Performance Measures to Improve Transportation Systems and Agency Operations

Report of a Conference

CONFERENCE PROCEEDINGS 26

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Performance Measures to Improve Transportation Systems and Agency Operations

Report of a Conference

Irvine, California
October 29–November 1, 2000

Committee for the Conference on Performance Measures to Improve Transportation Systems and Agency Operations

Sponsored by

Transportation Research Board
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Contents

General Overview

Introduction

Executive Summary

Conference and Proceedings Format

Opening General Session

Introduction

The genesis of the Conference on Performance Measures to Improve Transportation Systems and Agency Operations detailed in these proceedings goes back nearly a decade to the growing interest (and often the debates) that surrounded the development and use of performance measures to guide investment decisions at all levels of government. Several factors have encouraged this trend toward using performance measures in transportation planning and programming, including

- Desire to increase the accountability of public expenditures,
- Need to communicate results to customers and to get their support for investments by focusing on results in the face of reduced resources, and
- Responsiveness to federal and state statutes.

The Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) and the Transportation Equity Act for the 21st Century (TEA-21) directed a focus on performance by articulating planning factors, encouraging (and sometimes requiring) management systems, fiscally constraining capital improvement programs, and linking the plans to these programs, while many state legislatures moved toward performance-based budgeting. Simultaneously, there has been a strong aversion by many transportation professionals to have the dialogue on transportation performance controlled by people who do not have direct responsibility for the system. Responding to this trend of growing interest in the topic, the Transportation Research Board (TRB) and transportation agencies throughout the United States and abroad have actively explored performance measures, and important research has been completed. Although an enormous amount of experience has been gained, the Conference on Performance Measures to Improve Transportation Systems and Agency Operations afforded practitioners the opportunity to share experiences and address issues that impede the development of practical and useful performance measurement systems and processes.

The Subcommittee on Performance Measures of the TRB Standing Committee on Planning, Programming, and System Evaluation has long provided a forum for the theory and application of performance measurement. Because the topic can be very broad and far ranging, a focus for the conference was defined at a workshop during the January 1999 TRB annual meeting. Attendance at the workshop—more than 150 participants—far exceeded expectations. Workshop participants believed that the conference should focus on using performance measures for transportation investment decisions, but with a clear understanding that organizational performance (including program delivery) must be considered. Discussions also made it clear that the conference should consider all modes and deal with multijurisdictional issues as well. Finally, the conference focused on applying performance measures to system outcomes relative to investment decisions. Not only is there a lot of work yet to be done on this topic; many other areas of performance measurement also warrant the same level of investigation.

The contributions of the conference committee and the conference participants were critical to the success

of this event. The committee, cochaired by Lance Neumann and Sandra Straehl, developed the conference program. The full committee is listed on page ii. There were many more program participants than can be individually recognized in this preface; their contributions appear in these *Proceedings*. The committee and the Transportation Research Board also would like to acknowledge the following contributors to this event: the Federal Highway Administration, the National Transit Institute, and the American Association of State Highway and Transportation Officials.

These *Proceedings* were prepared by Henry L. Peyrebrune. The presentations, resource papers, and summaries of views expressed by conference speakers, panelists, and participants are included to provide a record of the conference. The views expressed do not necessarily reflect the views of the committee, TRB, the National Research Council (NRC), or the sponsors of the conference.

This report has been reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise, in accordance with procedures approved by NRC's Report Review Committee. The purpose of this independent review is to provide candid and critical comments that will assist the institution in making its published report as sound as possible and to ensure that the report meets institutional standards for objectivity, evidence, and responsiveness to the charge. The review comments and draft manuscript remain confidential to protect the integrity of the deliberative process. We wish to thank the following individuals for their review of this report: Ken Cervenka, North Central Texas Council of Governments; Bradley L. Mallory, Pennsylvania Department of Transportation; and Theodore H. Poister, Georgia State University.

Although the reviewers listed above have provided many constructive comments and suggestions, they did not see the final draft of the report before its release. The review of this report was overseen by Lester A. Hoel of the University of Virginia, Charlottesville. Appointed by NRC, he was responsible for making certain that an independent examination of this report was carried out in accordance with institutional procedures and that all review comments were carefully considered.

Executive Summary

In October 2000, more than 120 transportation and planning officials gathered in Irvine, California, for the Conference on Performance Measures to Improve Transportation Systems and Agency Operations. The objective of the conference was to bring together a group of government, academic, and business leaders who had experience in transportation systems performance measures and performance-based planning and programming to address

- Organizational approaches to implementing and using performance measures in transportation systems, including the connection between measures and decision making;
- Implementation experience regarding the state of the practice as well as lessons and guidelines for moving forward;
- Customer perspectives of transportation system performance;
- Application of multimodal measures in the planning process and the assessment of system performance; and
- Technical issues involving data, number and type of measures, and trade-off analysis.

The conference was organized around four main topics:

- Linking performance measures with decision making;
- Implementing transportation system performance measures in agencies;
- Selecting measures, data needs, and analytical issues; and
- Connecting system performance measures to broader goals.

(Note: The third general session was split into two parts: a general discussion of the topic that was attended by all participants and a discussion of technical aspects that was attended by a smaller group of participants.) In addition, a session was dedicated to a roundtable discussion of issues related to freight performance measures.

A brief synopsis of some of the major points discussed at the conference follows.

Overarching Themes

- Increasing demands on, broader goals set for, and limited resources available to transportation agencies have encouraged the development of performance measurement programs.
- Expectation for accountability of all governmental agencies (e.g., the Washington, D.C., report card and the Texas Transportation Institute Urban Mobility Report) is growing.
- Performance measures are not a fleeting trend but a permanent way of doing business that eventually will be used at all levels of transportation agencies.

Developing a Performance Measurement Program

- The first consideration in developing a performance measurement system should not be data selec-

tion. Instead, experience shows the importance of first identifying the goals and objectives to be addressed by the performance measures.

• Performance measures must be integrated into the decision-making process; otherwise, performance measurement will be simply an add-on activity that does not affect the agency's operation.

• Buy-in from customers, stakeholders, decision makers, top management, and front-line employees is critical for initial acceptance and continued success of the performance measures.

• The presentation of performance measures data must be carefully designed. The information must be easily understood, and the data analysis and presentation must provide the information necessary to improve decision making.

Defining Performance Measures

• No one set or number of performance measures will fit all agencies.

• Performance measures can include input (e.g., dollars per mile of pavement), output (e.g., number of miles resurfaced), or outcome (e.g., improved pavement smoothness).

• Performance measures should be based on the information needs of decision makers and should address the goals of both the agency and the larger community.

• One successful design is a set of nested performance measures. A small set of strategic performance measures used by the entire agency and top management is developed for the operating arms of the agency, and these measures could be developed in greater detail at the task level.

• The nested design helps all employees in the organization see themselves in the big picture.

• Performance measures should be easily understood.

• The set of measures should not be defined by what data are readily available (e.g., vehicle miles traveled, average travel times). Difficult-to-measure items, such as quality of life, are important to the community. The one caveat to this point is that transportation professionals should not be held responsible for conditions beyond their control. This concern may limit the participation of many transportation agencies.

• Reasonable performance measures can be incompatible. For example, improving travel times and reducing congestion can be achieved by adding roadway capacity and improving vehicle flow through intersections. These two actions, however, also can decrease pedestrian safety and lower the perceived quality of life. Conflicting goals and related performance measures are inevitable, but they should be explicitly recognized, and techniques for balancing these interests should be available.

• The level of detail and the reporting cycle of the performance measures must match the needs of the decision makers.

• Building performance measures around customer surveys and input is generally not sufficient. Customers tend to focus on improvements to the current system. So agencies must temper customer surveys with actions that support their roles as stewards of the transportation infrastructure.

• It is not necessary to begin with a comprehensive performance measurement program. Many agencies have been successful in beginning slowly, with a few measures, then building on initial successes.

Maintaining Performance Measurement Programs

• Feedback on and assessment of the performance measurement programs are essential. Although a stable set of measures applied over several years is ideal, the measures used to track progress must change as the goals of the agency and society change.

• Continued commitment throughout the organization is critical.

• One of the most difficult hurdles to sustaining a performance measurement program is a change in elected officials (such as governor or mayor) and the resulting change in agency administration. Successfully weathering this type of change is especially difficult if the performance measures have been developed in conjunction with a broad group of stakeholders.

Underlying Data Issues

• It is important to optimize the use of existing or easily accessible data.

• It is important to use multimodal or mode-neutral performance measures.

• Sharing data between transportation agencies is important to achieving multimodal measures. Sharing data will require some level of agreement on data definition and geographic units.

Next Steps and Research Recommendations

• Clarify terminology of performance measures.

- Fund the synthesis of best practices and other mechanisms to share experience.
- Research new measures, in particular
  - –Soft measures such as quality of life,
  - –Mode-neutral measures, and
  - –Systemwide measures.
- Identify strategies to better use existing data.
- Develop techniques to balance or weigh competing goals and measures.
- Provide staff training on performance measures, data collection and analysis, and presentation techniques.

Conference and Proceedings Format

The Conference on Performance Measures to Improve Transportation Systems and Agency Operations was held October 29 through November 1, 2000, at the Beckman Center in Irvine, California. The invitation-only conference was cosponsored by the Transportation Research Board (TRB), the National Transit Institute, the Association of State Highway and Transportation Officials (AASHTO), and the Federal Highway Administration (FHWA), which provided the primary funding for the conference. The more than 120 transportation and planning officials who attended were academics; consultants; and representatives from state departments of transportation (DOTs), metropolitan planning organizations (MPOs), transit authorities and operators, FHWA, national organizations, and city transportation agencies. The mix of representation allowed for a lively exchange of viewpoints. The title of these proceedings has been changed from the original conference title to reflect the limited discussion of the use of performance measures to influence agency operations.

Background

The need for a conference on performance measures was identified by several TRB technical committees. Representatives of these committees were on the steering committee for the conference and were instrumental in establishing the scope and objectives of the conference.

Conference Objective

The objective of the conference was to bring together a group of government, academic, and business leaders who have experience in performance measures for transportation systems as well as performance-based planning and programming to address

- Organizational approaches to implementing and using performance measures in transportation systems, including the connection between performance measures and decision making;
- Implementation experience regarding the state of the practice as well as lessons and guidelines for moving forward;
- Customer perspectives of transportation system performance;
- Application of multimodal measures in the planning process and the assessment of system performance; and
- Technical issues involving data, number and type of measures, and trade-off analysis.

Agency operations were addressed in the context of how operations affect performance measurement programs or how these programs can affect operations and decision making.

Conference Format

The conference steering committee and sponsors developed a format that afforded participants an op-

portunity to participate in several ways, as described below.

