leaders and leadership from local governments (mayors and county officials) often have goals that do not interrelate with TSM goals. The perceived political and economic impacts of TSM actions are difficult to deal with, when such varied interests are involved.

Fifth, these actions often require coordination among a large number of entities such as traffic, transit, judicial, and police agencies. For example, enforcement of HOV treatments and complementary parking requires a close working relationship between the traffic and police agencies, along with a willingness of the local judicial system to adjudicate violations. Jurisdictional turf problems and the effects of the actions of one agency placing additional demands on another can cause friction and thereby obstruct project development.

HOW CAN WE IMPROVE IMPLEMENTATION?

These impediments to TSM—lack of a constituency, the need for extensive interagency coordination, competition with capital projects, political sensitivity, and funding difficulties—indicate why the development of TSM programs has not been as rapid as most transportation planners would like. Nothing we can do will immediately change the situation, but I think we can accelerate the slow, but definite, movement toward many of these types of actions.

First, there are a number of success stories that could be disseminated to serve as models for other metropolitan areas.

Second, the energy effectiveness of TSM actions is impressive, as shown by a recent analysis of a number of potential TSM actions in terms of fuel savings (15). We should capitalize on this obvious attention-getting aspect of TSM.

Third, we must be better prepared to recognize and respond to the perceived political and public reaction to TSM actions and do much more to convince mayors and council members of the true value of these actions. Additional time and effort to assess the economic and social effects will certainly be necessary in responding to political and public concerns. We should be undertaking these analyses now.

Fourth, funding sources other than the normal ones should also be sought. State and federal legislatures should be made more aware of the benefits of these actions through more-effective contact or by direct lobbying. The recent automobile-use management initiative, a part of President Carter's energy initiative, is an example of federal efforts to change

legislation so as to increase funding for TSM actions. This could be supplemented by similar state actions.

Fifth, federal leverage could also be used through categorical funding programs, added inducements in existing programs, specific TSM project goals or targets in each urbanized area, or regulatory changes. This approach is frequently used to promote federal objectives although, in the case of TSM, it clearly would be more effective to begin with a local commitment to the concept.

Sixth, further technical-assistance efforts from the states and federal agencies should be made. Many localities do not have the capability to retime signals, design alternative work-schedule programs, design park-and-ride lots, upgrade transit management, or design HOV treatments. An aggressive, competent state-level technical-assistance program could prove very effective. Federal efforts in technical assistance are continuing, and we encourage your ideas as to where we can be most effective.

And finally, a more-critical look at the local and regional organizational roles relative to TSM planning and implementation and interaction among agencies is indicated. There is no one right way to organize for TSM planning and implementation; each metropolitan area will be different. But high-level local leadership will have to be made a necessary part of the organization if we ever expect to have effective project implementation.

As transportation experts, we cannot hope to implement the neglected high-achievement TSM actions alone. More and more, we must become involved in the political and economic processes in the local area. The TSM actions we are looking at do not affect transportation only but cut across a wide range of other local and national concerns.

REFERENCES

1. F. A. Wagner and A. K. Gilbert; Alan M. Voorhees and Associates. TSM (Transportation System Management): An Assessment of Impacts. Office of Policy and Program Development, Urban Mass Transportation Administration; Office of Highway Planning, Federal Highway Administration; and Office of Transportation and Land Use Policy, U.S. Environmental Protection Agency, Rept. UMTA-VA-06-0047-79-1, Nov. 1978, p. 37. NTIS: PB 294 986/5SL.
2. F. A. Wagner; Cambridge Systematics, Inc. Urban Transportation Energy Conservation: Analysis of Traffic Engineering Actions. U.S. Department of Energy, Sept. 1978.
3. Pinnell-Anderson-Wilshire and Associates. Management of Traffic Control Systems: Executive Course. Office of Traffic Operations and Office of Development, Federal Highway Administration, Participant Notebook, 1977, p. R5-7.
4. Peat, Marwick, Mitchell, and Company. Alternative Surveillance Concepts and Methods for Freeway Incident Management. Federal Highway Administration, Repts. FHWA-RD-77-58 through FHWA-RD-77-63, March 1978.
5. D. Jones, Jr., and others. TSM Actions: Implications of Flexible Work Hours. Research and Special Projects Administration, U.S. Department of Transportation, Rept. DOT/RSPA/DPB-50/78/29, Dec. 1978.
6. D. Jones, Jr., and others. Work Rescheduling and Traffic Relief: The Potential of Flextime. Univ. of California, Berkeley, Nov. 1979.
7. Federal Employees Parking Facilities. U.S. Office of Management and Budget, Circular A-118, Aug. 13, 1979.
8. D. Hinds. Rucus: A Comprehensive Status Report and Assessment. Transit Journal, Winter 1979.
9. D. Christiansen. Urban Transportation Planning for Goods and Services: A Reference Guide. Office of Highway Planning, Federal Highway Administration, Jan. 1979.
10. H. E. Kearney: Management Consultants. CARD Perspective, Chicago, Fall 1978.
11. Alan M. Voorhees and Associates. TSM Institutional and Planning Research: Phase 2. Office of Planning Assistance, Urban Mass Transportation Administration, Draft Final Rept., Sept. 1979.
12. M. L. Olsson and G. Miller. An Assessment of Pricing Strategies Applied to Urban Parking. Urban Institute, Washington, DC, Working Paper 5096-90-1, Sept. 26, 1977, p. 8-9.
13. B. Keyani and E. Putnam. Transportation System Management: State of the Art. Office of Policy and Program Development, Urban Mass Transportation Administration, Feb. 1977, p. 60.
14. Peat, Marwick, Mitchell, and Company. Study of Parking Management Tactics: Volume 1—Overview. Federal Highway Administration, Rept. FHWA-PL-79-020, Dec. 1979.

Results of the Workshop

Chairperson: Warren Travers, Travers Associates, Clifton, New Jersey
Recorder: Lorraine Harris, Federal Highway Administration

The purpose of this workshop was to identify those high-achievement transportation system management (TSM) actions that have been largely ignored, to enumerate principal reasons why these actions are being ignored, and to suggest appropriate countermeasures. The focus of the discussion was on TSM operational and policy actions that appear capable of significantly improving transportation system performance but that have not been widely implemented. The workshop participants were particularly suited for such a discussion in that they represented federal, state, regional, and local transportation agencies, university personnel who had been investigating several of the TSM actions discussed in the workshop, and consultants who also had had experience in the planning and implementation of these actions.

Much of the initial discussion focused on the resource paper prepared by Morin and in general followed the format of this paper, i.e., a review of high-achievement TSM actions, an outlining of the reasons why selected actions have been neglected, a discussion of strategies that could be used to overcome this situation, and the preparation of a list of principal TSM actions in priority order. It became apparent at the end of this discussion that most of us felt that there has been a problem of getting the TSM message to all levels of the public. In addition, we also felt that there is great need for local involvement (including political, technical, and financial representatives) in TSM implementation, that there is still some confusion as to the definition of TSM, that effective TSM evaluation is difficult to accomplish, and that, where possible, incentives are preferred over restrictive measures as elements of TSM actions.

We identified several high-achievement TSM actions and related issues that should be considered in the workshop discussions. These are summarized below:

Type of Action	Example or Issue
Ride sharing	Carpools
	Metropolitan planning organization-oriented vanpools
	Institutional vanpools
	Role of the private sector
Traffic control strategies	Signal-timing optimization (which is labor-intensive)
	Surveillance
	Reordering of priorities (i.e., traffic engineering responsibilities)
	Simplification of strategies
Alternative work schedules	Staggered hours (which responds to peak transit but not to carpools)
	Flextime (which responds to transit and carpooling)
	Four-day workweek (which needs more research)
Parking management	High-occupancy vehicle and small-car preference
	Pricing (peak-hour arrivals versus proximity)
	Increased enforcement of curb parking restrictions
	Elimination of parking subsidies
	Stimulation of parking discounts for high-occupancy vehicles
High-occupancy vehicle incentives	Preferential parking
	Staging areas (on-line opportunities)
	Line-haul priorities
	Ramp (freeway) entry priorities (which has enforcement problems)
	Toll reductions and lane priorities
Transit operations	Stockpiling and rehabilitation of equipment
	Monitoring and adjusting operations
	Brokerage concept
	Bus passes and employer subsidies
Urban goods movement	Curb sharing (time and space)
	Truck routing
	Access to terminals
	Off hours
Pricing	High-occupancy vehicle discounts
	Small-car discounts
	Peak-hour premiums
Bicycle and pedestrian incentives	Separation in space and time
	Selected applications

Each of these actions was considered by the workshop participants and discussed in terms of its implementation feasibility.

WHY ARE SELECTED TSM ACTIONS BEING NEGLECTED?

Many explanations were given as to why some TSM actions have not been considered more widely. These explanations were often illustrated by specific examples from urban areas around the country. In general, the following 15 problem areas were identified as major causes for the neglect of high-achievement TSM actions:

1. Political sensitivity—The action has a potentially controversial effect on a sizable group of voters, and public officials are thus unwilling to consider its implementation.
2. Nonvisibility to the public—The action is not a visible solution in the sense of the public identifying it as a solution to some problem. Public officials favor actions that indicate that major steps are being taken to help their constituents.
3. High labor costs—Many TSM actions require a large support staff for successful operation. Given the high cost of labor, such a requirement weighs against the consideration of such actions.
4. Public-private interface—Some TSM actions, such as ride-sharing programs, require active interaction between public planning agencies and employers. Such interaction has not often occurred in the past and, in many cases, represents a new step that must be taken to successfully initiate a TSM strategy.
5. Local agency coordination—The types of TSM actions listed above usually require the participation of many different agencies in an urban area. The problems related to achieving the required coordination inevitably delay the process of project implementation.
6. Lack of public interest—Unless faced with a serious problem, public interest in transportation will be negligible. There is thus little motivation for public agencies to actively consider high-achievement TSM actions.
7. Complex funding processes—The funds to support a TSM action often come from special programs that require interagency agreements. Also, those TSM actions that do not meet the criteria of federal categorical

programs are not considered in favor of those that do.

8. Lack of leadership—Given the complex institutional structure in most urban areas, it is difficult to find one agency that can take the lead role in identifying TSM actions. Thus, there is often no institutional home for the types of actions we are considering.

9. No legislative authority—Many agencies have no legislative mandate to examine high-achievement TSM actions and may indeed face legislative guidelines that forbid doing so.

10. Resistance to a federal mandate—In some regions of the country, the fact that TSM actions are being supported by federal agencies is reason enough not to consider them.

11. Lack of governmental awareness—Some local officials and transportation planners might be unaware of the advantages and effectiveness of the high-achievement TSM actions. The solution to this problem is to increase efforts at information dissemination.

12. Uncertainty of project outcomes—Whereas the evaluation of many traditional transportation alternatives uses an extensive analysis methodology to minimize the uncertainty surrounding their impacts, no such methodology is available for TSM actions. Thus, the uncertainty related to the outcome of the project creates a hesitation in considering its implementation.

13. Agency biases—Because many of the TSM actions considered in this workshop do not fall logically under the purview of one agency and most agencies are concerned with doing a good job and minimizing the level of public scrutiny of their actions, there is a resultant agency bias toward familiar actions. Innovative projects, especially those requiring cooperation with other agencies, do not receive high priority.

14. Insufficient professional capability—The analysis of many of the high-achievement actions requires professional skills that are not available in most agencies.

15. Perceived safety and enforcement problems—The possibility of serious safety problems or the perception that the action is unenforceable causes planners to discount the desirability of some actions.

Each of these factors alone could be considered a major reason for the neglect of certain high-achievement TSM actions. In all likelihood, however, many factors are found in each situation and thus reinforce the tendency to avoid serious consideration of the action.

WHAT MEASURES CAN BE TAKEN TO STIMULATE ACTION?

We identified several offsetting measures that could be taken to overcome the problems identified above and to stimulate action. These measures include the following:

A. Success stories—Disseminating information on successful implementation of a high-achievement action,

B. Community involvement—Encouraging more-active community participation in the planning process,

C. Demonstration projects—Funding demonstrations of the TSM action to illustrate its effectiveness,

D. Identification of trade-offs—Identifying in a more-explicit manner the trade-offs associated with implementing (or not implementing) the TSM action,

E. Increased flexibility—Allowing sufficient flexibility in funding and planning processes for consideration of the TSM action,

F. Executive authority—Providing adequate executive authority,

G. Incremental approaches—Adopting an incremental approach to implementation so as to avoid the shock effect of dramatic change,

H. Improved timing of actions—Timing the planning and implementation of the TSM action to avoid significant opposition and to take advantage of opportunities in the political and social environment,

I. Communication—Providing better public relations and communications links to the general public,

J. Political involvement—Identifying and encouraging a more-active role for elected public officials in the planning process,

K. Technical skills—Supplying technical knowledge to planners so that they can analyze TSM actions with confidence,

L. Substantive changes—Considering TSM actions that would have a visible effect on travel behavior,

M. Combinations of actions—Examining combinations of TSM actions that together significantly improve service to the user,

N. Contract services—Contracting service provision to organizations outside of government,

O. Involving other types of programs—Using other government programs (e.g., funds under the Comprehensive Employment Training Act of 1973) to overcome cost issues,

P. Volunteerism—Encouraging volunteer workers to actively participate in the operation of the TSM action,

Q. Shared responsibility—Promoting a shared responsibility for the TSM action among relevant agencies,

R. Brokerage—Establishing a clearinghouse or brokerage system to coordinate agency activities, and

S. Coordination—Organizing technical coordinating and advisory committees where problems of planning and implementation could be addressed.

Some of these measures would be useful in alleviating some of the problems identified above, but for others they would be ineffective. Thus, in an effort to assess the appropriateness of a measure for a problem, we produced the matrix shown in Table 1. As can be seen, some measures are considered more effective than others for particular problem areas and others, if aggressively pursued, would help in every problem situation (e.g., disseminating information on successful TSM action implementation, encouraging more-active participation from local elected officials).

HIGH-ACHIEVEMENT ACTIONS IN PRIORITY ORDER

We concluded after considerable effort that a priority listing of high-achievement TSM actions in a global sense was not feasible—principally because of major differences in the circumstances—locale, scale, and the like—surrounding each situation. Moreover, we also determined that, for essentially the same reasons, it was not possible to effectively relate potential problem areas (reasons why actions are being ignored) to specific high-achievement TSM actions. However, a sample form, similar to Table 1, that relates the potential problem areas to potential TSM actions, was prepared to illustrate how a user goes through the process—by using his or her own assessment of problem areas and, together with Table 1, develops the appropriate countermeasure to be undertaken to overcome the problem(s).

GENERAL CONCLUSIONS

We concluded that

1. The role of the metropolitan planning organization

Table 1. Matrix of potential problem areas and related offsetting measures.

Problem Area	Offsetting Measures																
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	X	X	X	X	X	X	X	X	X	X	X								
2	X	X	X						X	X		X	X						
3	X		X				X	X	X	X				X	X	X			
4	X	X	X	X	X		X	X	X	X			X	X			X	X	
5	X			X	X	X	X			X				X			X		X
6	X	X	X	X			X	X	X	X		X	X			X	X		X
7	X		X	X			X	X		X			X					X	
8	X					X				X				X					X
9	X	X								X	X		X						X
10	X		X																
11	X	X							X	X									X
12	X	X	X		X		X		X	X	X						X		X
13	X	X	X		X			X	X	X			X				X		X
14	X	X	X	X			X	X	X	X			X	X		X	X		X
15	X	X	X		X		X		X	X	X								X

tends to relate best to large-scale actions in terms of organizational and coordinating functions;

2. Most TSM actions are relatively small scale and tend to occur at the local level;

3. Politial interaction is necessary on a continuing basis—particularly at the local level;

4. Effective communications, including marketing, are essential both internally and externally;

5. System operations management appears to be handled best through existing operating frameworks;

6. To the extent possible, the implementation process should stress positive incentives;

7. Contingency programs should be pursued aggressively against the event of a sudden, involuntary decrease in existing system capability; and

8. Continuing research is needed for selected actions in terms of market potential and the short- and long-term effects on the overall transportation system.

An Areawide Planning Context for TSM

Integrating TSM into the Overall Transportation Planning Process

John R. Hamburg and George T. Lathrop, John Hamburg and Associates, Inc., Rockville, Maryland

In one of the overview papers for this conference, Lee and Meyer distinguish between "strategic" and "tactical" transportation system management (TSM) planning:

> "Strategic" planning can be defined as that characterized by a focus on systemic intermodal effects and the achievement of regional goals and objectives. "Tactical" planning is that characterized by the solution of localized, intramodal problems.