Tutorial Workshops

The conference began with two tutorials. The first was a presentation on the results of National Cooperative Highway Research Program (NCHRP) Project 8-32(2)A, "Multimodal Transportation: Development of a Performance-Based Planning Process," by Cambridge Systematics. A copy of the final report of the study, *NCHRP Report 446: A Guideline for Performance-Based Transportation Planning,* was provided to each conference participant.

The second tutorial was National Databases Available to Support Performance Measures. Several national databases were reviewed, including the Highway Performance Measurement System (HPMS), the National Transit Database (NTD), and the sources and services provided by the Bureau of Transportation Statistics (BTS).

Poster Sessions

The steering committee solicited the agencies invited to the conference to prepare poster presentations that documented their experience with the use of performance measurement. Twenty agencies prepared poster presentations and sent personnel to explain and discuss them. Time was available throughout the conference to view the poster presentations, collect literature, and share experiences. The poster session presentations are summarized in Appendix A.

Resource Papers

Four resource papers were commissioned by the conference steering committee:

- "Use of Performance Measures in Transportation Decision Making," by Steven Pickrell and Lance Neumann of Cambridge Systematics, Inc.;
- "Implementing Performance Measurement in Transportation Agencies," by Hal Kasoff of Parsons Brinckerhoff Quade & Douglas;
- "Transportation Data and Performance Measurement," by Doug Dalton, Joseph Nestler, John Nordbo, Bob St. Clair, Ernest Wittwer, and Mark Wolfgram of the Wisconsin Department of Transportation; and
- "Measuring That Which Cannot Be Measured —At Least According to Conventional Wisdom," by Michael Meyer of the Georgia Institute of Technology.

Copies of these resource papers were provided to the conference participants and are included in this proceedings document.

General Sessions

Participants gathered to hear presentations and to discuss issues and ideas in five general sessions. The topics of the general sessions were

- Linking Performance Measures with Decision Making;
- Agency Implementation of Transportation System Performance Measures;
- Selecting Measures, Data Needs, and Analytical Issues;
- Connecting System Performance Measures to Broader Goals; and
- Freight Performance Measures.

The first four general sessions consisted of a resource paper presentation and a panel discussion (three or four panelists commenting on the resource paper and presenting views on the subject, followed by an open question-and-answer session involving all of the participants). The third general session was split into two parts: a general discussion of the topic that was attended by all participants, and a discussion of technical aspects that was attended by a smaller group of participants. The fifth session was a roundtable discussion on issues related to the movement of freight and various approaches to developing freight performance measures.

Workshop Sessions

Each participant was assigned to one of eight workshop groups. The groups were established to include various types of agencies, organizations, and geographic locations. The workshop groups stayed together for the entire conference. After the four primary general sessions, the workshops convened to discuss four aspects of the general topic:

- State of the practice,
- Issues (related to the topic),
- Opportunities and constraints (related to improving the state of the practice), and
- Next steps (future actions and research needs to advance the state of the practice).

Each workshop group designated one member as the reporter of the workshop's conclusions on each of the four topics. The eight reporters for each topic met during the conference to prepare a summary report on the four aspects of the topic. The workshop reports were completed before the conference ended and were presented briefly at the closing session. The complete reports are included in this proceedings volume as Workshop Summaries. No summary was prepared for the Freight Performance Measures session; however, a summary of the general sessions is provided.

Conference Proceedings Format

This proceedings volume is organized according to the format of the conference. It includes the major elements of the conference:

- Four resource papers;
- Panel discussions on each of the papers, including summaries of the general discussions that followed the panelist presentations;
- Workshop summary reports from four workshop sessions on
  - –State of the practice,
  - –Issues,
  - –Opportunities and constraints, and
  - –Next steps;
- Summary of the freight performance measures session;
- Summary and conclusions of the general sessions; and
- Appendixes
  - –Summary of the 20 poster sessions, including the name and address of the agency contact person (Appendix A, page 155);
  - –Report of the statewide planning committee "peer exchange" session on performance measurement held in Madison, Wisconsin, in August 2000 (Appendix B, page 198);
  - –Research statements developed by the statewide planning committee as a result of the peer exchange meeting (Appendix C, page 214); and
  - –List of conference participants (Appendix D, page 216).

Opening General Session

Lance Neumann, *Cambridge Systematics, Inc.*
Sandra Straehl, *Montana Department of Transportation*
Tony Harris, *California Department of Transportation*

Opening Remarks

Lance Neumann and Sandra Straehl

First of all, thank you to our four conference sponsors. We also compliment the work of the steering committee and the TRB staff, particularly Jim Scott, Tom Palmerlee, Kim Fisher, and all their staffs for the conference structure and logistics.

Let me give you just a quick summary of the meeting. You are all here because you have interest in performance measures for transportation systems. The theme and the focus is how we use performance measures to improve the product that we deliver to our customers, and that product is transportation services and facilities. This topic enjoys broad and wide interest, and attendance at this meeting certainly reflects that interest. Many of us have worked on this topic over the years. Conceptually, it is pretty straightforward: performance measures offer a powerful tool for setting objectives, focusing resource allocation decisions, measuring results, and improving accountability. However, in practice, defining and implementing performance measures is a challenging task that requires more effort and commitment than the simplicity of the concept might suggest.

So we are here to focus on where we are in terms of the state of the practice in using performance measures for transportation systems, and to define what we need to do to advance that state of the practice. Over the next couple of days, we will focus that discussion on four themes. The first theme asks how we link performance measures with decision making: How do we make performance measures have an impact on what we do? How do we decide where resources are allocated? How do we decide how to operate and manage transportation systems? How do we make performance measures relevant? and How do we make performance measures have an impact?

The second theme is assessing where we are in the process of implementing performance measures in various agency contexts and with different focuses in terms of objectives and policies. Most important, we will discuss what the barriers are, what issues you need to address as an agency to implement this concept, and what the experience to date has been in terms of the most significant impediments and barriers that need to be overcome.

The third theme focuses on the data you need to implement and support a system of performance measures. What kind of analytic tools do you need to generate those performance indicators, including forecasts of system performance with and without different kinds of transportation actions?

The fourth theme recognizes that transportation is not an end in itself. We invest in transportation to support a whole range of societal goals related to the economy, the environment, quality of life, equity, and social justice. How do we relate performance measures for transportation systems to these broader societal goals and objectives? That is ultimately what we are trying to work toward.

In addition, because interest is emerging and a lot of work is focusing on freight transportation across the country right now, we are going to have a session on defining performance measures that relate more

to the freight transportation system than to the passenger transportation system.

Those are the themes that we are going to focus on over the next few days and that we want to engage the breakout groups in discussions about. As I said, there was a lot of interest in this meeting. We had to limit attendance because we wanted to have breakout groups and because of logistical constraints with the Beckman Center. The good news is that you are the chosen few, and you should be very happy about that. The better news is that you represent a very interesting and diverse cross section of agencies and geography, representing different levels of experience in terms of using and implementing performance measures. As a result, all participants in this meeting have a great opportunity to share information, to learn from each other, and to advance our knowledge about this topic.

Finally, because of the interest in the topic, we want to create some information that we can share with the broader transportation community. In addition to giving you an opportunity to spend a few days in a nice place, have a lot of fun with a great group of people, we also are going to put you to work. We want to produce a summary of these proceedings that includes the breakout group discussions so that we can produce a conference report that can be widely disseminated.

Welcome

Tony Harris

I want to take the opportunity to welcome each of you to beautiful, sunny southern California. It never rains here. I apologize for being a few minutes late, but one of the performance measures we have been looking at is trip reliability, and my transportation was not reliable in getting here in a timely manner. I want to take the opportunity to welcome each and every one of you on behalf of Director Jeff Morales. He is a very strong advocate and believer in performance measures. As such, he has encouraged us to look at ways to identify measures and use them throughout the entire department.

We have a challenge to meet in California. The themes of this conference hit on every challenge that we are beginning to face at this point in time. We currently have a department of about 22,000 employees, and it depends on whom you talk to, but I have been told that another 15 million people are going to move to California. The resources we have for transportation obviously are not going to allow us to be able to build our way out of the impact of the projected population increase. We are going to have to find a way to better manage the system. That is really the key, where performance measurements come into place as we try to move forward with this current and future problem. We recognize that we have to not only monitor and evaluate the problem but also be innovative in anything and everything that we do with the measures that we already have.

We have been making progress in this area. A group of people has been working on trying to identify measures to help our partners, the regional transportation planning agencies, and other departments throughout the state, over the past 3 years. We recently put together a prototype report that identifies what you can measure; the measures that were identified make sense to and seem to be usable by the decision makers. The measures are important not only for our own internal operations and how we manage here in California but even more so because our decision-making process is very fragmented. We take a large portion (75 percent) of our transportation dollars and put it into the control of regional transportation planning agencies. In my job, I am very interested in performance measures and being able to provide decision makers with timely, relevant, and accurate information so they can make the best informed decisions as we begin to address the issues on our transportation system.

It is congested out there. Those of you who had the opportunity to travel a little bit, you saw that you can get where you are going, but you have to plan ahead. We also are beginning to notice in California that we have different modes, but are they well connected? That is the challenge we are facing along the way. In addition, a significant amount of the goods that come into the United States come in through California. As a result, goods movement is becoming a critical issue that we have to address.

Now that we have identified some of the measures, one of the challenges confronting us is data. Data in different areas of the state are readily accessible and available on the highway system. Data are somewhat available in some of the transit systems. Even within those areas, there are significant gaps. How do we close those gaps? How do we pull that information in and use it in a timely manner? Data are needed for the measures as we move forward, so it is going to be a major issue. Then once you have information, how do you use it? How do you communicate it? How do you get it not only to decision makers but also to the users of the system in a timely manner so they can make necessary decisions? Should the trans-

portation agency be responsible, or should it be someone else, or should it be a combination? What are the different methods for getting the different information out there?

I know I am asking you a lot of questions and not giving you a lot of answers. Well, I am hoping that you are going to give me a lot of answers over the next few days, so we can move forward and address the issues that we have in California. I believe that this is the right approach. I am a firm believer if you know what you are going to measure and you provide the information, the decision makers will make the best informed decisions and the right decisions. You have the unique opportunity to share different ideas. I cannot emphasize enough what Lance and Sandy said earlier, that it is very important that we capture all of your discussion in the breakout sessions so that we can use it, not only in California but throughout the country. Performance measures are going to be key in how we carry out our business and how we inform decision makers about our transportation needs.

Please provide us some answers to all of the questions that I asked you. You would make me a very happy man, and I will invite you back again. Thank you.