They conclude that, with a few exceptions, the focus of TSM has remained tactical. This paper will briefly sketch an approach that is strategic, tactical, and integrated within an overall process that unifies regional versus subregional demands, long-range versus short-range needs, and capital-intensive versus low-cost improvements, actions, policies, and combinations of such. Although this may seem overly ambitious, such an approach is overdue if we are to survive the babel of current requirements, funding conditions, and methodologies. Moreover, the North Central Texas Council of Governments (NCTCOG) in the Dallas-Ft. Worth area is well on its way to implementing such an approach in a program that relates TSM actions to improvements in areawide air quality.

This approach has, basically, three stages:

1. Establishment of a regional context within which detailed subregional (corridor) plans can be developed, including assessment of growth in population and employment and identification of regional TSM actions that could be implemented and of committed transportation facilities that will be in place;
2. Development of subarea (corridor) transportation policies and plans within the constraints of regional growth and transportation actions; and
3. Synthesis of an overall regional transportation plan from the policies and plans developed for each of the subareas of the region.

This approach could represent a major breakthrough in the planning process. It has been made possible by the development of simulation software that permits focusing on an area of interest while simultaneously dealing with the remainder of the region and of sketch-planning software that permits estimation of regionwide effects. The simulation software has the additional advantage of being able to handle finely detailed networks and very small zones at a subarea level so that impacts that might be lost in the regional approach may be simulated and evaluated. By applying this approach to all of the subareas of an entire region, a set of subarea plans can be developed.

The major activities or tasks in each of the three stages are summarized in Table 1.

The layout of these stages of the process is simple, but the content is ultimately complex. Clearly, successful linkage of regional and local actions requires activities that to some extent occur in sequence. In reality, however, many subprocesses occur simultaneously. That there is a need for a regional plan, however, is indisputable. The transportation facilities that serve the region must be a system. Major highways must connect with each other. Public transportation systems must cross jurisdictional boundaries and the service on different lines must be coordinated. As the above approach suggests, however, a regional plan must evolve through a synthesis and integration of local plans that considers both regional demand and local supply.

ESTABLISHMENT OF A REGIONAL CONTEXT: AREAWIDE TSM-AIR-QUALITY ANALYSIS

The three-stage planning process described above requires that detailed corridor plans (stage 2) be developed within the context of overall regional conditions (stage 1). This regional context includes employment and population forecasts for future years by small areas (e.g., regional zones), transportation improvements that are committed, and regional TSM-air-quality-related actions that can be assumed to be in place. This regional analysis must be carried out and completed before the actual testing of alternatives at the corridor level can begin.

The advantages of conducting an areawide TSM-air-quality program include the following.

1. Improvement of air quality as required by the Clean Air Act as amended 1977: It is necessary to isolate and reach agreement on areawide TSM-air-quality strategies in order to take positive steps toward improving air quality before the completion of all of the subarea analyses in the region. The areawide program will partially fulfill the requirements specified in the Clean Air Act as amended 1977. The planning agency [i.e., the metropolitan planning organization (MPO)] would integrate the areawide TSM program into an implementation plan to ensure attainment of the national ambient air quality standards.
2. Ensurance of consistency of regional inputs into subarea analysis: A consistent regional context is necessary to ensure that all subsequent corridor analyses will use the same assumptions regarding network, population and travel, and areawide TSM-air-quality strategies.

Table 1. Major activities or tasks in each stage of planning process.

Stage	Activity or Task
1: Establishment of regional context	Classification of TSM actions: Subarea (corridor) versus areawide
	Specification of candidate actions and policies to be tested at the regional level
	Development of goals and goal-performance measures
	Estimation of impacts and effects of candidate actions and policies: 1982 and 1987
	Development of cost estimates of candidate actions and policies
	Evaluation and selection of candidate actions and policies: 1982 and 1987
	Presentation of areawide actions and policies to appropriate agencies and discussion to secure approval
2: Development of subarea (corridor) policies and plans	Establishment of base-year validation
	Establishment of future projections
	Identification of goals and objectives of the subarea (corridor)
	Specification of candidate TSM and air quality actions to be tested at the subarea level
	Determination of a reasonable time frame for implementation of actions and policies
	Development of packages of alternative TSM actions
	Estimation of impacts of alternative TSM-air-quality packages in subarea
	Analysis of subarea capital improvements
	Development of cost estimates of TSM-air-quality packages
	Evaluation and selection of subarea plan
	Presentation of corridor plan to appropriate agencies and citizens and discussion groups to secure approval
3: Synthesis of regional plan	Reassessment of regional actions, policies, and requirements given implementation of corridor plans
	Synthesis of corridor TSM actions and policies and capital improvements into a regional plan for 10-year and 20-year futures
	Adjustment and reconciliation of corridor plans and presentation to appropriate jurisdictions for approval
	Staging and coordination of elements of regional and corridor plans

3. Improvement of the efficiency and reduction of the cost of corridor planning: By making commitments to the implementation of areawide TSM-air-quality actions, it will be possible to reduce the number of alternative tests necessary in the subarea work (which otherwise would increase the time, cost, and complexity of the planning effort).
4. Expansion of awareness and understanding of air quality issues: The analysis undertaken in this phase can provide input to the technical staffs of jurisdictions, to elected officials, and to citizens groups and others interested and active in improving air quality through transportation-related programs.

Although there are a wide variety of possible TSM actions that can be considered, only a limited number can be dealt with in an areawide approach. From among these possible areawide actions, candidate actions must be selected for testing and review of their impacts within an evaluation framework. The costs of these candidate actions and policies must be estimated and integrated into the evaluation, and a selection of actions must be made. Finally, the proposed actions must be presented to and discussed with the appropriate agencies and other groups to obtain approval and move toward the implementation of the areawide plan.

Classification of TSM Actions: Subarea (Corridor) Versus Areawide

The list of potential TSM-air-quality actions must be classified according to whether a particular action should be analyzed and implemented at the regional, areawide, or subarea level. There are several bases for the hierarchical classification of such actions.

Modal Versus Jurisdictional

This approach suggests that actions and policies can be identified according to their involvement of one or more transportation modes and of one or more local governments (1, pp. 2-7 to 2-8). The different classifications of actions include the following:

Class No.	Type of Action	Description
1	Routine internal administrative or operational actions	Actions that have known consequences, fall within the scope of authority of the traffic engineer or the transit operator, and can be implemented immediately at little or no cost
2	Jurisdictional-level actions	Actions that fall within the area of responsibility of the traffic engineer or the transit operator but require management or jurisdictional budget approval and some degree of project analysis and justification
3	Local multimodal actions	Actions that fall within a single jurisdiction but require coordination among the traffic engineer, transit operator, and other; budget approval; and project analysis and justification
4	Interjurisdictional actions	Actions that affect one mode only but are regional or interjurisdictional in nature, and require coordinated budgeting and areawide analysis and justification
5	Regional multimodal actions	Actions that require regional coordination among jurisdictions and modes, areawide project analysis and justification, and coordinated budgeting

Air Quality Versus Mobility

A second approach groups actions according to their effects on transportation supply and demand (measured by speed of travel and vehicle kilometers of travel, respectively) in the context of two goals—air quality and mobility (1, pp. 3-3 to 3-5). The different classifications of actions include the following:

Class Letter	Type of Action	Description
A	Actions that shift the demand curve downward [reduce vehicle travel (VT) demand]	Actions that induce travelers to shift from lower-occupancy to higher-occupancy vehicles or to nonmotorized travel modes, thereby decreasing

Class Letter	Type of Action	Description
		VT demand without affecting highway supply
B	Actions that shift the highway supply curve downward (reduce travel time)	Actions that use a wide range of traffic engineering and control measures to reduce the disutility of highway travel experience at given levels of VT demand
C	Actions that shift the demand curve downward and the supply curve upward (reduce VT demand and increase travel time)	Actions primarily aimed at inducing travelers to shift from lower-occupancy to higher-occupancy vehicles or to nonmotorized travel modes but to do so by increasing the disutility of highway travel
D	Actions that shift both the supply and the demand curves downward	Actions that simultaneously decrease the disutility of highway travel for given levels of VT and induce travelers to shift from lower-occupancy to higher-occupancy vehicles

Direct Versus Indirect Impact on Supply or Demand

This criterion identifies effects on supply or demand as direct or indirect: e.g., a new highway facility has a direct effect on supply and, by a presumed increase in travel, an indirect effect on demand.

Local Versus Regional Effects

An action or a policy can be local or regional in its application or effect. However, this dimension is complicated by the ambiguity of the terms local and regional. For example, they could refer to geography, but that is further complicated by the possibility of extending a local action (such as paratransit service or intersection improvement) throughout the region. Alternatively, local and regional could refer to population subgroups, e.g., the elderly and the handicapped.

Immediate Versus Long-Range Impacts

An action or policy can be immediate or long range in both implementation and effect. Most actions or policies are easy to classify on the dimension of implementation (given reasonable definitions of immediate and long range), but difficult assumptions regarding the duration of effect are required and the rapidity of effect (the time to reach equilibrium) is difficult to agree upon. Is it reasonable, for example, to assume that the effects of a ride-sharing program will continue for 20 years?

Capital Costs

A traditional way to identify TSM projects has been the extent to which they are either capital or operating cost intensive. The assumption has always been that capital-intensive projects are not management oriented and therefore not TSM.

The primary objective in classifying TSM (and other) policies and actions is the practical one of determining which should be evaluated on a regionwide basis and which on a local basis. As can be expected, however, there is no one criterion that can be used to make this determination, which thus requires consideration along several dimensions.

The criteria for regionwide actions and policies that appear most useful include whether the action or policy (a) is not site specific, (b) does not involve a design element, and (c) can be evaluated by using sketch-planning techniques. Thus, by using these criteria, one can identify the following actions as being regionwide:

1. Promotion of ride sharing (carpooling and vanpooling),
2. Promotion of transit use [advertising, perhaps uniformly reduced fares—any action that could be undertaken regionwide that would not vary from location to location (as improved service might)],
3. A vehicle inspection and maintenance program (for continued compliance with vehicle standards for emissions control devices),
4. Conversion of a vehicle fleet to less-polluting or more-energy-efficient (or both) vehicles, and
5. Work rescheduling, either to staggered hours or to a four-day workweek (or both).

Alternatively, actions that would be analyzed and evaluated at the subarea level include

1. Express bus service and park-and-ride lots,
2. Local transit route and schedule improvements,
3. Paratransit systems,
4. Bicycle and pedestrian facility improvements,
5. General traffic engineering (the wide range of traffic regulation and control and minor design improvements aimed primarily at reducing travel time),
6. Freeway traffic management (including incident surveillance and response, ramp control, and driver advisory information aimed at upgrading freeway performance),
7. Truck restrictions and enhancements (those actions aimed at reducing the conflict between truck and automobile operations and facilitating the curbside pickup and delivery operations of trucks),
8. Preferential treatment for high-occupancy vehicles (exclusive lanes),
9. Automobile-restricted zones (ARZs),
10. Parking supply reductions (off-street parking restrictions),
11. Preferential treatments (exclusive lanes), and
12. On-street parking restrictions.

The final product of this classification is the identification of those TSM-air-quality actions that should be analyzed on a regional basis to provide input into subarea analysis and of those for which no firm decision or commitment, on an areawide basis, can be made until a subsequent, detailed subarea analysis is performed.

Specification of Candidate Actions and Policies to Be Tested at the Regional Level

Although candidate actions may not fall neatly into a regional versus local dichotomy, some bases for classification have been described. After candidate actions have been categorized by level of analysis, those to be tested at the regional level must be specified. The feasibility of implementation of a policy could be an important consideration in choosing the strategies to be tested, as would be the potential impact of a strategy and the availability of appropriate analysis tools. At the areawide scale, for example, detailed traffic simulation will not be used for estimating the impacts of candidate TSM-air-quality actions. Maximum use will be made of the available sketch-planning methodologies.

Another consideration in action selection is that, because these actions can be combined, it is also necessary

to review their anticipated impacts in terms of compatibility. A policy directed at air quality, such as, for example, increased carpooling, might be encouraged in several ways:

1. By reducing parking supply,
2. By increasing parking costs,
3. By reducing parking charges per vehicle as the number of occupants increases,
4. By increasing fuel costs,
5. By establishing vehicle toll charges,
6. By establishing park-and-ride fringe lots for carpoolers,
7. By establishing preferential or exclusive lanes for high-occupancy vehicles, and
8. By establishing carpool-matching programs at places of employment.

Each of these alternatives, and combinations thereof, should be considered.

Development of Goals and Goal-Performance Measures

The evaluation of candidate actions must take place within a specified goal structure, but a basic problem in evaluation has been that our goal system always contains conflicts. Dealing with trade-offs between goals—whether objectively or subjectively—is a difficult and time-consuming step in choosing between alternatives, and one cannot gloss over the process and hope it will disappear. Unless it is attacked early on and with citizen participation as well as jurisdictional decision making, the planning process can become mired in wrangling or, worse yet, litigation.

This issue will be addressed in greater detail below, but it appears that a narrower framework of evaluation of TSM-air-quality strategies should be used in the regional analysis, i.e., these strategies should be evaluated solely in terms of their effectiveness in improving air quality. This analysis of effectiveness should include appraisals of the cost-effectiveness of the actions and also present a measure of their impacts on energy consumption. However, this need not be a conflict requiring a trade-off between air quality and energy conservation because most actions affect both of these objectives positively. A saving in energy consumption through encouraging ride sharing will also result in improved air quality. Should an energy crisis require, the major emphasis of these regional strategies might shift to energy conservation with air quality improvements tagging along.

Estimation of Impacts and Effects of Candidate Actions and Policies: 1982 and 1987

For each candidate action, policy, or package of actions, it will be necessary to estimate impacts in terms of the goal-performance measures for the years 1982 and 1987 to be consistent with the objectives of the Clean Air Act Amendments. At this stage of the analysis, the impact estimation will be at a macro or sketch-planning level of detail, rather than at a level of fine-grained simulation techniques. This effort will provide the data base of impact measures to serve in the subsequent evaluation and selection of the final package of strategies. The procedural steps for estimating impacts are as follows:

1. Select the candidate action or policy to be analyzed—for example, use of ride sharing to increase vehicle occupancy and thereby reduce VT demand.
2. Identify any ongoing ride-sharing programs within the metropolitan area and any recent prior programs that attempted to encourage ride sharing. For each such program, obtain information on its sponsor, area of coverage, measures of impact, cost, and any additional information relevant to its success or failure.
3. Identify relevant and similar programs in other metropolitan areas and obtain the same data as in step 2.
4. From the data collected in steps 2 and 3, analyze the impact in terms of changed vehicle-occupancy levels and reduced VT demand to the extent possible. These impact estimates are an attempt to determine the extent of impact of actual programs.
5. Estimate the regional impact of the candidate action in terms of the goal-performance measures selected earlier (e.g., before-and-after air quality performance, energy consumption, VT demand levels). For example, if the motivation to be used to encourage high vehicle occupancy is reduced parking rates for each additional passenger in a vehicle, estimate the reduction in the number of vehicle trips that might occur under such a program and calculate the reduction in VT demand that would be associated with that shift in vehicle occupancy. First, analyze those packages representing actions or containing policies that are currently implemented and under way for the target year 1982. Where appropriate, policy variables should be input at levels consistent with specific activity levels. For example, transit fares should be input at levels consistent with those forecast for 1982 by individual transit operators. The results of this analysis will indicate whether or not it will be possible to attain air quality standards by 1982, given no new implementation but continued support of existing TSM-air-quality activities.

Second, make an additional analysis by using the variables set at their maximum reasonable level to determine to what extent air quality objectives could be achieved, given added emphasis and additional support for the strategies already under way.

Finally, analyze selected candidate packages for the 1987 time frame to include the travel changes expected by then to determine the extent to which an areawide TSM-air-quality program could achieve the specific air quality objectives.

Development of Cost Estimates of Candidate Actions and Policies

Because costs represent such a critical issue in the selection process and because the costs of TSM actions and policies have not been carefully identified and enumerated in prior studies, it is important to make careful estimates before proceeding to the subarea analysis stage.

First of all, the cost components of the candidate TSM action must be identified. Does the action require capital investment such as new buses, the construction of a bus-only or a high-occupancy-vehicle lane, new signal equipment? or Will there be ongoing operating or maintenance (or both) costs? Will there be special one-time costs? Will there be marketing or advertising costs? Will special personnel be required to implement and maintain the action? These costs can be estimated by using some broad rules of thumb on equipment, personnel, and operating costs, and such estimates should be made (2). However, to the extent feasible, costs of similar programs should also be reviewed.

For each candidate action, a complete cost estimate should be performed, including amortization period and interest used for each capital expenditure.

Evaluation and Selection of Candidate Actions and Policies: 1982 and 1987

After the development of the impact and cost estimates, it will be possible to compare the candidate actions and policies and begin to select specific proposals. This comparison should stress cost-effectiveness in improving air quality, but measures of other impacts (such as mobility, travel time, and energy) should also be provided so that effects will be known as decisions are made. This is basically a three-level process, as follows:

1. Prepare a summary matrix of the candidate actions. Each candidate action will be a row in such a matrix, and the impact criteria will be shown as columns. These criteria might fall in the following order:

    a. Program cost,
    b. Percentage improvement in air quality,
    c. Cost per 1 percent improvement in air quality,
    d. Percentage improvement in energy use,
    e. Cost per 1 percent improvement in energy use,
    f. Mobility score.

Include in this matrix the agency that would have the responsibility for implementation of the candidate action.

2. Assemble alternative packages showing the total percentage improvements in air quality, cost, and such, as in step 1 above. This assembly of alternative packages should consider the achievements of the candidate action on the several performance criteria as reported above and also whether or not the candidates are reinforcing or self-canceling. This assessment may require some testing of groups (packages) of candidates by using sketch-planning methodology.
3. Prepare the recommendation of regional actions to be submitted to the agency having approval authority.

It is critical that this process thoroughly document all of the work. Particular care should be taken to ensure that a clear record of the actions that were eliminated is maintained, including the basis for that elimination, e.g., to be tested at the subarea level, not cost-effective, not capable of implementation.

Presentation of Areawide Actions and Policies to Appropriate Agencies and Discussion to Secure Approval

The work described above will produce a package of areawide TSM-air-quality actions. During the course of the preparation of the package, it is important to obtain input from citizen groups and local government representatives as to the possibility of acceptance and feasibility of implementation of the specific actions being considered. It is anticipated that detailed discussions between the MPO and the approval body will be required in order to adopt a program of actions for the entire region. To facilitate this discussion and the review by the designated body, an overview briefing paper should be prepared that summarizes the areawide process, the TSM-air-quality impact analysis, and the recommendations. This overview briefing paper should be backed up by detailed working papers to be made available on request. In addition, a formal presentation should be designed that draws on and is keyed to the overview paper. This presentation and the discussions should lead to the adoption of an approved areawide TSM program. It is this program that will be input into the stage 2 subarea planning process.

DEVELOPMENT OF SUBAREA (CORRIDOR) TRANSPORTATION POLICIES AND PLANS

After an areawide context has been developed as described above, more-specific subarea planning can proceed. This section describes the conceptual approach to planning for a subarea (corridor) that will be used by NCTCOG.

A computer-based simulation and assignment model will be used to evaluate TSM and other actions within the corridor. In developing, testing, and evaluating alternative transportation programs in a subarea, a substantial number of subarea simulations will be required. The transportation analysis process and the transportation information system developed for NCTCOG make use of hierarchical zone and network structures that eliminate zone and network details unrelated to the user's area of interest (the subarea) and thus provide an economical assignment having the potential for greater precision than is found in traditional assignment procedures (3, 4). Although the computer programs are fast and economical, it is still necessary to limit the number of simulations to a reasonable level.

The four analysis components of the subarea process that use traffic simulation and associated traffic-impact measures are summarized in step A of Table 2.

1. Base-year calibration: This simulation will be used to demonstrate that the simulation (traffic-assignment) process yields link traffic volumes, vehicle kilometers of travel, average speeds on links, and such measures that correspond to actual observations in the subareas.
2. Baseline projections: These estimates of future travel over a transportation system that includes currently committed facilities and incorporates an areawide TSM program will be used as the base against which to consider subarea TSM actions and capital improvements.
3. Subarea TSM analysis: This series of runs will be used to diagnose, test, and evaluate subarea TSM actions.
4. Subarea capital-improvements analysis: This series of runs will be used to diagnose the need for subarea capital improvements within a complementary program of TSM actions. Specific proposals will be tested and evaluated for selection.

For each simulation, traffic performance measures must be calculated and compared with those for other runs in terms of relative levels of performance (step B of Table 2). The performance measures are important for diagnosing need, as well as for the testing and evaluation of proposals.

Based on these analysis tools, the steps leading to the development of a subarea plan are as described below.

Establishment of Base-Year Validation

This step will be used to establish that the methodology being used to test and evaluate the alternative transportation actions is capable of replicating the base-year traffic in the subarea. This basic validation run will utilize the existing network in the base year, the travel associated with the distribution of population and nonresidential activities in the subarea and, at a broader scale, the entire region.

In addition to a good description of the existing network and travel, accurate ground-count data within the subarea are also needed. It is these data that must be replicated before the process can be considered valid. Moreover, failure to validate the process will jeopardize

Table 2. Traffic assignment and evaluation runs.

Network Supply	Travel Demand	TSM Policies: Existing	Proposed Areawide	Proposed Subarea and Areawide
Step A: Basic Simulation Analyses				
Existing	Present	Base-year calibration		
Committed	Future		Baseline projections	Subarea TSM analysis
Subarea capital improvements plus committed	Future			Subarea capital improvements analysis
Step B: Typical Diagnostic Runs				
Existing	Present		Disgnosis of short-range TSM problems	
	Future	Null: to scale problems if no action is taken		
Committed	Future		Diagnosis of mid-range TSM problems	
Step C: Runs to Estimate TSM-Air-Quality Impacts for Subarea				
Existing	Present	Base year	Diagnosis of short-range TSM approaches	ARZs, parking supply reductions, traffic engineering, preferential lanes, transit improvements
	Future	Null		
Committed	Future		Baseline projections	ARZs, parking supply reductions, traffic engineering, preferential lanes, transit improvements
Step D: Analysis of Combined TSM and Capital Improvements for a Subarea				
Existing	Future	Null		
Committed	Future		Baseline projections	ARZs, parking supply reductions, traffic engineering, preferential lanes, transit improvements
Subarea capital improvements plus committed	Future		Rail rapid transit, additional freeway capacity, exclusive bus lanes	Combined (1, 2, and 3)

the resulting plans by leaving the methodology to stand on purely theoretical, rather than on empirical, grounds. The data needed include the following:

1. VT demand within the subarea,
2. Transit line volumes,
3. Transit central business district counts,
4. Link volumes (sample),
5. Average link speeds (sample),
6. Volumes at corridor crossings,
7. Peak-hour link volumes (sample),
8. Peak-hour speeds (sample),
9. 24-h screen-line volumes, and
10. Peak-hour screen-line volumes.

Establishment of Future Projections

This step will be used to establish the traffic conditions expected at future baselines. Years 1980, 1990 and, for some analyses, 2000 baselines are required. These baseline projections are made by using the committed network additions expected to be in place by the year being considered. The travel estimates should also take into account the future locations of population and nonresidential activities. Finally, these baseline projections should incorporate the areawide TSM program developed in stage 1.

Identification of Goals and Objectives for the Subarea (Corridor)

As noted above, goals often conflict with each other—mobility versus energy or safety versus economy. Clearly, trade-offs must be made, and the process to be pursued in analyzing alternative actions affecting transportation in a corridor is designed both to measure progress toward attainment of the identified goals and to identify the trade-offs in goal attainment inherent in any action or policy.

For purposes of this discussion, a goal is an ideal or abstract state that can be described but that cannot always be measured without further specificity. As shown in Table 3, goals include such factors as general welfare, health, economy, and stability. But, because goal attainment is difficult to measure, some people prefer to use objectives (which are tangible, attainable, recognizable and, in most cases, measurable). A measure expresses the specific term(s) in which the goal or objective is to be expressed and in which progress toward attaining it is to be measured. Finally, it is useful to avoid confusing actions or plans with objectives. Actions or plans are the ways by which objectives are attained. A moving sidewalk is an action. Whether it is a good action depends on its performance with respect to the goals and objectives of the region.

The critical point for the subarea analysis is to recognize that a number of goals and objectives will be affected by each proposed action—TSM or long-range, capital cost intensive or operating cost intensive, localized or regionwide. A single goal or objective may be identified for emphasis in a given context, but the effects of any given policy, action, or group of policies and actions must be recognized for all of the objectives.

In the discussion of the regional analysis process, primary emphasis was placed on analyzing the regionwide actions and policies in terms of the attainment of desired air quality objectives. Despite the suggestion that regionwide policies be evaluated in the context of only one or two objectives (air quality and cost), it is important to recognize that complete reliance on a single measure of performance as the figure of merit for evaluation of alternative packages can produce misleading results. For example, assume that the measure selected is person hours of travel (as a measure of the ob-

Table 3. Goals, objectives, and performance measures.

Goal	Objective	Performance Measures
General welfare	Mobility	Vehicle hours of travel, vehicle kilometers of travel, person hours of travel by highway, person kilometers of travel by highway, person hours of travel by transit, person kilometers of travel by transit, vehicle hours of travel by transit, vehicle kilometers of travel by transit, average travel speed, vehicle hours delay, kilometers of facility by volume-to-capacity class, kilometers of facility, number of transit lines, transit line kilometers, transit seat kilometers, seat kilometers per square kilometer, use measure(s) per supply measure(s), automobile ownership per household, no. of person trips by purpose and by mode
	Opportunity	Accessibility, trips per household by automobile, trips per household by transit, vehicle kilometers of capacity, accessibility to transit, accessibility to highway, automobile ownership per household, person trips to CBD, vehicle trips to CBD, median household income
	Equity	Mobility measures on a per capita basis
	Development potential	Accessibility
Health	Air quality	Percentage of trips served by transit, percentage of person kilometers of travel by transit, emissions—highway, emissions—transit
	Safety	Accidents—transit, accidents—highway
Economy	Least annual dollar cost	Capital cost, operating cost, supply measures per cost unit, use measures per cost unit
	Energy consumption	Percentage of trips served by transit, percentage of person kilometers of travel by transit, liters per joule consumed, patronage (various measures) per unit of energy
Stability	Disruption	Land dedicated to transportation, households relocated, businesses relocated, jobs relocated

jective of mobility) and that a higher value of this measure is associated with improved mobility. Assume further that, in (a hypothetical) case 1, there are 1 000 000 daily person trips at an average speed of 36 km/h (20 mph) and an average length of 8.8 km (5.5 miles). Compare this with case 2, in which there are 800 000 person trips at an average speed of 16 km/h (10 mph) and an average length of 6.4 km (4.0 miles).

Clearly the second case is less desirable. The residents of the region are engaging in less travel, which represents a loss in opportunity and activity for them, the travel is slower (and time spent in travel is, itself, nonproductive, so this represents a loss in utility), and the average area in which they travel and from which they make their choices for shopping, work, recreation, and so forth is diminished from 250 km^2 (95 $miles^2$) to 130 km^2 (50 $miles^2$). Yet a simple calculation shows that case 1 produces 275 000 person hours of travel while case 2 produces 320 000. Thus, on the basis of person hours of travel alone, case 2 would be judged superior! But there is nothing to recommend it, given the characteristics used in the example.

In this phase of the analysis, therefore, all objectives must be considered—mobility, safety, cost, energy consumption, development, and so forth—given, at least, no degradation in air quality and, at best, further improvement in it.

Specification of Candidate TSM and Air-Quality Actions to Be Tested at the Subarea Level

At the subarea level, the areawide TSM-air-quality program determined in stage 1 is assumed to be in place. The conditions or problems these actions will address would have been determined in (a) a simulation-evaluation run using the present network and the base-year travel demand and assuming the areawide TSM-air-quality program as having been implemented; (b) a run using the committed network, future travel, and assumed areawide TSM-air-quality program; and (c) the null case (future travel over the current network).

These candidate actions or packages will be tested by using simulation-evaluation runs in which the specific candidate effect is reflected in the travel assigned, the network to which the travel is assigned, or both. The primary objectives of specifying these actions or policies are to determine (a) the extent to which the short-range subarea transportation problems can be solved by a combination of areawide TSM programs and specific TSM-air-quality actions within the subarea and (b) the extent to which the midrange subarea problems can be solved by a combination of the capital improvements scheduled for the region (including the subarea), the areawide TSM-air-quality programs, and specific subarea TSM actions. No recourse to new capital improvements is to be considered in this analysis.

Determination of a Reasonable Time Frame for Implementation of Actions and Policies

To consider the possible transportation actions and policies in any rational way, it is necessary to answer the question, What is the earliest date by which a specific action or policy could be in place if the decision to do it were made now? This information is needed to introduce the action into the analysis at the appropriate time. Some actions require 5-10 years lead time; other policies can be put into effect next week.

Development of Packages of Alternative TSM Actions

The variety and number of TSM-air-quality actions and policies require some packaging or grouping of them because of the cost and time that can be consumed in evaluating all the potential combinations and permutations. The objective in packaging the policies and actions (in addition to reducing the cost of evaluation) is to group those policies that (a) have the same (or similar) effects relative to the objectives and (b) reinforce those effects, rather than canceling each other, relative to the objectives.

The preliminary process described below can be used for grouping the policies and actions.

1. Estimate the effect of each individual policy or action on each of the objectives. Whenever possible, make these estimates by using simulation or sketch-planning techniques. A realistic application should be used, although hypothetical applications are acceptable if necessary. Manual techniques or general estimates of effects may be considered as a last resort.
2. Group the candidate actions according to their effects on each of the objectives. This process is similar to that recommended by the Urban Mass Transportation Administration (2), but should not be limited to two objectives only and should be supported by the relatively more rigorous analysis in step 1.
3. If the results of step 2 require further analysis, assemble groups of two or three projects into prelimi-

nary packages and analyze their combined effects.

4. Based on the results of steps 2 and 3 and on the timing of implementation, assemble packages of actions and policies. Criteria for candidacy should include both the effects of the policy or action and the objective(s) for the action in the area under analysis. For example, as has been suggested above, the objectives emphasized in the regional analysis may differ from those of the subarea analysis. Similarly, the emphasis placed on various objectives in different subareas may vary with the conditions in the subarea.

Estimation of Impacts of Alternative TSM-Air-Quality Packages in Subarea

The simulation-evaluation models will be used to simulate system performance of each TSM-air-quality package proposed to be tested within a subarea. For example, as shown in step C of Table 2, a series of 10 runs might be made to estimate the impacts of five alternative TSM-air-quality actions. For short-term improvement, five comparisons are made—one for each of five possible subarea actions. When the impacts (on air quality, energy, VT demand, mobility, and such) are compared with those of the same measures in the base year, the improvement or degradation is indicated. When they are compared with those of the short-range diagnosis runs, the improvement over and beyond the areawide TSM program is indicated.

The comparison of future travel runs using the committed network and specific TSM proposals and the baseline projection gives an indication of system performance and impacts under a future condition that includes an areawide TSM-air-quality program. If comparisons are also made with the null case, we obtain a measure of how subarea actions improve performance compared with the improvement given by the committed network and the areawide TSM-air-quality program. Finally, the need for packaging is emphasized by the number of runs and the amount of analysis required.

Over and beyond the impact measures discussed above, it is also necessary to gauge the effects of various transportation system actions and policies on regional development potential. Recognition of the long-range development impacts of transportation improvements and policies is certainly not new. The major focus of recent efforts has been to examine the long-range impacts of major transportation improvements on settlement. For example, the planned construction of rail rapid transit systems anticipates ridges of increased residential density along the lines, clustering of work centers around transit stations, and a general buttressing of the economic vitality of the focus of these lines, the central business district. The configuration of limited-access highway systems (grid versus radial) is presumed to have influenced the settlement patterns around them. For example, in the Washington, D.C., area, the response of development to successive improvements in the Shirley Highway corridor is striking evidence of the relationship between access and land development.

Policies that limit or regulate access to parts of a region, dictate the mode of travel to be used, set aside exclusive lanes for high-occupancy vehicles, or radically change the cost of travel all can be expected to have long-range impacts on development. Therefore, in evaluating alternative strategies, in addition to considering the short-range impacts on air quality and energy, it is necessary to consider developmental impacts arising from changes in accessibility.

Analysis of Subarea Capital Improvements

After the seven steps described above have been completed, the extent to which the travel requirements of the subarea can be met through construction of already committed capital improvements, areawide TSM-air-quality programs, and specific subarea TSM-air-quality packages will be known. It is likely, however, that some problems will remain that suggest subarea capital improvements (e.g., rail transit, construction of express bus lanes, new freeway capacity including double decking). These capital improvements should be analyzed, and their performance should be reviewed against the baseline projection and the null case.