Linking Performance Measures with Decision Making

Use of Performance Measures in Transportation Decision Making

Panel Discussion

Workshop Summary

RESOURCE PAPER

Use of Performance Measures in Transportation Decision Making

Steven Pickrell and Lance Neumann, *Cambridge Systematics, Inc.*

Many transportation agencies have begun to introduce explicit transportation system performance measures into their policy, planning, and programming activities. The types of measures and methods of use vary widely from agency to agency. In some cases, performance measures define policy objectives at an early stage of policy or system planning, and in other cases, they provide the basis for an annual performance report on system conditions and performance as a communication and reporting tool. Many agencies use performance measures to help screen projects or set project priorities in the development of their transportation improvement program (TIP). Also, many agencies are beginning to explore the use of performance measures to help guide resource allocation decisions at the program level in the system planning and programming process. Of course, these applications of performance measures are not mutually exclusive. Some agencies are trying to implement performance measures in an integrated manner to set policy, allocate resources, and measure and report results. These comprehensive applications of performance measures were the focus of the recently completed National Cooperative Highway Research Program (NCHRP) research project on performance-based planning (Cambridge Systematics, Inc., 2000).

Although each agency must decide for itself where and how performance measures should be used, performance measures alone will not affect agency decision making or the effectiveness of policy and resource allocation choices. To influence decisions, performance measures must be linked to objectives and integrated into the planning, management, and decision-making processes of an agency. Although significant technical challenges are associated with defining and measuring transportation system performance, a series of management and institutional barriers also must be overcome to implement a performance measure system that really influences and guides agency decision making.

Performance measurement is being applied widely in many transportation agencies and often extends well beyond the performance of the transportation system itself. For example, many agencies define performance measures to track program and project delivery and to improve various internal agency operations and business processes. Some agencies have gone so far as to implement "pay for performance" programs to improve staff accountability and reward good performance. Although the use of performance measures in these contexts also can influence agency decisions and, ultimately, the ability of an agency to deliver transportation facilities and services, the focus is on the use of measures that directly reflect the condition and quality of the transportation system and the service it provides.

The first section of this paper is a definition of the elements of the process necessary to use performance measures to influence decisions and a summary of why agencies are increasingly interested in the use of system performance measures as a decision-making tool. Subsequent sections define several decision-making contexts within which performance measures may be applied and present some general lessons learned in working with a broad range of agencies that have begun to implement some aspect of performance-based planning and decision-making processes. Finally, some

case study examples are provided to illustrate particular findings, and overall conclusions are presented.

What Is Performance-Based Planning?

The use of performance measures to influence agency decisions, particularly policy and resource allocation decisions, involves much more than the measures themselves, although picking the "right" measures is a key element. This systematic, ongoing process (referred to as performance-based planning) must be integrated into an agency's ongoing planning, management, and decision-making processes. Figure 1 depicts a typical transportation planning process and illustrates how these steps fit into it to create a modified performance-based planning process. The following seven features and elements are common to any performance-based planning program.

Broad Goals

Broad goals are identified to describe what the agency needs to accomplish to carry out its stated mission or mandate. Transportation agencies often group their goals according to major areas of focus, for example, system maintenance, safety, or mobility. Within any of these areas, general goals are identified, such as "cost-effective highway maintenance" or "safer working conditions" (Moving Pennsylvania Forward, 2001).

Objectives

Objectives provide specificity and permit the quantification of progress toward general goals. They may be specific, clearly stating in quantifiable terms what the agency wants to achieve along each of the stated goals, for example, "reduce fatal accident rates on state roads by five percent from 1998 levels by January 1, 2002" (*Four-Year Business Plan 2000–2004*, 2000). Or they may remain more general and strategic in nature, for example, "implement prevention strategies to reduce the employee injury rate" (Cambridge Systematics, Inc., 2000). In either form, a comparison of performance data with agency objectives shows an agency how well the system is performing (now and over time); suggest future impli-

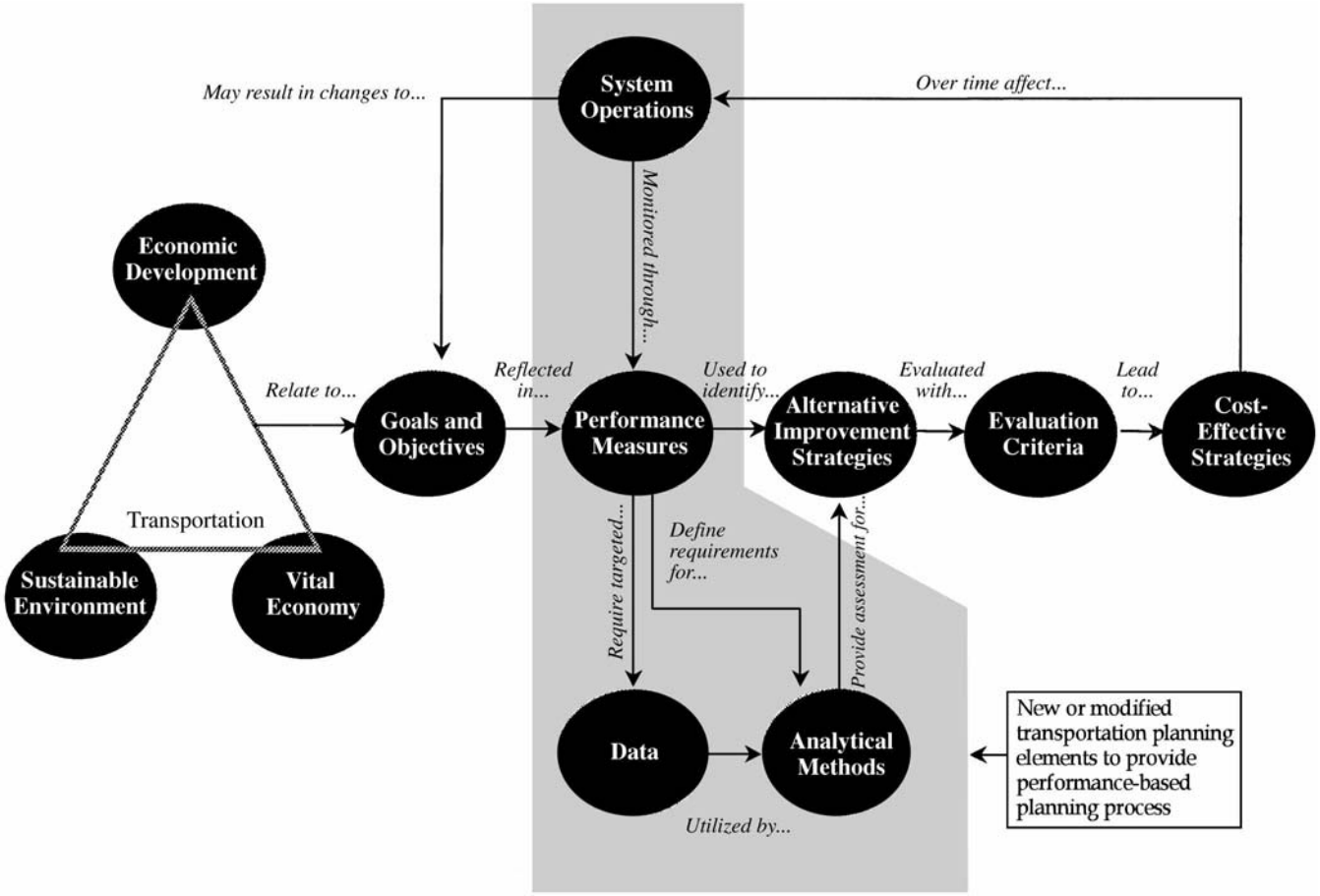


FIGURE 1 Elements of performance-based planning process (Cambridge Systematics, Inc., 2000).

cations of current or potential policies, plans, and programs; and identify opportunities for measurable improvement. Objectives must accurately reflect the overarching goals, and the desired direction or magnitude of result should be unambiguous.

Performance Measures

Performance measures should be identified in response to goals and objectives, rather than the other way around. This sequence helps to ensure that an agency is measuring the right parameters and that success on the measures will in fact lead to success in terms of goals and objectives. Performance measures are useful only in a context of clearly defined objectives that, in turn, are aligned with broad goals and an overall mission.[1] Otherwise, agencies risk spending resources on tracking unfocused measures that have little impact on performance. Examples abound of agencies and corporations having measured lots of aspects of their organizational or system performance, only to conclude later that some (or most) of the measured data do not reflect the achievement of objectives.

Analytical Methods and Data Needs

Analytical methods and data needs should be determined by what it will take to create or "populate" the desired measures. In many cases, an agency's capabilities may be limited by available analytical tools, data, and staff skills. One example is the common use of volume-to-capacity ratios to measure highway system congestion and to estimate a host of derivative measures (delay, speed, etc.). These limited measures may be used to describe an entire area of performance, such as mobility or accessibility because they are the most readily available. This situation often arises because many agencies have few predictive tools other than forecasting models for travel demand and do not have data-collection programs for travel time. Ideally, agencies will define the necessary programs of data collection and analysis that will, over time, support a more robust and descriptive set of multimodal performance measures.

[1]Federal Express Corporation, for example, has long emphasized the objective of on-time package delivery as paramount to customer satisfaction and, thus, organizational success. The company spent a great deal of effort tracking packages through its system and monitoring overall package volume before shifting its emphasis to tracking on-time delivery as the key metric and focusing operational decisions on ways to improve this critical measure.

Decision Support

Decision support is a key element in the use of information from performance measures to influence policy choices and resource allocation decisions. The measures are used to define the implications of policy or resource allocation choices so that decision makers better understand the likely outcomes of choices. The use of performance measures rarely makes these choices "easier" or automatic. However, they can inform a decision-making process and more effectively communicate the consequences of various choices. They may help improve the degree to which decision makers, staff, and the general public understand how a certain decision is reached and may improve the objectivity of the deliberation and decision-making process.

Monitoring and Feedback

Monitoring and feedback is a critical component of performance-based planning that includes the ongoing monitoring of system performance and the appropriate feedback to the planning and decision-making processes. This step is usually completed with observed data of actual system conditions and performance. Synthesized or forecasted data may be substituted for observed data in some cases, for example, where it is desirable to track the expected future outcome of an investment decision with a long-term payback period.

Communicating and Reporting Results

Communicating and reporting results is an element of the monitoring-and-feedback process. However, it is so important that it deserves emphasis. The audiences for performance-related information will vary from the agency staff responsible for delivering certain aspects of system performance to management, elected officials, and customer and stakeholder groups. The level of detail of reports may vary depending on the audience, but collectively, they are a key element in establishing accountability and providing a starting point for revising goals and objectives, performance targets, or even the measures themselves.

Why Undertake Performance-Based Planning?

Agencies have instituted performance measurement processes for various reasons: to provide better in-

formation about the transportation system to the public and decision makers, to improve management access to relevant performance data, or to generally improve agency efficiency and effectiveness. Another important consideration is the desire to improve the link between resource allocation decisions, system conditions, and performance results. The following six factors contribute to the desire to link performance data to decisions about system investment.

Accountability

Publicly funded agencies in particular have come under increasing pressure to be accountable to "owners" or "customers," however they are defined. Recent federal transportation legislation and funding programs provide increased spending flexibility to state and local agencies. Performance measurement provides a means of determining whether resources are being allocated to the priority needs that have been identified through reporting on performance and results to external or higher-level entities. The desired effect is more informed decision making by governing boards or bodies, with consequential positive impacts on results.