Finally, a combined set of TSM-air-quality packages that reinforces or complements proposed subarea capital improvements can be assembled as shown in step D of Table 2 for three combinations that are unspecified but labeled 1, 2, and 3 (C-3 future). These would be simulated and the impact measures would be available for selection of a final package.

Development of Cost Estimates of TSM-Air-Quality Packages

The level of detail and complexity involved in the component actions and policies included in the packages requires careful estimation of economic costs of each. This step is a logical extension of the earlier specification of candidate actions and policies in that dollar costs—for implementation, capital, and operation—must be specified with some precision for each candidate action and policy. In some instances, this may involve the determination and application of a unit cost or value for various measures derived in the simulation.

Evaluation and Selection of Subarea Alternative Packages for 1980 and 1990

The final step in the subarea analysis is the comparison and evaluation of the alternative policy and action packages and the selection of those to be implemented. Initially, this step will involve the MPO staff. However, the ultimate responsibility for the evaluation and selection will rest with a policy group and also require citizen approval. As in all planning efforts, the selling of the plan will require careful preparation of presentations, discussion papers, and an ongoing dialogue between the MPO and other concerned groups.

CONCLUSION

This paper has shown that a unified planning approach that combines TSM and more-traditional planning concepts is not only possible, but indispensable to the transportation planning process. The first two stages of this approach—(a) the regional context within which corridor planning can take place and (b) the corridor planning process itself—are being implemented in a program for the NCTCOG. The third stage—the synthesis and integration of the corridor plans into an overall plan for the region—will be developed further in future efforts.

ACKNOWLEDGMENT

The ideas and procedures presented in this paper draw heavily on work undertaken for the North Central Texas Council of Governments; we alone, however, are responsible for any shortcomings in the paper.

REFERENCES

1. Alan M. Voorhees and Associates. TSM Planning. North Central Texas Council of Governments, Arlington, Vol. 1, March 1978.
2. F. A. Wagner and A. K. Gilbert; Alan M. Voorhees and Associates. TSM (Transportation System Management): An Assessment of Impacts. Office of Policy and Program Development, Urban Mass Transportation Administration; Office of Highway Planning, Federal Highway Administration; and Office of Transportation and Land Use Policy, U.S. Environmental Protection Agency, Rept. UMTA-VA-06-0047-79-1, Nov. 1978, Chap. 3. NTIS: PB 294 986/5SL.
3. John Hamburg and Associates, Inc., and R. H. Pratt Associates, Inc. Functional Specifications for the North Central Texas Thoroughfare Planning System. North Central Texas Council of Governments, Arlington, 1976.
4. John Hamburg and Associates, Inc. Thoroughfare Analysis Process User Manual. North Central Texas Council of Governments, Arlington, Dec. 31, 1976.

Issues in TSM Methodology

A. Keith Gilbert, Transpo Group, Bellevue, Washington

There has been a great deal of research on transportation system management (TSM) planning over the past two years. One study (1) of TSM institutional and planning research introduced a new approach to the classification and packaging of TSM candidate actions and developed new data on the impacts of such actions. This paper will begin by reviewing that approach and then discuss five specific impact issues.

1. How can the aggregated impacts of areawide TSM actions be assembled in concise fashion for use by local elected officials?
2. How can major capital alternatives be evaluated against possible TSM strategies?
3. What is the relationship between long-range planning and short-range planning for TSM?
4. How can evaluation of TSM actions be incorporated in the urban transportation planning process?
5. Can there be one integrated TSM planning process or must there be more than one?

In addition to the results and conclusions cited above, examples and conclusions have been drawn from the TSM transit planning handbooks developed for the North Central Texas [Dallas-Ft. Worth] Council of Governments (2), a highway corridor study in Tulsa (3), and a TSM plan development project for the Flint, Michigan, area (4).

TSM ACTION PACKAGES

The TSM institutional and planning research project was a two-phase, broad investigation of TSM institutional arrangements and planning methods, TSM planning methodologies, and the effectiveness of and interrelationships among TSM actions. The results of phase 1 included the following:

1. A description of a simplified first-generation TSM planning process,
2. A catalog of analytical methodologies available for use by TSM planners,
3. A conceptual framework of supply-demand equilibrium that can be used to relate TSM actions to TSM goals and priorities and to better understand interactions among TSM measures,
4. An in-depth analysis of a systematic TSM planning process,
5. A series of six working papers quantifying the potential effectiveness of TSM actions, and
6. The prototypical TSM programs.

In phase 2, a more rigorous and comprehensive analysis methodology was used. Seven prototypical cities were selected; descriptions were developed of their current transportation system characteristics; and typical goals, objectives, and measures of effectiveness (MOEs) for TSM actions were identified. A set of 30 TSM actions were selected as representative of the wide scope of transportation system management, and the impacts of implementing these actions in each of the seven cities were estimated for the region and subareas, and for daily and peak-time periods. Cost-effectiveness was estimated in relation to mobility and conservation goals, and packaging concepts were developed on the basis of cost-effectiveness and similarities of impact magnitude and direction.

Supply-Demand Equilibrium

The phase 1 work on the application of supply-demand concepts to TSM may help in understanding and explaining aggregate impacts of areawide TSM and, to a degree, the relationship between long- and short-range planning. The methodology used for analyzing TSM impacts and interactions was based on the fundamental concept of transportation supply and demand equilibrium. This concept holds that the existing transportation situation in an urban area can be characterized by two fundamental curves,

1. A transportation supply curve that depicts the level of service provided by the transportation system as a function of the demand for personal travel and
2. A transportation demand curve that depicts the quantity of travel demand that the public will generate at different levels of service experienced in traveling.

From a theoretical perspective, plotting supply and demand curves on the same graph allows one to identify the equilibrium point at which the two curves intersect. TSM actions (and indeed any event affecting transportation) may change either the supply curve, the demand curve, or both. In turn, this will shift the equilibrium point where the two curves cross from the initial point to a new point. This fundamental concept of economics was used as a tool for clarifying and estimating the impacts of TSM actions.

The primary result of using this methodology was that the large number of available TSM actions could be grouped into four major classes, depending on how each action affects the supply and/or demand curves and the resultant shift in equilibrium.

The four TSM action classes are described below.

Class A: Actions That Reduce Demand for Vehicle Travel

Class A actions include those that induce travelers to shift from lower-occupancy to higher-occupancy vehicles (transit and ride sharing) or to nonmotorized travel modes or to reduce trip frequency or trip length, thereby decreasing vehicle travel (VT) demand without affecting highway supply.

The impact of class A actions on supply and demand is illustrated in Figure 1. When demand is reduced, the demand curve is shifted to the left while the highway supply curve is unchanged. The demand reduction results in decreased travel time for the remaining vehicles, and thus the supply-demand equilibrium point is shifted downward and to the left.

Class B: Actions That Enhance Highway Supply (i.e., Improve Traffic Flow)

This class includes a wide range of traffic engineering and control measures that reduce the travel time experienced at given levels of VT demand. The impact of class B actions is illustrated in Figure 2: The supply curve is shifted downward (i.e., the supply is improved) while the demand curve is unchanged. The initial decrease in travel time results in subsequent increases in VT.

Figure 1. Impact of class A actions on supply and demand.

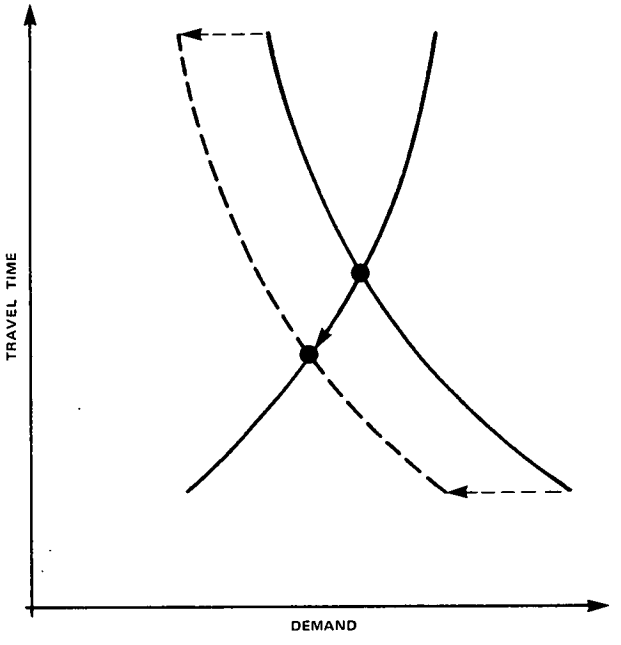
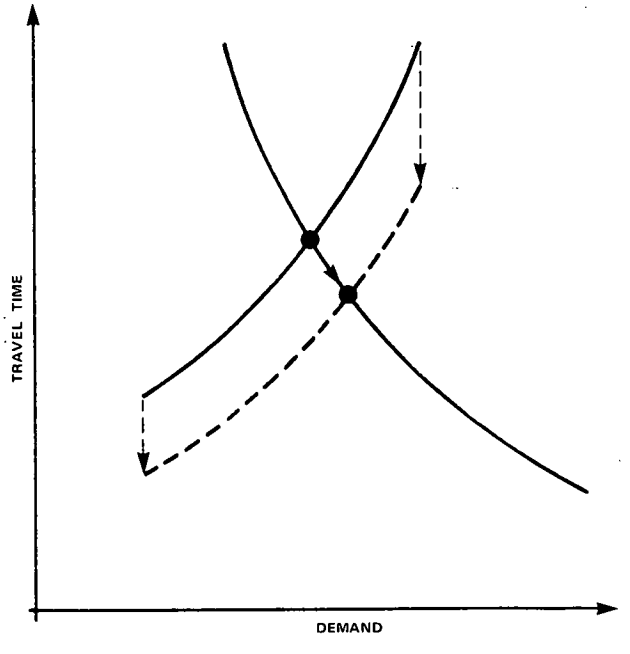


Figure 2. Impact of class B actions on supply and demand.



Class C: Actions That Reduce VT Demand and Degrade Highway Supply

This class includes actions primarily aimed at inducing travelers to shift from lower-occupancy to higher-occupancy vehicles or to nonmotorized travel modes, but does so by increasing general vehicular travel time while reducing travel time for high-occupancy vehicles (HOVs) or for nonmotorized modes. As illustrated in Figure 3, the effect of class C actions is to shift the supply curve upward (i.e., the supply is degraded) and the demand curve to the left (i.e., demand is reduced). This shifts the equilibrium point to the left and either upward or downward, depending on the slopes of the supply-demand curves and the magnitudes of the changes.

Class D: Actions That Enhance Highway Supply and Reduce VT Demand

These are actions that simultaneously decrease both the general travel time for given levels of VT and also, by even greater amounts, the HOV travel time and thus induce travelers to shift from lower-occupancy to higher-occupancy vehicles. The most striking example of this type of action is add-a-lane preferential treatment, such as the exclusive lanes for buses and carpools added to the Shirley Highway in the Washington, D.C., area and the San Bernardino Freeway in Los Angeles.

The impacts of such actions are illustrated in Figure 4. The supply curve is shifted downward (i.e., supply is enhanced) because additional capacity is added, and the demand curve is shifted to the left (i.e., demand is reduced) as a result of the preference given to high-occupancy vehicles or reduced trips by automobile. The equilibrium point is shifted downward and either to the left or right, depending on the slopes of the supply-demand curves and the magnitudes of the shifts.

Table 1 summarizes the grouping of TSM actions into the four major classes, and Figure 5 illustrates the likely general directions of shifts in supply-demand equilibrium that will result from each of the four action classes.

Several inferences may be drawn concerning which types of actions are most appropriate, depending on the goals for a given urban area.

If fuel conservation and emissions reductions are the most important goals, then conceptually, we find that

1. Class A actions should receive highest priority because these actions tend to reduce both VT demand and travel time and to shift the equilibrium point in an almost optimum direction for fuel conservation and emissions reductions;
2. Class C actions should receive next highest priority because these actions also shift the equilibrium point in almost optimum direction for fuel conservation and emissions reductions;
3. Class D actions are less desirable, because although these actions are fairly certain to conserve fuel and reduce emissions by reducing travel time, they will affect VT demand only marginally; and
4. Class B actions are least desirable, because although they may substantially reduce travel time, they will accommodate substantial VT demand increases.

If mobility goals are paramount, as they may be if current levels of congestion are severe or if fuel availability or air pollution are not perceived as major problems, then conceptually,

1. Class D actions should receive highest priority, because these actions shift the equilibrium in near optimum direction for mobility improvement and also reduce fuel use and emissions,
2. Class B actions should receive next highest priority because these actions afford substantial reductions in travel time while also permitting increased VT demand to be served,
3. Class A actions are also desirable because these actions substantially reduce travel time and also allow free-choice changes in travel demand, and
4. Class C actions are least desirable because these actions may actually increase travel time and because portions of the reduction in VT demand they produce may require undesired individual changes in travel behavior as well as user-cost increases for those who must con-

Figure 3. Impact of class C actions on supply and demand.

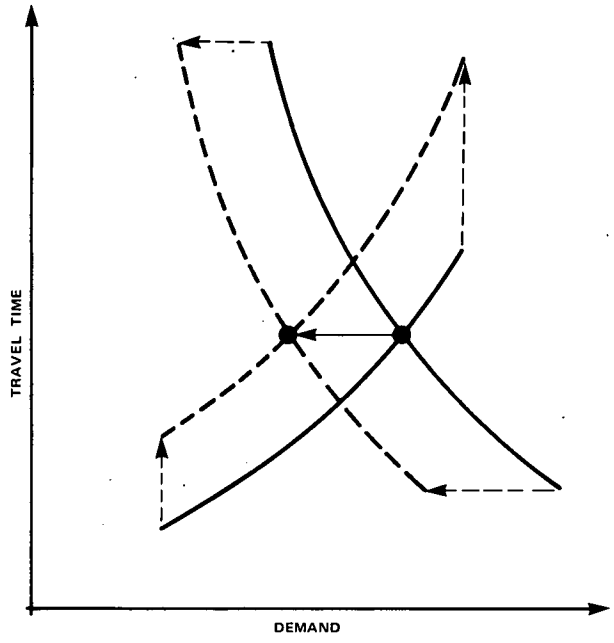
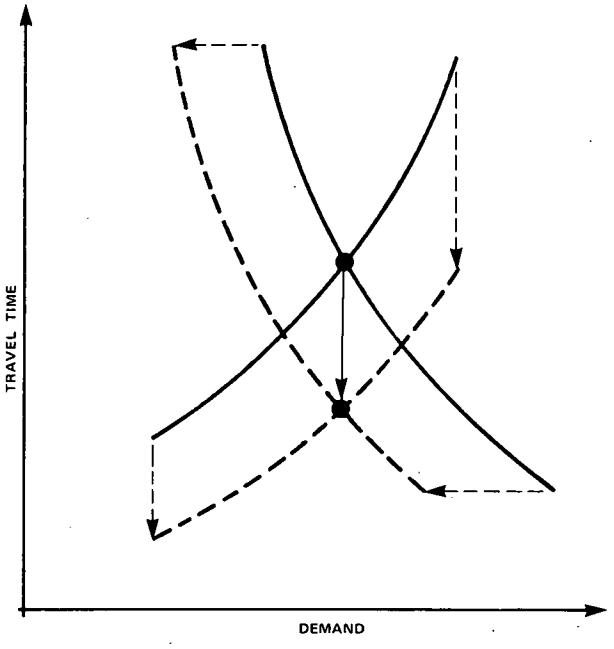


Figure 4. Impact of class D actions on supply and demand.



tinue to rely on private automobiles.

PHASE 2 RESULTS

Generally, the more-detailed analysis of phase 2 confirmed the supply-demand-equilibrium basis for grouping TSM actions. The methodology used in phase 2 consisted of estimating the initial impact of TSM action on VT demand, speed, and number of automobile trips in each prototype city by using demonstration results or sketch-plan modeling (or both). This was followed by equilibration of the VT demand and speed changes by using estimated supply-demand elasticities, calculation of the resulting emissions and energy-consumption

Figure 5. Shifts in supply-demand equilibrium: impacts of different classes of TSM actions.