Efficiency

Setting performance targets that are aligned with an agency's goals and mission will help staff, management, and decision makers stay focused on the priorities and increase efficiency as a result. By helping to focus actions and resources, performance measurement may increase the level of output or outcome achieved for a given level of input. It improves internal management and the ability to direct resources when needed, to track results, and to make adjustments with greater confidence that the changes will have the desired effect.

Effectiveness

Performance measurement may help an agency to better achieve objectives that have been identified through a legitimate planning process and to improve the correlation between agency objectives and those of the system users or the general public. It reflects a shift in agency thinking away from simply output (e.g., "tons of salt applied") to outcome (e.g., "reduction in ice-related fatalities") and allows progress to be tracked explicitly. Over time, performance measurement should result in investment decisions that bring about the outcomes desired by both customers and those charged with system operation and development.

Communications

As an adjunct to accountability, a good performance-measuring program cannot help but improve communications with an agency's customer base and constituency. It requires that goals and objectives be stated in unambiguous, quantifiable terms and that relatively straightforward measures of progress be put in place.

Clarity

Performance measurement can actually improve the planning process itself by lending clarity of purpose to an agency's actions and expenditures. The process forces clear thinking about the purpose of planning and programming actions and about the purpose of repeated investment in the transportation system. If applied at a sufficiently high level within an agency's planning and decision-making structures, it also can improve internal strategic planning and the assessment of organizational directions.

Improvement over Time

Monitoring, reporting, and evaluating allow for the periodic refinement of programs and services, guided by a better understanding of the impacts of alternative courses of action and the trade-offs among those alternative choices.

Linking Performance Measurement to Decision Making

Aside from the incidental goodwill that may result from the distribution of system condition or performance information to the general public, performance measures themselves will not do much for an agency unless linked to decision making. Linking performance measurement to decision making is an essential part of implementing a performance-based planning process if the program is intended to have a substantial lasting effect.

Transportation professionals are often skeptical about the ability to significantly change the decision-making process in public agencies. Agency staff often perceive the process as overly politicized and subject to last-minute abandonment of rational choices in

favor of necessary compromises. Yet it is also apparent that the effect of changes to the public agency decision-making process can be subtle and long term. For these reasons, it is still valuable to pursue a program that provides managers and decision makers with accurate, well-organized information on system performance. The rate at which the users adopt this information into their decision-making processes will vary, as will the eventual impact of the performance information, but the process will undoubtedly be better informed and more open to discussion and debate if useful information is put on the table.

Decision-Making Contexts

Transportation system performance measures can be used within various decision-making contexts. Several of these contexts are described below.

Policy Analysis

Performance measures can be used at very high, broad levels within an agency to assist with policy making and goal setting. For example, consider a statewide multimodal transportation plan that focuses primarily on the strategic direction of the agency, policies and goal statements to be met, the implementation of actions, and desired outcomes. Even at this high level, measures can be identified that are consistent with broad policy and goals and that specify the desired outcome in unambiguous, quantifiable terms. The actual measures selected must sum up the net effect at the system level of many smaller, discrete actions. The time frame of the effect of such actions may be relatively long; measures might not show marked change until a given policy has been implemented for several years.

Planning

Another common application of performance measures is in long-range planning. State departments of transportation (DOTs) and regional agencies [metropolitan planning organizations (MPOs), councils of government (COGs), transportation authorities, etc.] maintain long-range planning activities to determine how to build and manage the transportation system to meet the stated needs and goals of the relevant customer group. The statewide and metropolitan planning process is regulated by federal law when federal transportation funds are involved.

Such processes typically occur on a 5-year cycle, with a 20-year or longer time horizon. Analysis is typically done systemwide or at the modal system level, rather than at the project or program level. They usually include analysis of long-term (20-year) system and financial needs, with the focus on attaining or maintaining long-term goals. In this context, performance measures must be sufficiently specific to permit distinguishing the effect of investment in one modal system or program of activities versus another.

Resource Allocation and Programming

Programming is the process by which transportation dollars from numerous sources and special programs are allocated to specific programs, projects, or services. As with long-range planning, where the use of federal money is involved, the process can be quite regimented given various funding programs, eligibility requirements, and geographic allocation rules. The development of statewide TIPs (STIPs) by state DOTs and TIPs by MPOs also require significant collaboration with partner agencies at other levels of government, stakeholder groups, and the general public. Notwithstanding the complexity that the programming process can involve in generating a specific program of projects, several states and MPOs have begun to apply a more structured performance measurement system to this process as well.

The objective is to give decision makers better information about the likely impact and outcome of different mixes of investment (or budget) among different programs. A common example includes the linking or integration of pavement and bridge management activities with performance measures. This provides both actual and forecast estimates of system condition at some future point that would result from a defined level of system investment and usage. In such cases as Colorado and Montana, the use of performance measures helps determine the broad program allocation of funds and provide guidance to project selection decisions. In other cases such as the Metropolitan Transportation Commission in San Francisco, performance measures have been more oriented to screening and selecting specific projects.

Trade-Off Analysis

A specific activity that performance measures have supported in the policy, planning, and programming contexts in several agencies is trade-off analysis. This analysis may involve helping to set appropriate performance targets for a policy or system plan when the trade-offs involve different elements of the system (highways versus transit) or objectives (safety versus system preservation), given varying assumptions about

the resources that may be available over some time horizon.

In the programming process, the trade-offs tend to focus on the different levels and mixes of performance objectives that can be accomplished with a given funding constraint. The use of performance measures to help define the implications of these choices and trade-offs can be one of the most powerful ways to use performance measures to influence decisions. Many agencies have learned that it is risky to commit to any performance targets until this type of analysis has been performed.

Corridor and Project-Level Analysis

Many agencies already use performance measures of one kind or another to assist with project analysis and selection. A typical example would include a major investment study (or similar corridor-based analysis) of alternative modal solutions to transportation needs in a defined corridor or a highway corridor study to evaluate and select a preferred alignment when the mode has already been determined. In either case, the time frame for results of the decision is often shorter than the planning and programming activities, and the link between the decision and the outcome is clearer.

Conversely, such actions often have limited or undetectable impact at the system level, and the measures applied must be defined and used appropriately to accurately depict performance differences between alternative solutions. The focus is often on site-specific evaluation of project benefits and impacts, and the measures should be "tuned" to that level of specificity. As noted above, agencies should strive to ensure that the objectives and measures applied to a corridor or project-level analysis are consistent and aligned with but not identical to measures and objectives used in some of the broader applications, such as planning or programming.

System Operation

Opportunities are growing for the application of real-time traffic and transit information for the operation and management of transportation facilities. Such data, collected through various stationary and mobile sensing devices, typically are focused on system operating conditions and performance rather than on a physical infrastructure condition. Two such examples are transit vehicle location data, which can be used to improve adherence to transit schedules, and highway traffic speed or density information, which can be used to detect and respond to incident-related congestion or obstructions.

There are also opportunities for using such data for planning applications. Data storage and manipulation issues must be resolved, however, before such data can be readily applied to planning or programming uses with longer time frames that require significant aggregation and parsing of real-time data. Some DOTs report that institutional obstacles, in addition to technical ones, hamper smooth transfer of data from traffic monitoring centers to planning and analysis units.

Ongoing Monitoring and Evaluation

Performance measures can be used for ongoing monitoring of capital programs or transportation services. Some state agencies and MPOs generate trends and conditions reports often for wide distribution to elected officials, opinion leaders, and the general public. In and of themselves, these status reports are unlikely to have much of an influence on decisions about resources or to move an agency closer to achieving its goals. As part of an integrated planning and resource allocation process, however, ongoing monitoring and evaluation is a critical component.

Alignment of Measures with Goals and Objectives

A system of performance measurement can be used for any of the decision-making contexts in isolation. Indeed, many states and MPOs apply the concept in one context but not in others or not across the board. However, much of the value of the concept lies in the ability to tie these different but related elements of the overall transportation planning and delivery process together in a consistent framework of planning, monitoring, evaluation, and feedback.

Performance objectives and measures can be used to tie policies, plans, programs, and projects together to achieve progress at multiple levels toward a set of broadly held goals. Figure 2 illustrates this concept, in which measures and data are necessary to address decision support needs at different levels in an organization. Data and performance measures are aligned in a way that relates to a common set of goals. Objectives may be defined with varying degrees of specificity, depending on the level of decision making to be supported. As noted previously, objectives may be strategic in nature (e.g., "reduce fatal accident rates") or program-specific ("reduce the number of alcohol-related traffic fatalities 5 percent by 2002").

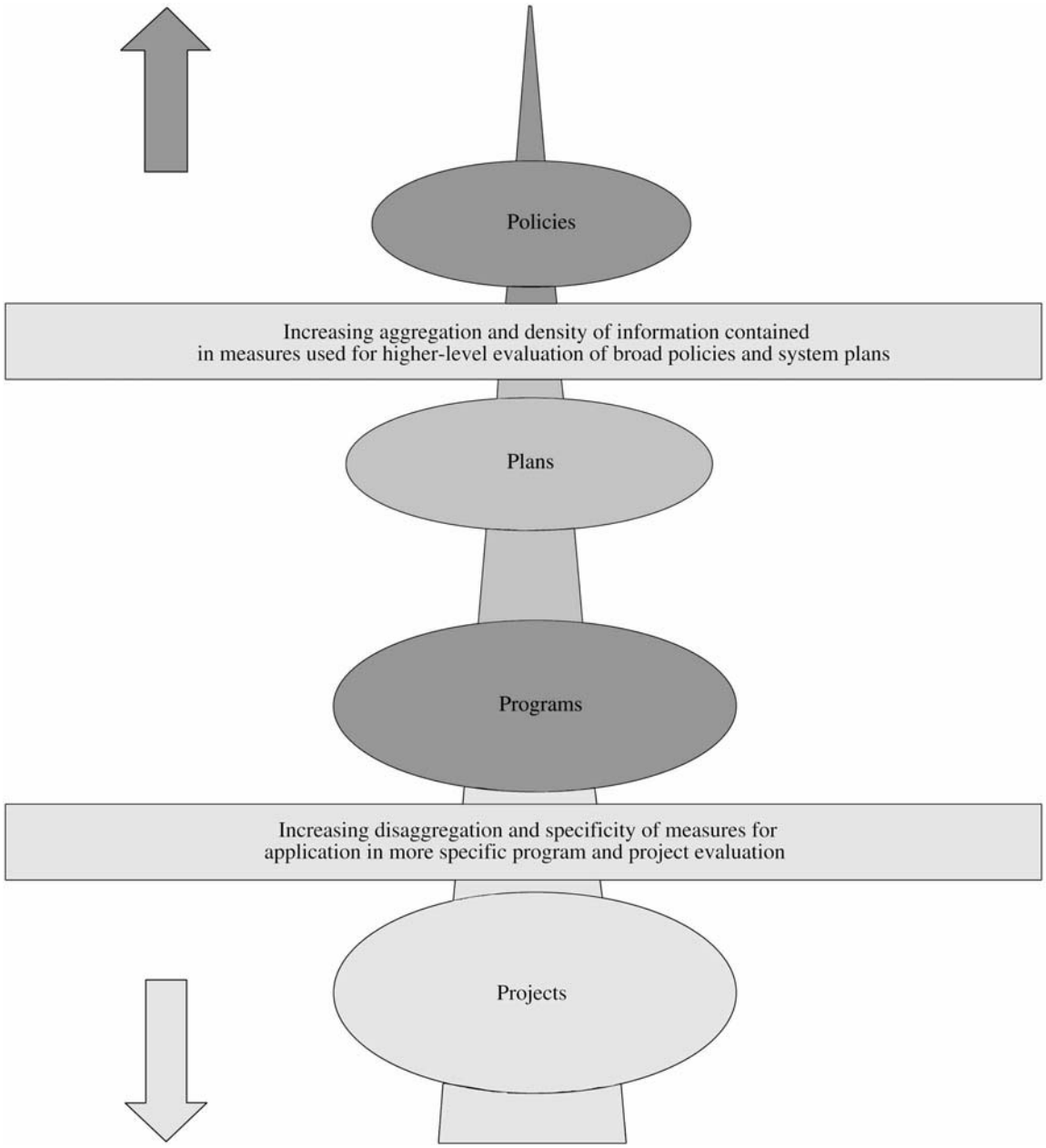


FIGURE 2 Alignment of measures with common goals.

Developing goals, objectives, measures, and analytical methods that are aligned top to bottom and appropriately detailed for different levels of decision making requires thought at each step of the way. Policies and goals must be articulated in a way that supports objective evaluation and monitoring. Are they clear statements of policy and intended outcome? Do the subsequent system plans and modal elements lay out more detailed objectives that are highly consistent with the broad policies and goals? Do the performance measurements selected at each level remain consistent with the broad goals and objectives but provide the appropriate level of detail, time horizon for results, and geographic coverage? Attention to these questions during process development will help to ensure that the information generated is useful in a decision-making context.

Implementation Guidance

A review of performance-based planning processes at numerous DOTs and MPOs offers useful guidance to integrating performance data into decision-making

processes. Some suggestions and examples of how agencies can improve their processes, measures, and data analysis to support decision making are listed below.

Process Issues

Numerous issues regarding the process of performance-based planning should be considered during design and implementation.

Set Realistic Expectations

Practitioners of performance-based planning have learned to set realistic expectations for the changes that will be brought about. This is particularly true in the area of decision making. Many agency staff have commented on the difficulty of significantly changing the process by which decisions about major transportation project and program expenditures are made. With increasingly complicated funding programs and formulas, planning regulations, and public involvement requirements, the decision-making process becomes even more difficult to track. Thus, although a logical system of performance measurement in functional areas of importance to an agency can lead to better-informed decisions, users are cautioned to be realistic about how quickly or fully the methods and data will be embraced by senior managers and elected officials.

Improve—Do Not Replace—Process

Performance measurement should be intended to improve, guide, and enhance the decision-making process rather than replace or "automate" it. Much has been said about the undesirability of creating a "black box" approach to planning or decision making. Experience and evidence suggest that overreliance on quantitative modeling will not necessarily lead to better results. In fact, practitioners have commented that in some cases, decision makers tend to overapply performance data and absolve themselves of the responsibility to apply professional judgment or take responsibility for decisions.

The emphasis should be on improving the transparency of the planning and programming processes rather than further cloaking them in quantitative language understandable to only a few. It should encourage participants to be clear about their objectives and more explicit about how they will work to achieve those objectives.

Recognize Politics

Decision making related to planning and programming is an inherently political process rather than primarily a technical one, with plenty of "wheeling and dealing" going on, both in plain sight and behind the scenes. Cities, regions, and states have developed their own unique processes in an organic fashion, modifying them incrementally over time in response to the needs and particulars of each system and constituency. This situation is likely to continue, even as agencies around the country strive to impart greater objectivity and precision to their processes.

Factors such as the composition of decision-making boards, leadership and management styles, political appointments, and term limits all contribute to a complex decision-making process that reflects the history and culture of an area. The introduction of performance measures is not likely to change this dramatically but should improve the process at the margins initially and more significantly over time.

Provide Better Information

Evaluation of decision-making structures and processes around the country reveals that there is still much interpretation and interpolation of data that goes into any process and end decision. Not only is much professional judgment required to decipher the stacks of analytical output, field observations, and financial data, but considerable political judgment is also applied before final decisions are made. Information is not always as current, complete, or accurate as might be desired, and sometimes late-breaking changes to the program or project in question are not reflected in the available data. Yet a performance-based planning and decision-making process still can bring significant useful information to the table without attempting perfection.

Add Structure to Decision-Making Process

By its nature and for some of the same reasons cited above, transportation decision making can at times devolve into a process that is less structured than is desirable. In the heat of the moment, as last-minute considerations begin to tear away at what might have been an orderly and structured process, it is common to lose sight of long-term goals and objectives. It is even easier to lose track of the inevitable connection between a short-term funding decision and long-term desired outcomes. Thus, performance measurement should add structure to the process or increase the

ability of the existing structure to stand up to the assault of late-in-the-game maneuvering.

With the appropriate structure in place, participants in the process will be more aware of the impact of their decisions on transportation goals and objectives. Performance-based planning should help to organize and tame the reams of paper and should "turn data into information." Officials will continue to make decisions that depart from the program, but at least they (and those around them) will be more explicitly aware of the trade-offs implied by those decisions.

Provide Guidance on Choices Among Alternatives

Much of transportation planning and programming these days comes down to tough choices among worthy alternative courses of action. We probably would not need such attention to the decision-making process if we had either enough money to do everything we wanted or no competing or conflicting "best" answers to a given need or problem. But the supply of money for transportation is not inexhaustible, and there is a significant difference of opinion as to the most appropriate uses for the available resources.

Performance measurement should help to better define the available choices and to articulate the trade-offs that are inherent in the choices among courses of action. To this end, additional research is under way to refine and improve processes and analytical methods for conducting trade-off analysis in a multimodal transportation environment (NCHRP Project 8-36A, 2001).

Involve Stakeholders in Process Development

Securing the involvement and buy-in of key stakeholders and decision makers is an important element of success. Those who are expected to use the process to shape and make decisions should be allowed to influence the design of the program from the beginning. Similarly, those who will be held accountable for results (who are not always the same as the decision makers) should be involved early on to ensure that they will support rather than circumvent the process or its intended outcome.

Performance Measures and Data

In addition to the process issues and considerations above, several specific considerations have to do more directly with the mechanics of performance-based planning, including the measures themselves, data, and analytical capabilities.

Limit Number of Measures

All other things being equal, fewer rather than more measures is better, particularly when initiating a program. Data collection and analytical requirements can quickly overwhelm an agency's resources. Similarly, too much information, too many kinds of information, or information presented at too fine a level of disaggregation can overwhelm decision makers. Numerous agencies and corporations report success using the smallest set of measures that provides the necessary information at the level of detail appropriate to the type of decisions supported. It is useful to imagine applying more numerous and specific measures in a programming or project selection context and fewer, broader measures when supporting the development of policy or system plans.

Make It Understandable

The process and its components must be clearly understood by the intended audience (e.g., key decision makers and the public). Measures can be more technical or industry specific when they are used to support internal decisions about, for example, the allocation of maintenance budgets to different geographic areas or programs. For example, many state DOTs maintain detailed indices or measures about pavement rutting or cracking as part of their internal evaluation and decision-making processes. When reporting information on these programs to higher-level decision makers or the general public, more generalized measures are appropriate (e.g., "percent pavement rated good or better").

Reflect Customer's Point of View

Where appropriate, the selected performance measures should reflect the point of view of the customer or system user. An agency must think about who its customers are (often, there are multiple customer groups or "market segments"), what the customers actually see of the department's activities and results, and how to define measures that describe that view. For example, the Florida DOT's Mobility Performance Measures Program uses several measures to define mobility, some of which are specifically selected to describe the quality of travel from the users' perspective [e.g., average travel speed on the state highway system and ratio of auto to transit travel

time (i.e., "how much longer or shorter would the same trip take if made on transit rather than by auto?")] (*Florida's Mobility Performance Programs*, 2000). These measures stand in contrast to more internally oriented measures of mobility, such as the average number of vehicles per lane mile (a measure of traffic density or system utilization).

Also the "customer" may not always be a user of the transportation system. Customers can include people internal to the department (e.g., managers), vendors and suppliers, and others. The point is to consider both the context and the customer audience in mind when defining measures.

Consider Time Frame

The decision-making contexts described above can have significantly different time frames, both for the making of the decision and for the effect of that decision to take place. Using performance measures to monitor the effectiveness of a policy plan requires measures that can reflect long-term changes in system usage or condition. For example, Oregon DOT uses the aggregate present value of its entire inventory of bridges on the state system as one measure of system preservation and strives to maintain that aggregate value through maintenance, rehabilitation, and replacement programs. The present value measure changes rather slowly over time and is an appropriate tool to help determine whether, over relatively long periods of time, the department's investment priorities and allocation decisions are achieving the desired objective of preserving the bridge inventory (*1999 Oregon Highway Plan*, 1999).

In contrast, measures focused on factors such as pavement condition (e.g., "percentage of miles with pavement rated fair or better") can and do change more significantly over relatively shorter time frames, depending on investment policies, maintenance practices, and even external factors such as weather and travel demand, which can have relatively short-term fluctuations.

Specify Measures

The geographic area covered by a measure varies depending on the decision-making context in which it is used. The scope of measures used to evaluate progress on broad policies and long-range planning goals and objectives often is systemwide. To be effective in a programming exercise, measures may need to be focused on a geographic subarea (e.g., highway district or region). At the corridor or project level, a specific focus on corridor performance is needed to help planners and decision makers distinguish the different outcomes between alternatives.

This same consideration applies to the underlying data as well; data must be collected and aggregated at a level of specificity appropriate to the investigation. Systemwide averages or distributions are the norm for broad policy and planning purposes as well as some programming applications; more disaggregate data are usually required for more specific applications. One obvious rule of thumb is that the measure should be just specific enough that a change in decision causes a response in the measure (i.e., "moves the needle").

Make Data Available

The ability to support measures in different applications varies considerably according to the availability of data suited to the application. Agencies may have ready access to certain data that support measures of mobility at the corridor or facility level, for example, but few data to support systemwide measures of mobility. For example, commonly collected data such as 24-hour traffic volume data or transit boardings are useful at the corridor or project level but less so at a system planning level.