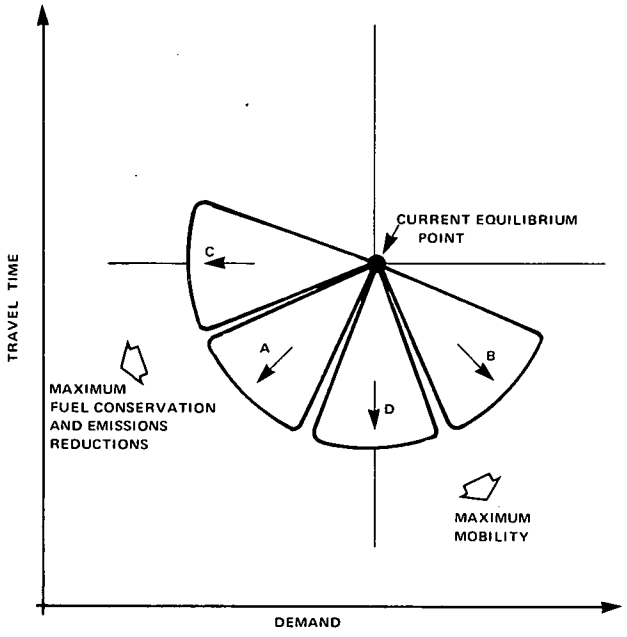


Table 1. Summary of TSM action classes.

Action Class	Impact on Highway Supply	Impact on VT Demand	Actions
A		Reduce	Encourage ride sharing, transit marketing, express bus service and park-and-ride lots, transit route and schedule improvements, paratransit systems, bicycle and pedestrian facilities, pricing such as transit fare reductions, pricing such as reduced taxes, tolls, fees, and fares for HOVs or increases for automobiles, work rescheduling (four-day workweek)
B	Enhance		General traffic engineering, freeway traffic management, truck restrictions and enhancements, work rescheduling (staggered hours and flextime)
C	Degrade	Reduce	Preferential treatment for HOVs, (exclusive lanes), automobile-restricted zones, parking supply reductions
D	Enhance	Reduce	Preferential treatment for HOVs (exclusive lanes)

changes, and estimation of the mobility impacts by using a travel-time budget concept (5). Preliminary results indicated that VT demand and speed, on an individual action basis, are reasonably good proxies for emissions-reductions and fuel-conservation impacts.

When the changes in VT and speed for the various TSM actions (after equilibration) were compared with the phase 1 class definition (A, B, C, and D), the results were similar and the concept was supported. The phase 2 analysis of ride sharing, park-and-ride, express bus service, local bus service, paratransit, and pricing verified all of these actions as class A and that of traffic engineering improvements verified them as class B. The few differences that were found between the phase 2 analysis and the phase 1 classification system seemed to be explained by the different assumptions about modal-split changes and the overall magnitudes of

Table 2. Composition of TSM action packages.

TSM Action	Package			
	Automobile Mobility	Transit Mobility	Emissions Reductions	Fuel Conservation
Right turn on red	X	X	X	X
Signal improvements	X	X	X	X
Freeway HOV lanes	X	X	X	X
Ramp metering	X		X	X
Ride sharing	X		X	X
Bikeways	X		X	X
Bus service improvements		X	X	X
Work rescheduling projects	X		X	
Reversible arterial lanes	X		X	
Central business district truck management	X		X	
Carpool parking			X	X
Park-and-ride lots			X	X

impacts used in the different phases (small impacts were eliminated in the phase 2 analysis when rounding off the results).

When the preliminary phase 2 estimated impacts were converted to a cost-effectiveness basis, the most cost-effective actions (those having good or at least reasonable implementation potential) were strikingly similar for both the mobility and the conservation goals. The pattern of appearance of the various TSM actions in four goal-oriented packages is summarized in Table 2.

The overall impacts of the four goal-oriented packages were also estimated to be similar despite their slightly different components:

1. Automobile mobility was increased by 3-10 percent, varying by city;
2. Transit mobility was increased by 3-15 percent, varying by city;
3. VT demand was essentially unchanged, varying from an increase of 1 percent to a decrease of 1 percent;
4. Speeds were increased by 4-9 percent;
5. The number of automobile trips was reduced by as much as 2 percent;
6. Carbon monoxide emissions were reduced by 1-11 percent;
7. Hydrocarbon emissions were reduced by as much as 5 percent;
8. Nitrogen oxide emissions were essentially unchanged, varying from an increase of 1 percent to a decrease of 1 percent; and
9. Fuel consumption was reduced by as much as 3 percent.

SPECIFIC TSM IMPACT ISSUES

Communication About TSM Impacts to Decision Makers

The first issue concerns how information about aggregated TSM action impacts can be assembled and communicated to decision makers and how strategies relating to different types of subareas and different time periods can be considered together. The results discussed above suggest a simplification that may help resolve this issue. It seems clear that TSM actions can be grouped together in relation to goals and, further, that there is considerable overlap among various goal-oriented packages. In addition, the preliminary results show that the majority of TSM actions maintain their position relative to VT demand and speed changes (in other words, their designation as class A, B, C, or D) on either a regional or a subarea basis and on either a daily or a peak-hour basis. It would appear, then, that TSM programs need not be markedly different even if goals vary from area to area or from city to city.

These concepts do not provide the complete answer to problems of understanding and explaining TSM or of overcoming institutional constraints and other obstacles. Still, if these research conclusions are verified in practice, then the packaging and determination of impact characteristics of the more routine TSM actions may be simpler than anticipated and at least that part of the TSM picture may become easier to deal with.

This probably will not be the case, however, for pricing and other disincentive actions. Consideration of such actions (which have a low implementation potential under current conditions) would probably require a large amount of area-specific and detailed analysis to forecast implementation consequences for use in political review and decision making.

TSM and Capital Projects

The issue of how capital projects can be evaluated against possible TSM strategies would seem to have a straightforward resolution in terms of the MOEs used. If both types of improvements are assessed in common terms (by using MOEs such as volume, capacity, VT demand, speed, emissions reductions, and fuel consumption), direct comparisons of capital and TSM actions are possible. Consider, for example, a corridor study in Tulsa, Oklahoma, in which screen-line capacity and demand were estimated and compared for various alternatives. The impacts of transit improvements, pricing, pooling, and work rescheduling were calculated as reductions in future demand levels. Capacity increases were estimated for both capital projects (new arterials and freeways) and TSM capacity-improvement actions (reversible roadways, for example). The common MOE was afternoon peak-hour vehicle volume, either traffic demand or traffic-carrying capacity. These comparisons showed that TSM improvements alone could not achieve a demand-capacity balance for either of two future-growth scenarios, but that TSM actions could make it possible to meet future demand levels by constructing a parkway-type facility rather than a full freeway.

In another recent example, a TSM solution was recommended for an arterial corridor in downtown Flint, Michigan. All previous proposals had featured capital improvements, including street widening and new river crossings. An in-depth analysis of corridor traffic operations, undertaken with TSM potential in mind, combined with new growth scenarios, produced a recommendation for a TSM solution that consisted of intersection and traffic control improvements. Here, careful and sensitive analysis showed that a TSM solution was a feasible alternative to capital improvements.

In both of these examples, the consideration of both

TSM solutions and capital improvements proved to be no problem in terms of either analysis methodologies or study credibility.

TSM in the Planning Process

The next two issues concern the relationship between TSM and long-range planning. A suggested approach to the resolution of these issues involves a goals-and-objectives-oriented methodology and, again, use of a common system of MOEs.

MOEs play a critical role in the diagnosis of system performance and the evaluation of TSM actions. They are the basis for measuring action effectiveness by prediction before implementation and by surveillance afterward. MOEs are critical to almost any priority-ranking process, again by expressing effectiveness and providing the basis for a TSM information system that can be the foundation on which to build a continually improving program of TSM actions.

In both the development of the TSM planning handbooks in Texas and the Flint TSM plan and the TSM research study, a large number of MOEs were identified for potential use. However, in the application stages of the studies, it was found that only a very short list of variables was necessary. In phase 2 of the research study, an initial list of 25 candidate MOEs was sharply narrowed by eliminating hard-to-quantify items and then identifying the common factors used in calculating the remaining MOEs. For example, VT demand can be and often is used to calculate number of accidents, emissions reductions, fuel consumption, operating costs, and so forth. By using this approach, the list of significant MOEs was reduced to VT demand, speed, number of trips, and capital costs. A similar exercise in the Flint TSM study led to reducing a list of 44 MOEs to 8—volume, capacity, VT demand, number of accidents, number of bus passengers, bus kilometers of travel, transit coverage, and bus operating costs.

With the list of MOEs reduced to these few key items, the same ones can easily be applied to both long- and short-range planning and to the joint evaluation of both capital and TSM alternative projects.

The TSM Process

The final issue is that of a single, integrated TSM process. There seems to be little question that the TSM planning process is separate from the long-range planning process, even though TSM projects can be integrated with capital projects and considered in long-range planning as discussed above. This dichotomy is probably due to the diverse natures of candidate TSM actions and of the public and private agencies that can take part in the process.

Integration within the TSM process is a different question, however. There is little or no competition for funds between highway projects and transit projects, and thus there is little real-world demand for a single integrated, multimodal TSM planning process. The development of a TSM planning process for the Flint area eventually focused on the questions of a method for establishing project priority. A problem-based priority system developed for use in establishing priorities for federal-aid urban system (FAUS) projects was already in use in Genesee County, Michigan. In this system, relative merit is established in terms of current volume-to-capacity ratios and accident rates. The alternative to the FAUS system was a much more complex cost-effectiveness approach.

Because it was already in use, readily understandable, accepted by the participating agencies, and treated TSM projects in an appropriate manner, the FAUS priority method was adopted for TSM projects as well. In this way, both capital and TSM solutions will be considered together, by using the same criteria and implementation priorities related to the severity of the deficiencies to be remedied. It is significant, however, that, largely due to separate funding sources for highway and transit projects, the FAUS priority system in Flint was not designed to, and does not, cover transit improvements. These move through the process separately and have internal priorities set by the transit agency. From that standpoint, the TSM process is not integrated until the transportation-improvement-plan stage, but no pressing need was seen by local agencies to adopt a more complex, unfamiliar, multimodal, integrated cost-effectiveness approach at this time under the current funding structure.

CONCLUSION

Several issues—(a) assembly of aggregated impacts of areawide TSM action for use by local elected officials, (b) evaluation of possible TSM strategies against major capital alternatives, (c) relationship between long- and short-range planning for TSM, and (d) incorporation of TSM actions in the urban transportation planning process—can be at least partially resolved through simplifications inherent in TSM. On the other hand, development of a truly integrated multimodal TSM process is not likely to occur until a pressing need appears that justifies the additional complexity involved.

REFERENCES

1. F. A. Wagner and A. K. Gilbert; Alan M. Voorhees and Associates. TSM (Transportation System Management): An Assessment of Impacts. Office of Policy and Program Development, Urban Mass Transportation Administration; Office of Highway Planning, Federal Highway Administration; and Office of Transportation and Land Use Policy, U.S. Environmental Protection Agency, Rept. UMTA-VA-06-0047-79-1, Nov. 1978, 188 pp. NTIS: PB 294 986/5SL.
2. Alan M. Voorhees and Associates. TSM Planning. North Central Texas Council of Governments, Arlington, Vol. 2, Aug. 1977.
3. Alan M. Voorhees and Associates. Riverside Corridor Study. Indian Nations Council of Governments, Tulsa, OK, Dec. 1978.
4. Alan M. Voorhees and Associates. 1979 Transportation System Management Plan. Genesee County Metropolitan Planning Commission, Flint, MI, Aug. 1979.
5. Y. Zahavi. Travel Time Budgets and Mobility in Urban Areas. Federal Highway Administration, May 1974, 90 pp. NTIS: PB 234 145/1.

Monitoring System Performance: A Foundation for TSM Planning

Michael D. Meyer, Department of Civil Engineering, Massachusetts Institute of Technology, Cambridge

Transportation planning processes have long placed strong emphasis on the collection of data for the determination of the existing conditions on the transportation network. Since enactment of the Federal-Aid Highway Act of 1962, and the resulting development of the comprehensive, continuing, and cooperative ("3C") process, a continuous feedback of network performance and demographic information has been required. The concept of monitoring is thus not new to the field. However, because of the increased focus on operations planning and the increased willingness by many communities to consider transportation system management (TSM) actions, monitoring has become even more important. This importance derives from the need to determine the success or failure of a specific transportation action in a short time.

This paper examines the role that monitoring has (and should have) in TSM planning. Specifically, the paper addresses the following questions:

1. What is monitoring and how useful is it for TSM planning?
2. Can a regional TSM program be effectively monitored and evaluated given that most TSM actions are directed toward alleviating extremely localized problems?
3. How can the results of implemented TSM actions be determined, monitored, and reported?
4. Who should do this monitoring?
5. How can a TSM action that has been implemented be evaluated against improved transportation system performance?
6. And, finally, how should the monitoring procedures be tailored to the size of the particular urban area?

FOCUS OF CURRENT MONITORING PROCEDURES

The concept of collecting information on system performance or conducting a before-and-after study of a particular action is not new to the transportation field. The U.S. Department of Transportation (DOT) and many state departments of transportation have for many years required the collection of data on the performance of the highway network, the most important of which is vehicle kilometers of travel (1,2). More recently, DOT has initiated several programs aimed at establishing a unified reporting system for data on transit performance (43 Federal Register 58 928-58 944). Such data as bus-fleet age distribution, bus revenue vehicle kilometers, bus revenue seat kilometers, and bus route kilometers are to be collected from each urbanized area so that federal funds can be distributed by need and performance characteristics.

At the regional and local levels, monitoring procedures have typically been used to collect information on travel trends and to provide input into the processes by which decisions are made on the long-range level of investment in transportation. Transportation studies that focus on long-range concerns do in fact require extensive sets of primary and secondary data. Most certainly, however, some of the information needed for long-range planning and the techniques used to collect it are different from that required for TSM planning (3,4).

In the past, monitoring of TSM-type actions has been conducted only on an occasional basis and then only to satisfy specific requirements. Data have usually been gathered on location-specific problems and have had limited value in developing valid regional estimates of the effectiveness of TSM actions. The data base needed for examining the impacts of TSM strategies on a regional basis has thus been, in most cases, not available.

Recently, efforts have been made to develop regional travel monitoring procedures that can be used to complement the more extensive traffic-counting programs used to monitor changes in vehicular flows. These procedures focus on specific measures that can be estimated from field data at a relatively low cost and can supposedly be used to assess (at a regional scale) the overall effectiveness of a TSM program (5,6). These measures are related to several categories of need, such as evaluating the effectiveness of TSM actions, monitoring changes in air quality indices, determining the energy efficiency of travel, and following the general trends in transportation characteristics. As can be seen from this list of needs, the monitoring procedures are designed not only to inform the TSM process, but also to address other concerns in the regional transportation planning process.

The need to monitor transportation system performance has thus been recognized ever since the transportation planning process was formally created. The procedures that have been developed to satisfy this need and the type of information gathered in the monitoring process, however, have not been particularly useful for TSM planning. Most of the data-gathering activities that do collect information useful for TSM planning are extremely limited in scope, in both a geographical and a functional sense. Although some efforts are now being made to develop procedures for evaluating the effectiveness of regional TSM programs, the question need be asked whether such efforts can, given the localized nature and relatively small effects of most TSM actions, ever succeed in reaching such judgments.

ROLE OF MONITORING IN TSM PLANNING

Initial responses to the requirements of the TSM planning regulation were problematic. However, one of the first steps taken by most regional planners was to establish some sort of mechanism to monitor the performance of TSM actions and, in some cases, the process used to develop the TSM plan. The reasons for such monitoring activities were many. External to the TSM planning process itself, it makes sense to monitor both the physical installation of actions and their performance in altering the transportation system once installed. The first of these is (7)

> a way of measuring the product of service oriented planning, the second a form for supplying feedback on the effectiveness of decisions taken. It [is] also important to monitor the process itself, including the design of actions, the installation of new relevant skills and resources in the participating agencies, the evaluation of actions proposed and the preparation of the necessary reports.

That monitoring became an important component of TSM planning should not be much of a surprise. In addi-

tion to its obvious contribution to any planning process, monitoring also represents the mildest form of process development; it is the logical place to start, particularly if more vigorous measures are obstructed. Given that the regulations require that reasonable progress be shown in the development of TSM projects, monitoring procedures can also be reasonably considered an implicit requirement of the TSM regulation. Furthermore, in an institutional environment where metropolitan area organizations have, in some cases, been hesitant to promote TSM vigorously, monitoring activities provide the most practical means to adjust quietly to modes of working together while avoiding the problems of establishing a formal, methodologic approach.

As the TSM process evolved, the role that monitoring had in it was slightly modified to reflect the changing characteristics of TSM planning itself. In most cities, some form of monitoring has been conducted that reflects the needs of the TSM process and the characteristics of the urban area. In larger cities, for example, monitoring strategies are usually based on the principle that it is not necessary to monitor every TSM project. In these cities, where the number of TSM-type actions could range into the hundreds or even thousands, existing resources do not permit detailed monitoring or evaluation of each TSM improvement (8). Small to medium-sized cities have continued their ongoing efforts to collect data on TSM programs, projects, and activities, with these efforts of course dependent on available resources. In all cases, however, it is agreed that monitoring activities are especially necessary when innovative TSM strategies are being implemented.

In preparation for this paper, letters were sent to TSM [usually metropolitan planning organization (MPO)] planners in 30 cities in all geographic areas of the country and representing different city sizes. In general, the importance of monitoring is recognized by most planners, although the stages of development vary considerably, as is illustrated in the following statements:

> We will be placing additional emphasis on monitoring project implementation and effectiveness. The latter is particularly crucial, we feel, given the relatively non-traditional nature of many TSM improvements, as well as the new demands (e.g., for air quality improvement) being placed on more established efforts such as signal synchronization projects.
>
> Monitoring the performance of transportation operating agencies is the heart of an effective TSM process. Without an operating feedback mechanism, we have no means to determine how effective proposed TSM strategies are in achieving objectives. [We] have instituted two processes: performance auditing and standardized reporting systems for transit operators.... This information is the basis for evaluating the system-wide effectiveness of TSM efforts.
>
> Specific projects developed with Federal funding support usually are closely monitored. Funding support at the metropolitan level for data collection and monitoring is somewhat more difficult to realize. The many demands the Federal Government has placed on MPO's to satisfy planning requirements has made it difficult to allocate the needed resources to system performance monitoring.
>
> I would tend to view this [system monitoring] as an integral element of any urbanized area's transportation planning process. The inclusion of system monitoring as a "TSM procedure" is open to some discussion. The more critical question, however, is whether an urbanized area has "in place" a mechanism for evaluating both overall system performance and the more specific advantages and disadvantages of new and innovative techniques.
>
> [Our] monitoring program consists mainly of traffic counts....
>
> The issue of system monitoring has been on the minds of all the transportation planners involved in TSM. Two things seem to get in the way: one is staff limitations. Only in the past two years has TSM been assigned as an ongoing responsibility (the first-year TSM was prepared by an ad hoc Task Force). Staff assigned to TSM have that added to their other responsibilities, rather than as a full-time duty. The second problem is state of the art. Good monitoring and evaluation techniques are not always available and where they are, often involve extensive data collection (surveys, counts, etc.). This data collection is often much more costly than implementation of the original project and cannot be justified to department decision-makers.

In essence, these statements are saying that monitoring is an important component of TSM planning, especially for innovative projects, but that there are administrative and financial limitations to developing a monitoring program at the scale needed to evaluate a TSM program on a regional basis. This means that any attempt to develop a monitoring program must not only consider the type of technical support data needed but also must keep in mind that these administrative and financial constraints have to be addressed if the program is to be successfully implemented.

What role does monitoring have in TSM planning? There are several functions that a monitoring program should perform in a TSM planning process:

1. Project design and preparation—This is the movement of a specific action from proposal to implementation. It includes preparing a functional design to meet specified objectives, refining it to a detailed design, securing approvals for implementation from appropriate agencies and, with respect to all these steps, arranging for the necessary technical services.
2. Project execution—This is the actual construction of the project or its implementation by a series of official actions. Agency services lent for its continued operation also fall into this category.
3. Project performance—This includes measurements that determine the achievements and impacts of a project, either individually (of special interest for innovative TSM projects) or in combination with others, to determine overall program effects (9-11).
4. System performance—These are measurements that show the condition of the entire transportation system, with special emphasis on conditions affected by TSM actions. These are the background data for TSM planning.

It is of course very easy to say that a monitoring program should be established that addresses both project and system performance but quite another thing to suggest how this is to be accomplished. To do the latter requires a general awareness of the existing system of data collection and the organizational responsibilities for carrying it out. Thus, let us begin by discussing in general terms what monitoring should be.

MONITORING AS A DECISION SUPPORT SYSTEM

In examining any planning process, the most important question, one that must be asked right at the start, is, What type of information is needed to reach a decision? The type of information needed quite clearly depends on the type of decision that is to be made, and the effectiveness of a decision is many times closely related to the comprehensiveness and comprehension of this information. At the project implementation level, the type of decision that occurs includes changing specific characteristics of the project to reflect new conditions or terminating the project because it has not achieved its original purpose. Thus, the performance of a high-occupancy-vehicle (HOV) lane implemented to provide time savings for transit or ride-sharing vehicles should be monitored to see whether it has indeed been successful in reducing travel times. However, if the ultimate objective of such a project is to encourage automobile drivers to change their style of commuting, a survey to determine whether such changes have occurred would

then be necessary. On the other hand, an HOV lane could be serving its main purpose effectively (as shown in collected data) while at the same time causing serious adverse impacts on the highway system of which the project is a part. An example of this would be an increase in the number of accidents that could be related directly to the project. If monitoring is to be really useful in this case it should be directed toward providing information not only on what is happening (e.g., the increase in the number of accidents) but also on why it is happening (e.g., insufficient physical separation between lanes) so that remedial action can be taken.

At the program and system performance level, the decisions to be made become less tied to details of specific projects and more related to general indicators of how well we are doing. How to allocate limited resources among a set of transportation programs becomes the overriding issue and, for this decision to be made, information must be available that can illustrate those areas (or efforts to attain regional objectives) where additional resources are needed. Thus, indicators of system performance, e.g., vehicle travel (VT) or transit ridership, are critical.

Information gathering and handling thus has a significant influence on the decision-making process. Presenting too much information, however, is liable to burden the decision makers with too many facts and figures, while insufficient information runs the risk of missing factors that could be crucial to the outcome of the decision (12). Can viewing the monitoring process as a means of supporting decisions provide us with any useful insight as to how monitoring should be done and who should do it? The remainder of this paper will argue that it indeed does.

A focus on information handling and how it affects decision making is largely found in the management literature. Decision support in this context implies the use of computers to (13, 14)

1. Assist managers in their decision processes in semistructured tasks;
2. Support, rather than replace, managerial judgment; and
3. Improve the effectiveness, rather than the efficiency, of decision making.

The procedures for decision-support systems are similar to but in some ways distinct from other approaches using management information systems, operations research, and management science. An important distinction is that a decision-support framework characterizes organizational activities in terms of the types and levels of decisions involved, i.e., the same distinction as made above for the development of a monitoring methodology. The information needs for each type of decision differ according to the accuracy of the information; its level of detail; time horizon; frequency of use; and sources, scope, type, and age. Each of these criteria would be a useful variable to consider in the formulation of a monitoring program. For example, decisions on whether TSM actions should be modified or ended require relatively accurate information as compared with longer-range actions in which the decision maker is dealing with uncertainty and often ill-defined variables. Also, because the time horizon for the implementation of TSM actions is so short, the frequency with which the information must be gathered and used is greater than that for the information gathering associated with long-range planning and decision making. A TSM-oriented monitoring program should also rely on a well-defined and narrow set of variables aimed specifically at certain types of actions, whereas the scope of information for long-range planning and decision making would typically be very broad.

A theme developed in the overview paper by Lee and Meyer for this conference provides a useful point of departure in relating TSM planning and decision making to the type of information needed from a monitoring program. In this paper, a distinction is made between "strategic" TSM planning (which focuses on systemic, intermodal effects and the achievement of regional goals and objectives) and "tactical" TSM planning (which is more concerned with localized, intramodal transportation problems). By far the most common example of TSM planning is found in the tactical category, although one should be quick to point out that there are not one but many TSM processes throughout the United States. Further, TSM has become a conceptual touchstone for many different processes, ranging from air quality planning to being a source of leverage in furthering urban development objectives.

In developing a monitoring program, the type of decisions and planning associated with the TSM actions, i.e., whether they are strategic or tactical in nature, will greatly influence the structure of the program and the type of information needed. What would be the structure of a monitoring program in the case of strategic TSM planning? In the case of tactical TSM planning? And what elements of each can be combined into a monitoring program that will rely on the strengths of both approaches? Two types of monitoring programs are described below—one that examines the structure of such a program in a strategic TSM planning process and one that looks at the role of monitoring in a TSM process based solely on tactical planning. In each case, the types of information needed and the responsibilities of the respective agencies are specifically addressed.

Monitoring in a Strategic TSM Planning Process

In a strategic TSM planning process, the major purpose of monitoring is to provide the information needed to relate the effectiveness of the TSM program to regional goals and objectives. Implicit in this approach is the development of measures of effectiveness (MOEs) that can be used to evaluate the individual TSM actions in light of their impacts on regional goals. Because the scope of such a monitoring program is at the regional level and cuts across modal operations, the MPO must take the lead role in developing the format for data collection and establishing the decision-making process in which the information is to be used. The operating agencies such as the transit authority or highway department will collect information on TSM projects for which they are responsible. The information will then be forwarded to the MPO, where it will be used to determine the particular effectiveness of any individual strategy in regard to regional goals and objectives and also to evaluate the overall effectiveness of the TSM program.

The key to this monitoring program is that MOEs can be developed that are (a) measurable and (b) easily related to the goals and objectives of the transportation program. These measures are the basis for predicting effectiveness before implementation and by surveillance afterwards. MOEs thus provide "the basis for a TSM information system which can be the foundation on which a continually improving program of TSM action implementation can be built" (15). Two measures that have been used in the past to determine TSM program effectiveness include regional vehicle occupancy and person travel (5, 6). To accurately assess changing commuting patterns, however, a continuing program to monitor

carefully selected sites at regular intervals is necessary. Variations in the data collected, such as those accounted for by season, must be adjusted for. This information, along with that from the TSM strategy-specific monitoring, will then be considered in decisions to change specific components of the TSM program.

A strategic TSM planning process thus implies that the MPO will play a significant role in directing the monitoring program for the region, not only in developing the format for data collection but also in assigning responsibilities for monitoring activities to the various agencies. Further, the type of information gathered will not only relate to specific TSM strategies but also attempt to measure on a regionwide basis the effectiveness of a TSM program. This means that one of the first tasks in developing a strategic monitoring system is to identify those MOEs that will be used as criteria for determining TSM program effectiveness. Monitoring can then be conducted on a continuing basis to collect the information necessary to determine attainment of goals and objectives. One modification of this approach is to design the monitoring program on a corridor-by-corridor basis, which will allow TSM planners to structure the data-collection procedures to address the specific travel characteristics of each corridor. This information can then be aggregated in such a way as to obtain some estimate of the regional effectiveness of the TSM program.

An example of the relationship between TSM goals and objectives and MOEs is shown in Table 1, and similar matrices could be developed for the entire set of TSM tactics that are appropriate for a metropolitan area (16). The role of monitoring in this strategic framework is to gather the information needed to relate the MOEs to the attainment of specific TSM objectives. Information such as average delay per vehicle, number of accidents per million vehicles, and volume-to-capacity ratios are best obtained from the agency responsible for implementing the specific tactic. The role of the MPO is to take this information and relate it to strategic TSM objectives to evaluate the overall effectiveness of the TSM program.

Table 1. Measures of effectiveness for various traffic operations tactics.

		Characteristics of MOEs by Tactic				
TSM Objective	MOE	1: Intersection Widening	2: One-Way Streets	3: Turn-Lane Installation	4: Turning Movement Lane-Use Restrictions	5: New Freeway Lane Using Shoulder
Travel time	Point-to-point travel time		Avg travel time between selected locations within project impact area during peak and off-peak periods	Same as tactic 2	Same as tactic 2	Same as tactic 2
	Vehicle delay	Avg delay for all vehicles during peak and off-peak periods, measured for each approach	Avg delay for all vehicles during peak and off-peak periods measured by direction over project impact area (also, at intersections, see tactic 1)	Same as tactic 2	Same as tactic 2	Avg delay for all vehicles during peak and off-peak periods, measured by direction over project impact area
	Vehicle stops	No. of stops for all vehicles, measured for each approach	Avg no. of stops by direction over project impact area (also, at intersections, see tactic 1)	Same as tactic 2	Same as tactic 2	Same as tactic 2
	Vehicle hours of travel		Vehicle hours of travel within project impact area during peak and off-peak periods	Same as tactic 2	Same as tactic 2	Same as tactic 2
Safety	Accidents	Annual no. of accidents by type and severity within project limits	Annual no. of accidents by type, severity, and location within project limits	Same as tactic 2	Same as tactic 2	Same as tactic 2
	Accident rate	No. of accidents per million entering vehicles	No. of accidents per unit no. of vehicle kilometers	Same as tactic 2	Same as tactic 2	Same as tactic 2
	Freeway incidents					No. of incidents per day by type, severity, duration, and direction
Comfort and convenience	Parking accumulation		No. and percentage of parking spaces occupied by location within project impact area			
	Vehicle delay	Avg delay for all vehicles during peak and off-peak periods, measured for each approach	Avg delay for all vehicles during peak and off-peak periods, measured by direction over project impact data (also, at intersections, see tactic 1)	Same as tactic 2	Same as tactic 2	Same as tactic 2
Reliability	Variance of avg point-to-point travel time		Variance of avg point-to-point travel time as described above	Same as tactic 2	Same as tactic 2	Same as tactic 2
	Freeway incidents					No. of incidents per day by type, duration, and direction
Capacity	Level of service	Level of service corresponding to the volume-to-capacity ratio defined below	Same as tactic 1	Same as tactic 1	Same as tactic 1	Same as tactic 1
	Volume-to-capacity ratio	Ratio of peak-hour traffic volume to capacity at selected locations within project limits	Same as tactic 1	Same as tactic 1	Same as tactic 1	Same as tactic 1

Monitoring in a Tactical TSM Planning Process

In a tactical TSM planning process, the major purpose of monitoring is to gather data on existing system or facility performance and relate them to specific actions to be taken by individual agencies. In this approach, no attempt is made to gauge the effectiveness of a regional TSM program because, by definition, the TSM program consists of the separate planning activities of individual agencies. The MPO will attempt to coordinate these planning activities but, with specific regard to monitoring, has a very small role to play. At best, it can play an active role in the planning, monitoring, and evaluation of innovative or regionally oriented projects, i.e., projects that do not currently fall under the jurisdiction of any particular agency.

One of the more advanced monitoring approaches in this category (and indeed one that is closely related to transportation system monitoring in a strategic process) is the concept of a system performance indicator. There has been considerable attention given in recent years to the development of performance indicators, especially in the transit industry (17, 18). These indicators, which give the transit operator some information about the level of effectiveness and efficiency at which the system is operating, include (19)

1. Total ridership,
2. Ridership per route kilometer of service,
3. Ridership by category of rider,
4. Ridership per vehicle kilometer,
5. Ridership per vehicle hour,
6. Ridership per capita,
7. Ridership per employee, and
8. Ridership per dollar of cost.

Some efforts are currently under way to automatically collect bus passenger boarding and alighting and travel time information by route segment for each trip. The transit information system concept, for example, which is being tested in Cincinnati, uses wayside bus locators, on-board passenger-counting equipment, and real-time transmission of data via radio to a central computer, where the information is edited and put in report form for use in service planning and scheduling (20).

Efficiency indicators relate units of cost or work to units of service or other types of output, e.g., mechanics per vehicle, vehicle kilometers per operator, annual kilometers of service per vehicle, costs per hour, costs per rider, or costs per passenger kilometer.

In most cases, what distinguishes these indicators from those used for strategic planning is that they are not used to determine system impact on regional objectives relating to such factors as air quality, congestion, mobility for the elderly and the handicapped, energy, center city development, and quality of life. The monitoring program is aimed solely at obtaining information that can be used by transit managers and highway officials to determine the performance characteristics of the particular transportation system for which they are responsible.

In summary, monitoring in a tactical TSM planning process involves defining a limited number of key data items that can be measured efficiently and used as basic input for routine planning decisions, the identification of appropriate data-collection techniques, and the development of a sampling plan for their application. Design of the monitoring phase requires answering nine questions:

1. What data are needed for effective planning?
2. Which items can be measured directly at reasonable cost and which are better measured through surrogates?
3. What level of accuracy is needed in the measurement of each data item?
4. What is the variability in each data item?
5. What are the possible data-collection techniques?
6. What data can each technique provide?
7. What combinations of techniques can provide all the required data?
8. What sample sizes are required for each data item, given its underlying variability and the desired accuracy?
9. What is the minimum cost combination of techniques?

For certain planning decisions, the data collected in the monitoring phase will not be sufficient; in this case, it will be necessary to gather additional data.