The availability of data varies by system ownership as well. It is not uncommon for a state DOT to have good data on its own highway system but poor data on the rest of the multimodal transportation system, which limits the usefulness of any multimodal mobility measures. Even within one state's highway system, data availability often varies significantly by facility class (e.g., Interstate highways versus low-volume connectors).

Use Analytical Methods

The analytical methods most common to many agencies include those that have been developed over time in support of project analysis (e.g., forecasts of highway and transit demand) but are not well suited to broad policy or program analysis. The output data are not always readily aggregated to meaningful measures at the system level. Agencies need the ability to analyze data and transform it into meaningful statistics, indexes, and so forth; they also must be able to generate forecasts of future performance or conditions that would result from pending policies, programs, and projects. Several new or refined analytical models have been developed in recent years that generate cost-benefit information for various multimodal improvement strategies, travel demand management strategies, and even operational strategies such as

those commonly deployed in intelligent transportation system (ITS) programs.[2]

There always will be factors that are not fully captured in any set of measures but influence decision making. Rather than try to capture every possible variable or factor in performance data, agencies should strive to focus measurement on the key indicators of system performance and condition that are most relevant to the kinds of decisions that must be made repeatedly.

Other Common Issues and Problems

Several other issues that can affect the success of using performance measures to influence decisions must be dealt with during the implementation process.

Benchmarking

The practice of comparing an agency's performance with that of its peers or peer groups has its supporters and its opponents. Agencies that engage in performance measurement should expect this issue to arise. In some cases, benchmarking to the performance level of a group of peer agencies may help an agency to initially define what a reasonable or desirable level of performance is. It may be less useful to compare an agency with a group of agencies that are not necessarily peers. For example, a national ranking of agencies (state DOTs, MPOs, etc.) according to some broad indicators of system performance may have little utility if a true peer group has not been established or if the reasons for the differences in peer scores are reported but not well understood or explained.

Differences in condition or performance are often as much a result of divergent objectives, resources, or external factors and constraints as of agency effectiveness or efficiency. Because performance measures and objectives should be tailored to overall mission and goals, agencies can reasonably be expected to perform quite differently on standardized measures that are not derived from local goals.

[2]Examples include the surface transportation efficiency analysis model, for economic cost-benefit analysis of multimodal transportation alternatives at the corridor or facility level; the ITS deployment analysis system, for cost-benefit analysis of ITS strategies; and the highway economic requirements system, for analysis of the economic requirements and cost-benefit ratio of highway system investments. These analytical models were developed by FHWA and are generally available at low or no cost to public agencies.

Performance Targets

Defining an acceptable or desirable level of performance can be tricky. Performance targets (sometimes called "objectives" or "standards") must reflect an agency's priorities, goals, and resources. It is best to begin with a cycle of objective measurement to define the agency's current position and to conduct sufficient analysis to determine how much improvement might reasonably be expected given current or likely resource availability before setting numerical targets or objectives.

External Factors

Agencies must be aware of, and even attempt to account for, outside influences on results. There is a varying degree to which performance in different goal areas can be conclusively linked to agency actions as opposed to external factors such as population growth or economic activity. For example, many system condition measures (e.g., of pavements and bridges) are direct functions of agency practices, whereas measures of mobility or safety (which involve considerable human interaction) might be influenced more by external factors such as population growth or economic activity, which are beyond the control of the agency. In some cases, indexed rates are more desirable than absolute measures to isolate some of the external factors (e.g., fatalities per million vehicle miles of travel rather than number of fatalities per year).

Performance-Based Planning in Decision-Making Context: Examples

Although various technical and nontechnical issues must be addressed in implementing a process of using transportation system performance measures to influence agency decisions, many agencies have started this process and are seeing results. The purpose of the following brief examples is to just give a sense of the range of these applications as a background for the broader lessons and conclusions presented in this paper.

Santa Clara Valley, California

The Santa Clara Valley Transportation Authority (VTA) is the agency responsible for planning and programming transportation projects and services in Santa Clara County, California—home of northern

California's high-tech computer, communications, and electronics industries. Since the mid-1980s, county residents have supported a 0.5 percent increment to the local sales tax that helps to fund various roadway, transit, and other transportation projects and services. Because of the county's size (current population is 1.76 million) and economic vitality, the tax generates roughly $100 million annually to supplement federal and state transportation funds (*Valley Transportation Plan 2020*, 2000, pp. 5–24).

The Valley Transportation Plan 2020 (VTP 2020) is VTA's 20-year plan of transportation investments and services. Plan development began in 1997, and the draft plan was released in September 2000 for review and adoption. The plan lays out a prioritized expenditure program that defines major new projects and improvements in corridors, services, and activities. It describes which improvements have priority and the benchmarks used to measure whether VTA is succeeding over time in implementing the VTP.

The VTP prioritized list of expenditures was developed in significant part through the use of a performance-based analysis system developed by VTA. The plan offers a systematic approach to planning and programming capital projects that will be maintained through the 20-year planning horizon. The same performance-based approach that was used to develop the capital projects list is proposed for all future updates to the plan. This approach allows decisions to be made on a consistent, technically sound evaluation of project proposals and to be preceded by clear and consistent communication with outside organizations and the community. After programming decisions are made, the VTP 2020 approach promotes sustained commitments to major planned projects to secure funding and deliver the projects.

The VTP approach includes three applications of the performance evaluation methodology: project selection for the plan; project planning, programming, and delivery after the VTP is adopted; and updating and amending the VTP. The VTP performance-based process was based on eight distinct measures of system condition, capacity, and performance that include measures in the areas of mobility, accessibility, air quality, and congestion management:

- Traffic level of service, in number of miles of roadway that are deficient and defined by peak-period speeds of less than 35 mph (freeway) or 13 mph (expressway);
- Duration of congestion, in number of hours that specific segments are congested;
- Hours of delay per person trip during peak hours;
- Travel time for 10 specific origin-destination pairs for single-occupancy vehicles, high-occupancy vehicles, and transit travel;
- Modal split;
- Vehicle miles of travel and vehicle hours of travel;
- Transit accessibility, in number of peak-hour work trips served by transit with walk access; and
- Air emissions (four specific tailpipe pollutants).

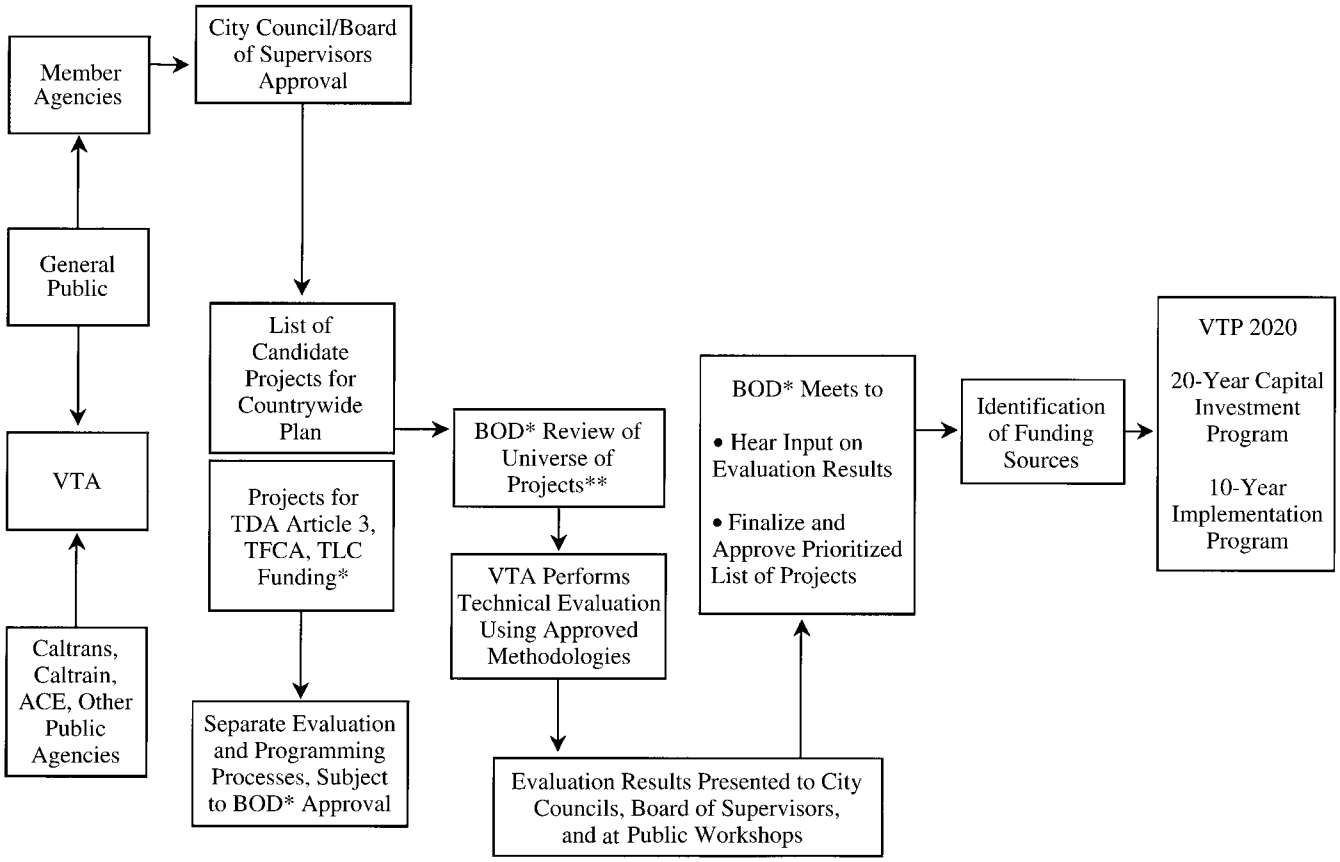
The VTA's member agencies, accompanied by broad public input, were the primary sources of projects identified for the capital investment program. VTA also conducted comprehensive planning studies of future transit, ITS, and nonmotorized transportation investments as well as land use studies during the 2 years before plan adoption. All of the projects were evaluated using methodologies approved by the authority's technical committees and directors.

Figure 3 illustrates the broad project selection process developed by VTA and the specific "location" of the technical performance evaluation step within it. Results of the technical evaluation of individual projects are presented to member agencies and the public. Presentations provide member agencies and the general public opportunity to comment on the VTA's evaluation. The VTA Board of Directors then acts with this combination of technical information and public preferences to finalize the prioritized list of projects.

After finishing the first cycle of planning and project prioritization, VTA identified the weaknesses in the process and began to refine it. One particular drawback was the relative scarcity of data to support transit-focused performance measures. The resulting transit measures were not as quantitative or as robust as those identified for the highway system, and some participants observed that this led to overattention to highway projects. VTA acknowledges that this is an incremental process in which the agency's capabilities to support decision making have been expanded and will continue to evolve. Although the selection and prioritization of projects for the expenditure plan were still highly political, without a doubt, the end results were influenced by the presentation of detailed performance information within a structured deliberation and decision process.