DEVELOPMENT OF A MONITORING PROGRAM FOR TSM PLANNING

Clearly, a TSM monitoring program should reflect both the institutional responsibilities for planning and implementation and the technical capabilities to successfully carry out the monitoring process. The minimum level of effort for an effective TSM monitoring program should attempt to satisfy the following objectives:

1. To provide information on system problems that can be treated by TSM measures;
2. To provide advance knowledge of the relative merits of alternative TSM actions;
3. To alert agencies to the fact that their participation is on display and thereby generate pressure toward the advance of their respective proposals; and
4. Perhaps most important, to provide an output on which to base the overall TSM strategy.

There are several ways by which monitoring activities can assist in strategy development. For example, monitoring can distinguish the impacts of particular actions on various objectives—reduction of VT, increase of passenger throughput, increase of local amenity, and such—to aid in balancing the trade-offs among objectives. Similarly, monitoring can lead to increased understanding of the cumulative consequences of TSM actions. Indications are mounting that, although overall objectives can be listed and the projects that tend to accomplish them can be identified, the real question is the extent to which such projects really serve the objective after, say, 10 years of implementation. Estimates of future cumulative impacts give the impression that the payoff will be disappointingly low. This is not surprising. When objectives and the means of achieving them are not analyzed in relationship to one another, it is understandable that the more-convenient, nominally relevant actions will constitute the majority of those proposed.

By far the largest number of TSM actions planned and implemented in any area are those that proceed naturally through an operating agency's planning, design, and implementation procedures. The decisions regarding these projects are made internal to the organization, and monitoring project performance is necessary only to the extent that more information is needed to make these routine decisions. Aggregate information, such as total ridership, should be given to the MPO planners so that a regional data file can be kept on all system components. There are other types of TSM actions, however, that require a planning and decision-making process that cuts across established agency responsibilities. Such actions are usually regional in scope, require the par-

ticipation of several jurisdictions, are not the sole responsibility of any one agency, and are typically considered an innovative application of a new or modified service concept.

Thus, there are several types of actions that must be carefully monitored. These are actions that show a variety of characteristics: (a) the prospect of substantial positive effects (compared with the costs involved) is uncertain or in need of demonstration to some participants or interested observers; (b) the avoidance of excess negative impacts is not ensured or must be shown; and (c) the system of implementation is experimental and may need to be changed. Typical TSM actions falling into these categories include

1. Service improvements—such as subscription buses or vans, shared-taxi services, park-and-ride lots, and coordination at transfer points;
2. Preferential treatments—such as with-the-flow or contraflow bus lanes, ramp bypasses, and signal preemption;
3. Pricing and fare-collection policies—such as bridge tolls, area licensing, parking strategies, special fares, and no-fare services;
4. Institutional changes—such as staggered work hours; and
5. Amenity improvements—such as automobile-restricted zones, pedestrian malls, and transit malls.

Most of these innovations are normally monitored under agency operating procedures by that organization responsible for implementing the action. Thus, many of these actions may not be part of a TSM monitoring process focused on a regional program. Also, the level of controversy and the degree of impact of each type of action are sure to differ among metropolitan areas, which makes it difficult to determine which projects are prime candidates for monitoring. In Boston, for example, an automobile-restricted zone and a park-and-ride project have become prime candidates for the TSM monitoring process. At one time in Atlanta, a ramp-metering project was the focus of regional attention. One can imagine, given recent experience, that preferential lanes on freeways could be subject to detailed monitoring in southern California.

Once a TSM project of one of these types has been implemented, several types of decisions that require information on project performance will eventually be necessary. First of all, one must ask, What impact is this project having on the behavior of travelers or on the ability of the transportation system to handle a changed demand? Second, What aspects of the project can be changed to result in a more desirable impact? And third, Is it feasible to implement this type of project in other parts of the metropolitan area? The type of project monitoring needed to obtain the information for answering these questions thus has two components: (a) a periodic collection of data for use in modifying the project concept during the initial period following implementation and (b) a collection of information needed as input to a full-scale evaluation. This latter task attempts to determine the existence and magnitude of changes in such attributes as congestion, vehicle occupancy, transit ridership, and air quality; to measure the extent of the changes attributable to the project; and to identify those characteristics or factors that reinforce or mitigate the changes. Thus, some of the information gathered for these projects will be project specific and chosen by the operating agency, while other information (especially on effects on regional objectives and feasibility analysis) will be standardized by the MPO.

Because these types of projects require interagency coordination and also necessitate an attempt to relate project performance to regional goals and objectives, the MPO should play an active role in evaluating them. The MPO, in cooperation with the relevant operating agencies, must agree during the formulation of the evaluation-study design who will be responsible for collecting the necessary information and what will be done with it once collected. In the case of regionally relevant TSM projects, the MPO should be directly responsible for their evaluation, although it can rely mainly on the operating agencies to collect the needed data.

Thus far, the monitoring program proposed in this paper is probably very similar to that which currently exists in most metropolitan areas. As discussed above, however, one of the most important outputs of monitoring could be in distinguishing the impacts of particular TSM actions on various TSM objectives. This could be done by a carefully designed monitoring program. For example, the idea of establishing monitoring posts on the major routes into an urban area and then attempting to relate the results to the effectiveness of a TSM program would be, from an experimental design point of view, most ineffective. So many factors external to the transportation system itself influence travel behavior that it would be almost impossible to determine the cause-and-effect relationship between a TSM program and transportation system performance. Also, to make any conclusion meaningful, the monitoring techniques and statistical measures used to measure the impact would have to be extremely precise and the mere cost of such a program would most likely be prohibitive. Finally, in most cities, there is no such thing as a TSM program. Clearly, system performance must be monitored and VT, transit ridership, vehicle emissions, vehicle occupancy, and other measures should be closely watched to identify trends, but this type of monitoring should be part of the overall transportation planning process, rather than only for a TSM program.

One way to address these issues is to adjust the scale of monitoring to the level of analysis that occurs in TSM planning. Whereas it is very difficult to determine on a regional basis what impact the TSM program is having on system performance, focusing on subareas or corridors could allow a planner to draw conclusions about the effects on travel behavior and the environment of specific TSM strategies in that corridor. By focusing on a corridor, one can largely avoid the problem of events in other areas of the region affecting the variables that are being measured. Also, the effects of TSM strategies are much more easily discerned when the boundaries of the study area are reduced to include only the immediate impact area. Finally, a corridor-based monitoring program can tailor the monitoring procedures and data gathered to the specific characteristics of the corridor. In corridors where transit ridership is high, it makes sense to include in the program some measures of transit system performance, whereas in corridors that have low levels of transit service, it makes greater sense to emphasize other measures.

The question of corridor-based monitoring highlights an important consideration in developing a TSM monitoring program—How should monitoring procedures be tailored to the size of an urban area? Clearly, the approach suggested above for a minimum TSM monitoring program applies for any size city, i.e., the operating agencies monitor the projects that are internal to their own organization and report system performance measures to the MPO, while the MPO takes the lead in evaluating systemwide, innovative, intermodal TSM projects. In small and medium-sized cities, however, focusing on corridors may not make as much sense as looking at the

regional level. Furthermore, the impact of TSM projects in small cities is probably much greater than the impact of similar projects in larger cities.

The key concept in developing a monitoring program for any size city is that the information to be gathered must be related to the directions that have been set for transportation planning. In large cities, where the problems are complex and severe, an extensive monitoring system will be necessary. Thus, the extent to which goals and objectives in small cities are different from those in large cities is the extent to which the emphasis in their monitoring programs is different.

Because the information that is gathered from data collection activities is used in making decisions about project and program implementation, it should be easily comprehended and relevant to the decision-making situation. It is, however, infeasible to suggest in this paper a format that should be used for reporting the results of TSM monitoring, although a format should indeed exist. At the minimum, each project evaluation or corridor monitoring report should provide information on specific TSM MOEs, if for no other reason than to provide a basis for comparison between strategies. These TSM measures should be related to the established regional goals in that they will give some indication of which goals and objectives are being addressed.

CONCLUSION

Monitoring the performance of the transportation system and the impacts of individual actions is the key to an effective TSM planning process. This has been recognized by most TSM planners, and a wide range of monitoring processes have been established. Any monitoring program should be designed to provide the information needed to make decisions about specific projects and also should rely, to the extent possible, on the existing capabilities of agencies within the metropolitan area.

A large number of the TSM projects planned, designed, and implemented each year need not be the concern of a TSM monitoring program or of an MPO involvement. Aggregate information on system performance, however, which includes the summed impacts of all the individual projects, should be forwarded to the MPO. However, projects that are regionally significant should be monitored closely by both the MPO and the operating agencies, so that modifications can be made during initial implementation to improve service performance and evaluations can be conducted to determine the feasibility of this type of project in the metropolitan area.

In summary, then, the TSM monitoring program for a metropolitan area should have the following characteristics:

1. Those TSM actions that have been the responsibility of operating agencies in the past and have no significant impact on the regional transportation system will be monitored only to the extent that the operating agencies need additional information to make decisions about future project implementation.
2. Regional projects and those that do not fall naturally under the purview of one agency will be monitored in a cooperative manner by the MPO and the relevant operating agencies. The evaluation of these projects will include MOEs that relate closely to the stated TSM goals and objectives and will thus serve as a basis of comparison between TSM projects.
3. System performance indicators, on a regionwide basis, will be used to monitor the performance of the transportation network and identify trends in travel behavior. This monitoring activity will be part of the ongoing transportation planning process for the metropolitan area. Efforts to relate TSM program effectiveness with system performance must be carefully designed so that causal relationships can be clearly established.
4. When appropriate, corridor-based monitoring systems will be used in those corridors where TSM actions are being implemented. The results of this monitoring will be used by MPO staff to determine which TSM goals and objectives are being addressed. This implies that a standard set of measures will be used in all TSM evaluations in each metropolitan area.

This proposed monitoring program very much depends on the willingness of MPO and operating agency staffs to cooperate in gathering and using the needed information. This program is designed to reflect the existing institutional relationships in most metropolitan areas and is thus one attempt to determine what is feasible given these constraints. By no means is it the only alternative. There are probably as many different approaches to monitoring as there are cities in the United States. One thing is certain, however—the monitoring of system performance and of individual actions forms a strong foundation for transportation, and specifically TSM, planning.

REFERENCES

1. Guide for Traffic Volume Counting Manual. Federal Highway Administration, Transmittal 96, March 1970.
2. Wilbur Smith and Associates. Guide to Urban Traffic Volume Counting. Federal Highway Administration, Oct. 1975.
3. Creighton, Hamburg Planning Consultants. Data Requirements for Metropolitan Transportation Planning. NCHRP, Rept. 120, 1971, 90 pp.
4. TRB. Proposed Urban Transportation Data Reporting Requirements for States and Metropolitan Planning Organizations, National Academy of Sciences, 1976.
5. R. Ferlis. Field Data Collection and Sampling Procedures for Measuring Regional Vehicle Classification and Occupancy. TRB, Transportation Research Record 701, 1979, pp. 1-6.
6. M. Lester, J. Dare, and W. Roach. Techniques for Monitoring Automobile Occupancy: Research in the Seattle Area. TRB, Transportation Research Record 701, 1979, pp. 7-15.
7. R. Gakenheimer and M. Meyer. Transportation System Management: The Record and a Look Ahead. Urban Mass Transportation Administration, Rept. WP-77-8, Jan. 1978.
8. M. Meyer. Review of TSM Planning and Procedures Around the Country. Proc., Seminar on TSM—Policy, Procedure, and Practice, Metropolitan Sections of ASCE and ITE, New York, May 15, 1978.
9. C. Heaton, C. McCall, and R. Waksman; Caci, Inc. Evaluation Guidelines for Service and Methods Demonstration Projects. Transportation Systems Center, Cambridge, MA, Urban Mass Transportation Administration, Rept. MA-06-0049-76-16, Feb. 1976, 187 pp. NTIS: PB 251 891/8SL.
10. Systan, Inc. An Experimental Design Plan for the Evaluation of a Preferential Lane on the Santa Monica Freeway. Urban Mass Transportation Administration, 1975.
11. J. T. McQueen, D. M. Levinsohn, R. Waksman, and G. K. Miller. Evaluation of the Shirley Highway Express-Bus-on-Freeway Demonstration Project. Urban Mass Transportation Administration, Rept. UMTA-DC-06-0110-75-1, Aug. 1975, 184 pp. NTIS: PB 247 637/2SL.
12. D. Wilson and J. Schofer. Decision-Maker-Defined

Cost-Effectiveness Framework for Highway Programming. TRB, Transportation Research Record 677, 1978, pp. 1-6.
13. P. Keen and M. Morton. Decision Support Systems, an Organizational Perspective. Addison-Wesley Publishing Company, Inc., Reading, MA, 1978.
14. R. Anthony. Planning and Control Systems: A Framework for Analysis. Harvard University Press, Cambridge, MA, 1965.
15. S. Lockwood, A. K. Gilbert, and F. A. Wagner. Evolution of the Transportation Systems Management Process. Paper presented at the 58th Annual Meeting, TRB, 1979.
16. JHK and Associates and Peat, Marwick, Mitchell, and Company. Recommended Measures of Effectiveness for TSM Tactics. Office of Research, Federal Highway Administration, Working Paper 7, Nov. 1977.
17. G. Fielding, R. E. Glauthier, and C. A. Lave. Development of Performance Indicators for Transit. Urban Mass Transportation Administration, Rept. CA-11-00-14-78-1, Dec. 1977, 132 pp. NTIS: PB 278 678/8SL.
18. J. Attanucci, L. Jaeger, and J. Becker. Bus Service Evaluation Procedures: A Review. Urban Mass Transportation Administration, Rept. MA-09-7001-79-1, March 1979, 227 pp. NTIS: PB 296 314/8SL.
19. A. C. Burke, B. I. French, D. J. Pearl, and K. A. Perry; Public Technology, Inc. Transit System Productivity: An Information Bulletin of the Transportation Task Force of the Urban Consortium for Technology Initiatives. Office of Research and Development Policy, U.S. Department of Transportation, Rept. DOT/TST-77-8, Mar. 1977 (rev. ed., July 1978). NTIS: PB 268 593/1SL.
20. O. Bevilacqua, R. Knight, J. Schmidt, W. Wade, and R. Waksman; Sage Management Consultants, Inc. Evaluation of the Cincinnati Transit Information System. Transportation Systems Center, Cambridge, MA, Urban Mass Transportation Administration, Rept. MA-06-0060-79-1, Aug. 1979, 123 pp. NTIS: PB 300 355/5SL.

Results of the Workshop

Cochairpersons: Ralph Gakenheimer, Department of Urban Studies and Planning, Massachusetts Institute of Technology, Cambridge, and Harvey R. Joyner, Barton-Aschman Associates, Inc., Washington, D.C.
Recorder: Michael L. Halladay, Transit and Traffic Engineering Branch, Federal Highway Administration

The objectives of this workshop were to develop a transportation planning process that places emphasis on transportation system management (TSM) activities and to examine the important relationship between TSM and major national goals. Initial discussion focused on the three resource papers and their identifications of issues in TSM methodology—Gilbert's paper, which investigated a new approach to packaging TSM actions; Hamburg and Lathrop's paper, which proposed a methology in which TSM is integrated into the overall transportation planning process; and Meyer's paper, which described a monitoring and evaluation system that could serve as the foundation for a TSM process. Several observations were made that served as important points of departure for the remainder of the discussion. First, we decided that measures of effectiveness (MOEs) must be considered critical components of any TSM methodology but must also be easily understood and measurable. These MOEs should be related to the goals and objectives of the transportation planning process (although some workshop participants pointed out that there is often a significant difference between stated and operative goals and objectives).

The second point considered relates to the opening comments by Orski and the somewhat different interpretation by Hamburg and Lathrop. We agreed that regionalism has been viewed for a long time as a panacea for the many transportation problems facing urban areas and that, in most cases, it has not served that role. However, we also believe that there are ways to deal with both regional and subarea-local concerns in a planning methodology. The methodology developed by Hamburg and Lathrop attempts to do just that.

Finally, the need to relate the methodology to the level and types of decisions to be made is an important starting point for the development of that methodology. As illustrated by Meyer, the structure of a monitoring system, when considered as a decision-support system, is very much affected by the type of decision environment assumed.

What are the problems faced by TSM planners and what are the characteristics of a methodology that could solve some of these problems? We noted that, since its introduction in 1975, TSM has had an important positive effect on urban transportation. It has taken an active role in shifting the national focus from high-capital approaches to meeting transportation needs to greater consideration of low-capital solutions to such needs. In this way, it has emphasized the better management of existing transportation resources as a new focus for dealing with urban transportation problems. This focus on management has brought new options to the transportation planner and given new life to actions that have been little used in the past. Such actions as pricing, ride sharing in various forms, parking constraints, and priority treatment of high-occupancy vehicles allow us to make better use of existing facilities. The need to consider these and other management-oriented transportation actions has required new professional skills in the transportation field, and traffic engineers, transit operators, transportation planners, and others have learned to work together more closely, which has produced a better appreciation of others' abilities.

Because of its emphasis on management of resources, TSM has led to greater sensitivity to the need of working within a context of continually changing goals and limited resources. TSM has involved new agencies and interest groups in a coordinated approach to transportation problem solving. Government agencies at the local, state, regional, and federal levels are working with private interests in such areas as ride sharing and transit operations on a scale unforeseen a few years ago. Finally, TSM has created new constituencies for supporting transportation programs through the new services it provides and its emphasis on resource management.

There are problems, however, that compromise the potential effectiveness of TSM and that must be addressed. The TSM process is still plagued by institutional conflicts concerning the relative roles of the various agencies involved and their competing directives. Related to this problem of roles is the frequent lack of metropolitan leadership and effective implementation of actions. Inadequate funding and barriers to effective programming have caused many promising TSM actions to be shelved. Some agencies continue to complain of the lack of personnel adequately trained for working in a multimodal-system management-oriented context. Similarly, administrative red tape is cited by many as a serious impediment. Others cite the problem of effectively monitoring implemented TSM actions to determine their workability and worth. Perhaps the most vexing problem has been that of defining the limits of TSM as a planning process and its appropriate relationship to the broader comprehensive transportation planning process. Questions that need to be asked in this regard include, How are short-range actions differentiated from long-range ones? Are there geographical limits on TSM planning? How do the short- and long-range planning processes mesh?

To take advantage of the benefits that have accrued from the TSM experience and to help address the problems cited above, we propose the following reorientation of the urban transportation planning process. This includes

1. Identification of the requirements for a comprehensive transportation planning process in which TSM actions play a major role;
2. Description of the specific elements of the overall program development process—planning, programming, implementation, operations, and monitoring and feedback—in relation to the characteristics of the new process; and
3. Discussion of the implications of this proposed process on existing processes, the types of actions considered, the ability of a metropolitan area to respond to constraints imposed on the transportation system, and the institutional relationships for transportation management.

REQUIREMENTS FOR A COMPREHENSIVE NEW PROCESS

A successful comprehensive transportation planning pro-

cess must respond to the problems discussed above and have at least the following characteristics:

1. The constraints on mobility must be recognized: As discussed by Deen, the overall goals of transportation planning in the United States are dominated by mobility as a central objective—which is supported by Americans at so many levels to be virtually a cultural objective. Other concerns—energy, air quality, the environment, safety, and so forth—are principally constraints in the quest for mobility. But they are increasingly important constraints and could become much more so on short notice. The process must be able to cope with this.
2. The scope of the process must be comprehensive: The planning and implementation of TSM actions should be a part of the total, areawide transportation planning process, not a separate process. This helps to force real trade-offs among options and eliminates artificial distinctions about what is or is not short- or long-range and what is capital-intensive and what is not.
3. TSM-type actions should be prominent among all options considered: The process must not drown TSM in planning, but rather should infuse the entire process with the action-oriented spirit and the kinds of actions that are the thrust of TSM.
4. The process must not be a top-down approach: The operators and the private sector often have the clearest ideas of where the problems are. These groups must be intimately involved in the process of defining problems and evaluating candidate solutions. Indeed, the process should be characterized by consensus building among a wide variety of actors and should concentrate on local and corridor needs, as well as including areawide needs.
5. The process must start with the existing system and its problems: Devising massive, regionwide alternatives, as some older planning processes have tended to do, will not work. We must start with what we have and work from there.
6. Solutions and analysis levels must be scaled to problem levels: Many problems can best be dealt with at the regional scale, but many others are more appropriately handled at the local or corridor level. The solutions and the analysis methodologies used to evaluate the problems must be at the scale that will best serve, and be used by, the appropriate agency.
7. The process must encourage nonconventional actions and implementors: The focus should be on management of system elements, with operational improvements and entrepreneurial initiatives considered along with conventional capital projects. Management of travel demand by positive response to consumer needs is as important as supply of transportation facilities.
8. Other federal programs must be tied into the process: Many of the constraints under which the planning process must operate are embodied in the requirements of federal agencies unrelated to transportation (e.g., U.S. Departments of Energy and of Housing and Urban Development, Environmental Protection Agency). These planning requirements need to be melded into a comprehensive transportation planning process.

ELEMENTS OF THE PROCESS

In discussing the development of a methodological approach to transportation planning, we determined that such a methodology must not be divorced from other important elements of the overall process, i.e., programming, implementation, operations, and monitoring and feedback. The characteristics of these elements and the problems faced by transportation professionals in each element must therefore be considered in developing the process.

Planning

The suggested process unifies regional and subarea demands, long-range and short-range needs and capital-intensive and low-cost improvements, actions, and policies. It is the means by which our stated requirements can be met.

The approach has three kinds of activities:

1. Establishment of a regional context within which detailed subarea plans can be developed (this activity involves several tasks—the articulation of regional goals and objectives; an assessment of the urban setting, including an examination of growth in population, employment, and transportation-sensitive variables; and the identification of regional TSM actions);
2. Development of subarea transportation policies, plans, and actions within the constraints of regional growth, funding opportunities, and transportation actions (these include initiatives by local governments, operating agencies, and private interests, as well as subarea planning by the regional agency); and
3. Synthesis of an overall regional transportation plan from the policies and plans developed for each of the subareas of the region and their reconciliation with regional actions.

The layout of the activities of the process is simple, but the content is ultimately complex. Clearly, successful linkage of regional and local actions requires activities that to some extent occur in sequence. In reality, however, many subprocesses occur simultaneously. The need to stimulate positive actions and cope with their need for prompt attention when opportunities are presented has to be respected. Responsive programming is particularly necessary.

We believe that this approach could represent a significant extension of the planning process. Earlier approaches to regional transportation planning have proposed construction programs that have ignored detailed traffic engineering alternatives and other complementary actions for coping with local transportation problems. These capital programs were typically to be implemented by the state with the major share of funds coming from the federal government. A specific town or jurisdiction was expected to solve its local transportation problems on its own, but the ability of a jurisdiction to handle its own transportation needs without considering its setting within the region and the impacts that regional growth and transportation plans could have on its transportation system was at best limited.

The major tasks in each of the three activities are summarized in Table 1 of Hamburg and Lothrop's paper.

Programming

Guidance of the programming step may need development beyond that offered by the transportation improvement plan because the process proposed here makes special demands. Candidate projects, in line with the expanded participation, will be presented by a wide variety of local agency and private-sector sponsors. It will be necessary to consider trade-offs very carefully and with a view toward their consequences to these numerous institutional participants. The funding pattern that determines which of the projects are in competition will be a complex one. In addition, many important proposals will lack strong sponsors or interested constituencies.

Implementation

Implementation is also complicated by the plurality of the process. There are many different implementors participating at the same time. Types and scales of projects will be substantially different from one to the next. Under these circumstances, the monitoring of implementation is particularly important and must be adjusted to the different project objectives and the sensitivity of regional goals to project achievements. It must also be considered that some options will require quick action if benefit is to be obtained from them. This is particularly true of opportunities made possible by private-sector interests.

Operations

In this process, operations is in a single context in which high- and low-capital projects occur as part of a managed system change. The need is to keep an accounting of the changing costs of services and of the changing constraints on resources available. Services must be kept in perspective with other uses of funds.

Monitoring and Feedback

The suggested planning process investigates alternative investments, policies, or courses of action in a manner responsive to public goals, welfare, and needs. Monitoring, both of systems performance and the consequences of individual transportation actions, is a vital component of this process; it provides the information necessary for making decisions on future investments, policies, or courses of action or in altering those that have already been undertaken. Yet, it is especially difficult because the variety of types of actions, the numerous implementors, and the widely different scales of application mean that an intricate set of measures, actors, and ways of summarizing the monitoring data will be required.

Many TSM actions are implemented in a localized context for which regional level monitoring is impractical or simply so coarse that any detectable effects are obscured. The choice of monitoring technique and procedural design must therefore be adapted to the action and to the anticipated results. The sheer scale of the monitoring efforts for such diverse and numerous actions and policies mandates a shared (and coordinated) responsibility for monitoring, as well as a clear procedure for summarizing or aggregating the effects of these policies.

If planning, analysis, and evaluation of disparate projects are to be successful, a small number of meaningful MOEs must be identified and presented for each action or policy. These MOEs must recognize different kinds of objectives for the transportation system. The efficiency of operation (e.g., revenue service hours per vehicle), the effectiveness of the system (e.g., passengers per revenue service hour, delay at intersections), and the performance of the system relative to nonsystem objectives (e.g., energy consumption relative to other activities, total cost, safety, emissions) must all be carefully monitored.

Finally, the monitoring process must be carefully designed to provide feedback to each of the steps in the overall process: operations, implementation, programming, and planning.

IMPLICATIONS OF THE PROPOSED PROCESS

This is a process intended to integrate TSM into a comprehensive transportation planning process. We feel that it meets the need to expand and intensify the effect of TSM as it matures and improves the way in which the transportation planning process is approached. Although it retains the thrust and spirit of the TSM program and the content of actions presented to the field, it puts these actions into direct relationship with others, packaged as best to meet the needs of the problem to be solved. The new process includes a bottom-up emphasis in which local actions are synthesized with regional level actions and is guided by regional objectives in the selection of particular actions by local government, operating agency, and private-sector actors. It integrates the long and short ranges into a flexible activity, where evaluations of performance can be addressed to any time horizon. It extends the planning process to a number of actions not normally included in such processes, e.g., transit operations and flextime, and deals with them in a management context. The management focus of TSM is projected into the entire planning process. It is a process that is flexible with respect to the incorporation of new balances between goals and between goals and constraints and in line with anticipated requirements arising from issues such as energy conservation. In knitting the whole transportation process together again, it is prepared to respond to change in a way that a more segmented process could not.

IMPLICATIONS FOR CHANGES IN STATUTES AND REGULATIONS

The proposed process also has implications for the federal statutes and regulations that now govern TSM and other aspects of transportation planning. Although conclusions were not reached in this workshop on whether and how these statutes and regulations should be changed, the following important questions were raised.

1. Should there be a change in the roles of federal, state, metropolitan, and local governments and the private sector in the planning process (as defined in the statutes and regulations)?
2. Should the statutes and regulations governing nontransportation programs (e.g., energy use) be revised to require designation of the metropolitan planning organization (MPO) as the planning institution?
3. Should the regulations be simplified to reduce documentation and procedural requirements and so facilitate undertaking a process such as we propose?
4. Should the funding for planning now coming from several categorical programs (e.g., U.S. Department of Transportation, Environmental Protection Agency, Housing and Urban Development) be consolidated into a single federal program to fund comprehensive planning? Or, conversely, should a new categorical planning funding program for TSM be created?
5. Should the channels of funding for capital programs (e.g., highways and transit) be revised, e.g., sending all funds through the MPO to ensure plan implementation, channeling more of the capital funding directly to local agencies, channeling more (or all) of the funding through the states?
6. Should the current regulatory distinction of TSM and long-range planning as separate elements be dropped?
7. Should all federal agencies issuing regulations affecting TSM be required to issue a single comprehensive regulation?
8. Should certification acceptance replace federal procedural requirements?
9. Should national goals be translated into quantified objectives (e.g., there are national ambient air quality standards, but no nationally fixed energy reduction targets)? This might make them more satisfactory as input into a planning process responsive to several at once.

Participants

C. M. Abrams, JHK and Associates, San Francisco, California

W. G. Barker, North Central Texas Council of Governments, Arlington
P. N. Bay, Tri-Met (Tri-County Metropolitan Transportation), Portland, Oregon
R. J. Benke, Minnesota Department of Transportation, St. Paul
W. D. Berg, University of Wisconsin, Madison
R. H. Bradley, Connecticut Department of Transportation, Wethersfield
M. L. Brooks, Urban Mass Transportation Administration
A. C. Burke, Office of the Secretary, U.S. Department of Transportation
C. H. Buttke, Carl H. Buttke, Inc., Portland, Oregon

L. Canner, University of Massachusetts, Amherst
E. J. Cantilli, Polytechnic Institute of New York, Brooklyn
E. McC. Casebeer, Office of Transportation Administration, Metropolitan Dade County, Miami, Florida
D. L. Christiansen, Texas A&M University, College Station
L. Cobb, Dallas Chamber of Commerce, Dallas, Texas
N. L. Cooper, Office of the Secretary, U.S. Department of Transportation
P. C. Cosier, IV, U.S. Environmental Protection Agency, Philadelphia, Pennsylvania
K. C. Crowley, Pennsylvania State University, University Park

T. B. Deen, Alan M. Voorhees and Associates, McLean, Virginia
J. J. DeShazo, Jr., Young, Hadawi, DeShazo, Inc., Dallas, Texas
H. Doo, Office of the Secretary, U.S. Department of Transportation
V. Dugonjic, Massachusetts Institute of Technology, Cambridge

G. Euler, Federal Highway Administration

J. L. Foley, Jr., Federal Highway Administration
E. J. Foreman, Federal Highway Administration, Fort Worth, Texas
C. Fuhs, Metropolitan Transit Authority, Houston, Texas

R. Gakenheimer, Massachusetts Institute of Technology, Cambridge
A. L. Gausmann, Wisconsin Department of Transportation, Madison
A. K. Gilbert, Transpo Group, Bellevue, Washington
A. T. Gonseth, Port Authority of New York and New Jersey, New York

J. Goodman, Urban Mass Transportation Administration
D. W. Gwynn, New Jersey Department of Transportation, Trenton

M. L. Halladay, Federal Highway Administration
J. R. Hamburg, John Hamburg and Associates, Inc., Rockville, Maryland
L. M. Harris, Urban Mass Transportation Administration
R. E. Heightchew, Henningson, Durham, and Richardson, Washington, D.C.
J. O. Hibbs, Federal Highway Administration

D. W. Jones, Jr., University of California, Berkeley
H. R. Joyner, Barton-Aschman Associates, Washington, D.C.

R. W. Kelly, City of Dallas, Dallas, Texas
D. R. Koski, City of Minneapolis, Minneapolis, Minnesota
C. A. Krouse, Committee on Public Works and Transportation, U.S. House of Representatives

G. T. Lathrop, John Hamburg and Associates, Chapel Hill, North Carolina
J. Layden, Allright Auto Parks, Inc., Houston, Texas
D. M. Levinsohn, Office of Transportation and Land Use Policy, U.S. Environmental Protection Agency

M. Manheim, Massachusetts Institute of Technology, Cambridge
G. E. Maring, Federal Highway Administration
D. A. Maxwell, Texas A&M University, College Station
A. D. May, University of California, Berkeley
C. H. McCann, San Antonio Metropolitan Transit Authority, San Antonio, Texas
W. R. McGrath, Raymond, Paris, Pine, and Weiner, Inc., Tarrytown, New York
M. D. Meyer, Massachusetts Institute of Technology, Cambridge
D. A. Morin, Federal Highway Administration

C. K. Orski, German Marshall Fund, Washington, D.C.

J. Reightler, Regional Planning Council, Baltimore, Maryland
M. Replogle, Public Technology, Inc., Washington, D.C.
J. J. Roark, PAWA, Inc., Dallas, Texas
T. K. Ryden, North Central Texas Council of Governments, Arlington

L. Samuelsen, Urban Mass Transportation Administration
J. Schneider, University of Washington, Seattle
James A. Scott, Transportation Research Board

G. A. Shunk, De Leuw, Cather, and Company, San Francisco, California
E. L. Simm, Department of Traffic and Transportation, Miami, Florida
W. O. Somerfeld, Madison Department of Transportation, Madison, Wisconsin
R. P. Steinmann, Urban Mass Transportation Administration

R. Taube, Metropolitan Transit Authority, Houston, Texas
W. Travers, Travers Associates, Clifton, New Jersey

D. R. Troiano, New Jersey Department of Transportation, Trenton

H. Volk, Middlesex County Planning Board, Belle Mead, New Jersey

T. Watson, North Central Texas Council of Governments, Arlington
W. A. Wild, Regional Transportation District, Denver, Colorado
David K. Witheford, Transportation Research Board