Montana

The Montana Department of Transportation (MDT) has been implementing a performance-based programming process (PPP) over the past several years (*Performance Programming Process*, 2000). The ini-



*Santa Clara Valley Transportation Authority (VTA) Board of Directors (BOD) action follows review and action by VTA advisory committees.
**Proposed for major funding sources such as the state transportation improvement program, Transportation Equity Act for the 21st Century (TEA-21), the next evolution of TEA-21, major earmarks, future sales tax, or bonds.

FIGURE 3 ***Valley Transportation Plan 2020*** **(2000): project selection process. ACE = Altamont Commuter Express (rail service); TDA = Transportation Development Account (state funding source); TFCA = Transportation Fund for Clean Air (state funding source); TLC = Transportation Liveable Communities Program (state funding source).**

tial motivation to implement the PPP grew out of a desire to establish a strong link between broad policy goals established in MDT's long-range system plan (TRANPLAN 21) and an investment programming process that was largely driven at the district office level.

On the basis of the broad goal categories defined by TRANPLAN 21, MDT established several working groups to develop candidate performance measures and preliminary performance targets in each goal area. The candidate measures were reviewed by the PPP implementation team, and an initial set of measures was selected for the pavement, bridge, safety, and congestion goals. The availability of data, the capabilities of various management systems or other analytical tools, and a philosophy that implementation should be incremental but start with the goal areas and programs when the department was spending the most resources all guided the selection of the initial measures. In the case of pavement area, the recommended performance measure was changed after an additional review with top management to define a measure that would be most meaningful and understandable to top management, the legislature, and the general public.

The proposed measures, the basic steps in the process by which the measures would be used to help define program funding targets, and, most important, the link between these funding targets and the district office-based project selection process were all documented and reviewed widely by key staff in the department (Figure 4). Although the basic philosophy and logic behind PPP were widely supported, the implications of this new way of doing business on ex-

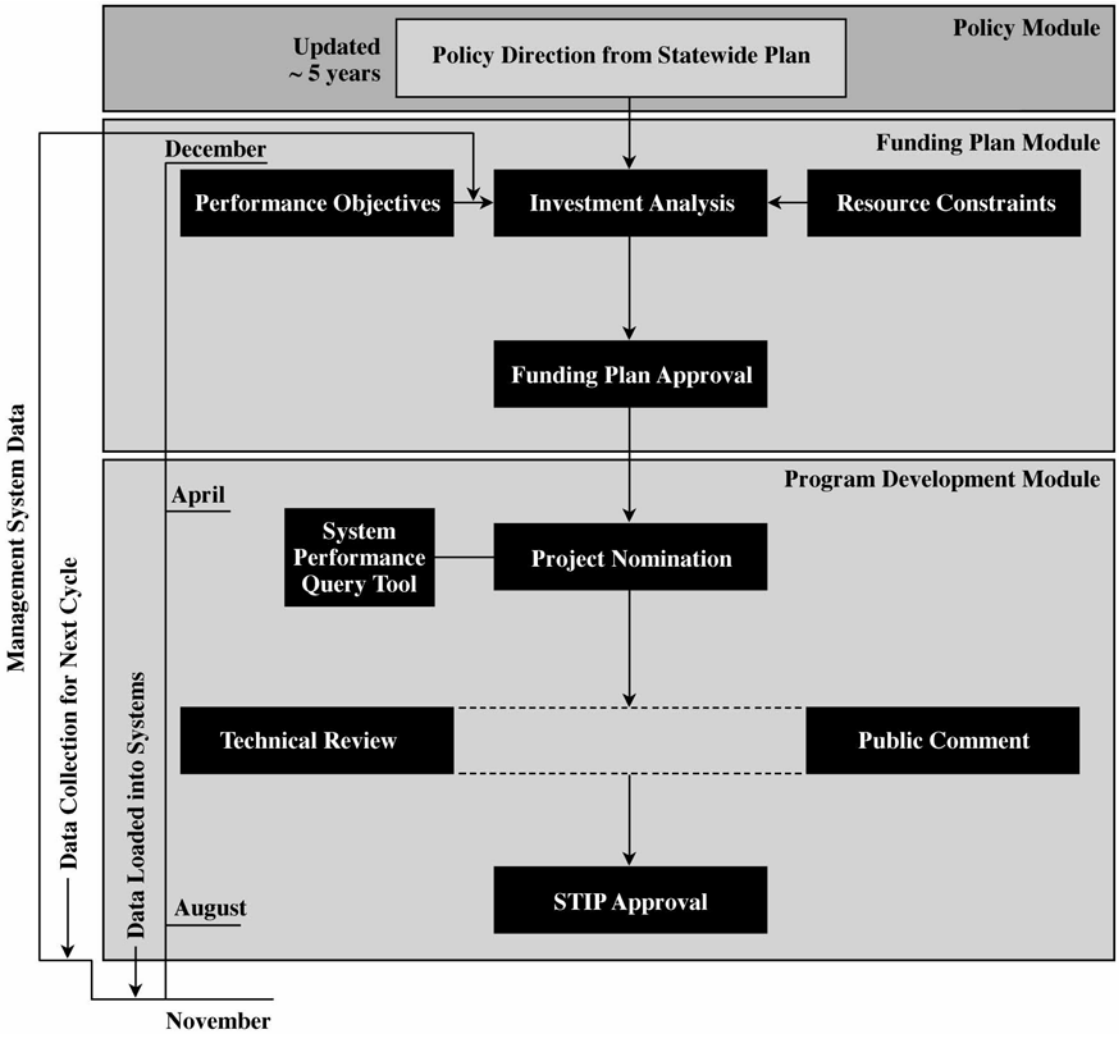


FIGURE 4 Performance programming annual cycle (*Performance Programming Process*, 2000). (STIP = statewide transportation improvement program.)

isting decision-making processes and prerogatives were not lost on anyone. At key points in the rollout process, reaffirmation of support from top management was critical. Clearly, a key factor in that support was the expressed request by the legislature for the department to better explain what the MDT budget was providing for the citizens of Montana.

During the fall of 1999 and the spring of 2000, specific performance targets were defined in each of the goal areas and program funding-level guidelines were established during the initial cycle of the PPP process. The availability of performance measure information to top management while discussing various funding trade-offs was viewed as extremely helpful and led to some adjustments in funding allocations. Although the first cycle of PPP was well received, it also highlighted areas where improved data and analytical methods would be desirable, and future cycles will begin to address these issues and broaden the goal areas included in the process.

Colorado

The Colorado Department of Transportation (CDOT) has developed over the past several years a performance-based decision support program called the Investment Strategy. The program is intended to help higher-level decision makers consider trade-offs between strategic program areas when making significant budget allocation decisions.

The Colorado Transportation Commission makes investment decisions to program nearly $1 billion of state and federal funds per year to address Colorado's transportation needs. Although CDOT uses several traditional policy and planning instruments, various

investment decisions are made independently and without the benefit of analysis to clarify the impact of decisions on long-term goals or on other program areas. Programs typically receive incremental budget increases based on funding levels from the previous year. Program area effectiveness is measured in terms of departmental activity levels or output (e.g., "plow miles of snow removal"). This historical budget process did not consider the effects of investment in one area on performance in other program areas or the overall results of the investment in terms of outcome for the system user or customer. In contrast, the evolving CDOT Investment Strategy focuses on the trade-off between spending on one program versus another and measures the results in terms of customer-oriented outcomes.

The Investment Strategy is a good model of a performance-based system that strives for alignment between broad goals and performance measures. Multimodal goals and objectives are framed as customer-oriented statements of purpose and explain what the state is trying to achieve with its transportation system investments. Tracking performance measures over time gives the Colorado Transportation Commission (the highest decision-making body for state transportation policy and investments) information about how programs are performing in terms of meeting these goals and objectives and guides the commission's investment decisions regarding how much to spend on each transportation program. The performance measures are then used to monitor the performance of these programs, feeding back into the next cycle of goal or target setting, program evaluation, and investment decisions.

The Investment Strategy strives to ensure that transportation investment decisions link program performance evaluation with long-range system planning goals. The approach considers all modes; evaluates results in terms of customer-focused, outcome-based measures; and takes a broad range of customer, agency, and societal benefits and impacts into account.

CDOT grouped its many activities into five major categories for the purposes of investment analysis: safety, system quality, mobility, strategic projects, and program delivery (Figure 5). These investment categories cover all of CDOT's major activities, such as planning, design, construction, and maintenance. This grouping is noteworthy for at least two reasons:

- Department activities are organized according to their impact on customer-oriented measures of results. For example, snow and ice removal activities, although functionally a part of maintenance activities, are evaluated in terms of their effectiveness of investment in the mobility category rather than the system quality category because the primary result of effective snow and ice removal is improved or maintained mobility for travelers rather than infrastructure maintenance.
- Investment categories consider, at least implicitly by measuring net results, the activities of several other major transportation agencies or providers in Colorado. For example, measures of mobility take

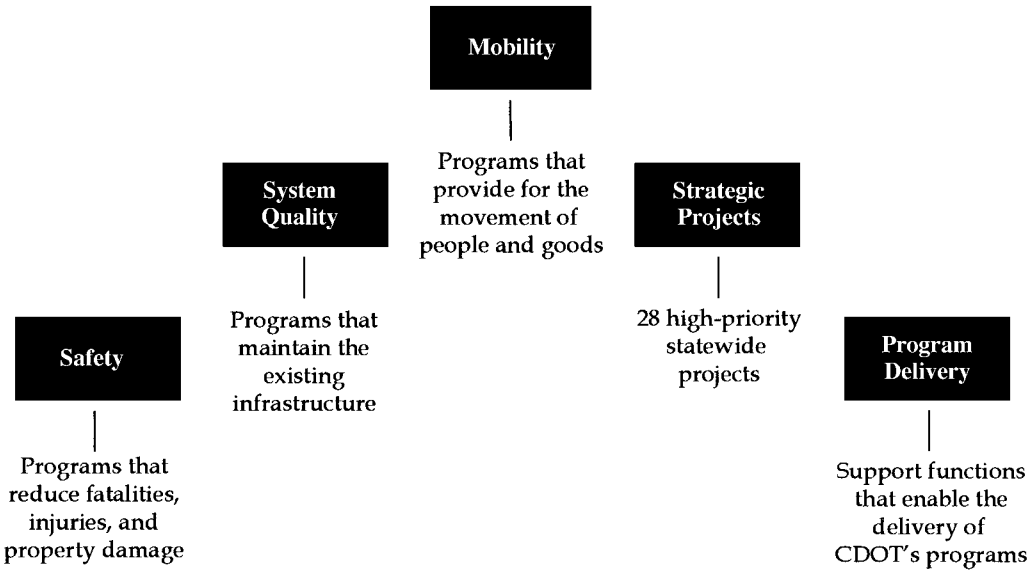


FIGURE 5 Colorado Department of Transportation investment categories (*Preliminary Performance Report*, 1999).

into account the capacity and performance of transit service operated by regional authorities such as the Denver area's Regional Transit District because these services are a critical component of multimodal mobility in the metro region.

Numerous measures have been developed for each investment category, for example, "statewide total fatal and injury crash rates" in the safety investment category and "pavement condition" in the system quality category. A quantified performance objective has been identified for each measure when sufficient historical data exist. For example, CDOT's objectives are to "reduce the fatal crash rate from 1.38 to 1.35 per 100 million vehicle miles by 2005" and to "improve state highway pavement condition to 60% in fair or better condition and no more than 40% in poor condition" (*Preliminary Performance Report*, 1999). In some cases, trend data or comfort with the selected measures is not yet sufficient to warrant establishing quantified objectives. For example, in the mobility category, CDOT is tracking new measures for roadway congestion and travel time variability. However, target values for the congestion index probably will not be identified until the concept is tested on a corridor rather than systemwide. Customer perception (from surveys) of travel time variability will be used with the congestion index findings to help guide decision makers to the most effective actions to address congestion.

These measures are being tracked to monitor performance and to help inform future budgeting decisions. Currently, the amount of data available to calculate the chosen performance measures is limited. For several of the measures initially selected by CDOT, only 1 or 2 years of data exist, making it difficult to establish performance trends (recent or historical) or future performance objectives with any real degree of confidence. As CDOT implements more of the necessary data-collection systems, reporting mechanisms, and supporting documentation, the commission will have the tools and information necessary to make investment decisions that include an objective consideration of how well programs deliver on their stated goals and how much money they consume to deliver the program. Over time, a clearer picture should emerge, and the full power of the investment strategy for making investment decisions should be revealed.

Conclusions

Interest in the use of transportation system performance measures to influence agency decisions continues to increase, and the many state DOTs, MPOs, transit operators, and local agencies that have begun to implement performance measures offer a range of experience. Although there always tends to be a gap between the theory and the practice, in performance measurement, the "devil" truly is in the details. Many efforts have either failed or made very slow progress because the implications of using performance measures (or the level of effort and support required for success) were not well understood from the outset. On the basis of direct work in a variety of agencies and the research done as part of NCHRP Project 8-32(2) (Cambridge Systematics, Inc., 2000), several conclusions can be made about the integration of performance measurement into the decision-making process:

- Use of performance measures for influencing agency decision making involves much more than the measures themselves. An integrated framework that includes aligned goals, objectives, measures, and analytical methods will best support decision making at various levels of an organization.
- In the early stages of implementation, emphasis needs to be placed on building an ongoing performance-based planning and programming process rather than on rapid near-term results in actual system performance.
- Successful applications of performance measures must be tightly linked to overall agency goals and objectives and must connect both the strategic and operational levels of an agency. Performance data must be evaluated and presented at a level of detail that is consistent with the decision-support needs of the users.
- Progress will be incremental, and the implementation strategy should be incremental as well. It is perfectly legitimate and often desirable to start with a few measures and only a subset of an agency's programs. Over time, additional programs can be brought into the process, and new or refined measures can be introduced to take advantage of specially tailored data-collection programs and analysis methods.
- Support of top management is critical. Anyone who will be held accountable for results should participate in the process of defining the performance measures, the key elements of the performance-based planning and management process, and the implementation strategy.
- A performance measurement process should be used to better inform the decision-making process, not replace it. The veracity of this statement quickly becomes clear to anyone trying to implement performance measures. Yet it is often one of the biggest

concerns and points of resistance within an agency. On the one hand, decision makers may be reluctant to adopt performance measurement out of concern of losing control of the process. On the other hand, managers and analysts may become paralyzed with inaction over the concern that the process is not accurate or reliable enough to support critical resource allocation decisions. Agencies should be comfortable entering into a performance measurement process, even with the realization that the initial impacts may be subtle.

- Agencies should be clear about causality between actions within their control and performance results. They also should be realistic about setting performance expectations that can be met given likely future agency resources.
- Data, analytical tools, and information are at the core of using performance measures successfully. An incremental strategy of applying existing data and tools is usually necessary to make the case for any additional data-collection or analytical method development efforts. Agencies often have more data available than are actually turned into useful performance information to inform decisions.
- The use of existing data in new ways, or the use of existing management systems or other tools to define performance goals or expectations, may meet with as much resistance as the introduction of the performance measures themselves. Institutional obstacles to the development and application of new methods are common and insidious. The champions of performance measurement in an agency must anticipate these obstacles and marshal the necessary organizational or political firepower to meet them.
- Feedback and assessment of the implementation process are just as critical to the ultimate success of the use of performance measures as the monitoring and feedback of system performance are to the improvement of system performance over time. Ongoing assessment and adjustment of implementation mechanisms and strategies are critical to sustain results. Agency (and stakeholder) resources must be allocated for the long haul if a program is to be successful.

In summation, transportation professionals and policy makers have many reasons to be enthusiastic about the potential benefits of integrating performance measures into the decision-making process. However, several nuances and potential pitfalls to the process can be avoided through adequate planning and preparation. Attention to the suggestions presented in this paper will help agencies more fully anticipate what lies ahead when they embark on a performance measurement program.

Acknowledgment

The authors thank the staff at the numerous agencies cited in this paper for sharing information about their programs.

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Any conclusions drawn from this information are those of the authors alone. Although we have tried to be both accurate and current in our examples, we remain responsible for any inadvertent misinterpretation or misrepresentation of fact.

Panel Discussion

John Poorman, *Capital District Transportation Committee*
David S. Ekern, *Minnesota Department of Transportation*
Pilka Robinson, *Sacramento Regional Transit District*
Mary Lynn Tischer, *Arizona Department of Transportation, Moderator*

Implementing Performance Measures

John Poorman

I was at another conference last week, and a lot of pot shots were taken at engineers there. One joke was based on that saying, that the optimist sees the glass of water as half full and the pessimist sees it as half empty; well, the engineer sees the glass as too big. I would like to add that the planner sees the ring on the table.

I am going to be talking about our experiences in the Albany, New York, area, the capital district, in implementing much of what Steve Pickrell said. Then I will present specific add-ons, caveats, and comments to the caveats that we need to be aware of, which come as much from the planners' view of the "ring on the table" as anything else.

Our metropolitan planning organization (MPO) at the Capital District Transportation Committee (CDTC) has a long tradition of a collaborative working relationship and dependence on technical quality and objective decision making. It has allowed us, with the passage of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA), to broaden our perspective beyond the traditional kinds of tasks that all of us in this room have been involved in, to issues such as social goals, community impact, and so on.

We chose to go through an exhaustive, extensive, and intensive exercise to develop a new long-range transportation plan. We spent 3½ years working on it with nine task forces, hundreds of people from stakeholder groups, multiple conferences, workbooks out to the community, 50–60 public meetings to lay out some options, and 1 year of public review before we adopted a regional transportation plan. In that process, we ended up developing several principles for 17 project types or categories (e.g., bridge renewal, community compatibility, economic development) that were adopted, including strategies, actions, and budget categories for the next 20 years from all fund sources.

I guess I should not have been surprised because in the process of doing this, there was a heavy performance measure orientation. We had to develop a lot of performance measures to complement the traditional transportation measures. We came up with measures for compatibility between the transportation system and residential and commercial land use, and measures for access to reasonable alternatives to the automobile. We were one of the first MPOs and perhaps the only MPO that has seriously used as part of our performance measures the whole concept of full-cost accounting for all social and environmental impacts, including the cost of construction, constructing garages in suburban areas, and so forth to really give a full measure of what is going on. We also recognized a need to introduce some soft measures, such as quality of life, because what we heard from the task forces and from the public was "Travel time is great, but I am concerned about my community and my quality of life."

This process was successful, and many of you have heard me discuss it in the past. What I want to discuss is what has happened since then and the value of that process. I was surprised—and I should not have been because we did a good job with the plan—but the first opportunity that our decision makers (i.e., the 18 local elected officials and the 16 trans-

portation agency heads that sit on our board) had to use the results of our plan, they did. In 1997, with $90 million on the table not committed to existing projects, these folks committed every one of those dollars to implement parts of the plan that had been underfunded in the previous two plans.

In the 3 years since, we have had one major investment study, several other major studies, and a major 16-mi corridor study. We are looking at light rail and other options. These performance measures have been implemented at that level, even down to quality of life, access, and the full-cost concept, which has led us to push for a bus rapid transit system, not light rail, in this one major corridor because we could not show environmental and social benefits in a low-growth area like the capital district that would pay for the half-a-billion-dollar capital investment in light rail. So the performance measures have real benefits for real decisions in keeping people on the same wavelength.

We saw the follow-through again in our 1999 transportation improvement plan (TIP) update. We had to wait 2 years before anybody was even willing to ask, but in soliciting our participants and going out to the public and saying, "Here is what we did in 1997, and we are trying to implement it; are we on the right wavelength?," there was a strong confirmation. There were some cost adjustments and schedule changes, but our update process was very easy because we had pretty much gotten it right before. The joy of all joys is, when the state legislature and the governor put $3.8 billion out for a bond issue vote this fall, we were able, as an MPO, to fully embrace the bond issue referendum because every single project funded there came from the long-range plan and the TIP.

I will make seven cautions and caveats quickly:

1. This approach was successful in our area because of strong working relationships. You are going to have a hard time getting state DOT pavement goals and local community urban revitalization roles integrated in any location if state and local agencies do not have good working relationships.

2. I do not know whether this comes through on Steve's stuff, but I am sure you would agree with this: goals, objectives, and measures have to resonate with society. We had that benefit because all aspects of society were working with us on our plan. That is where the quality-of-life measures and other measures arose. If we were just talking to the engineers who were worried about the glass being too big, we would have focused too much of society's point of view on pavement, bridge conditions, level of service, travel time, and the like.

3. As a corollary to Point 2, if you pursue this approach, be careful not to assign too much weight to traditional measures and ones that you can measure easily. Measures that cannot be measured but can only be sensed may be as important to the community as those that can be measured easily. These are challenges that I hope we can discuss over the next few days.

4. It may be difficult to be honest, but if you are doing these things accurately, it is important to be honest. In our long-range plan, we did not promise that we would have less congestion in the future than we had in 1997 because we could not make it happen with reasonable resources, land use controls as they are, and the quality-of-life aspects that we were trying to pursue.

5. Recognize that the weights among the performance measures change. What constitutes an attractive package of investments may change. It can be judged only in the holistic sense.

6. Related to Point 5, various outcomes of decisions may all be legitimate in the same set of performance measures, depending on how the different outcomes are weighted among the different objectives.

7. The final point is one that we are struggling with in our staff right now with a cooperative state DOT and other consultants doing the engineering work. We are running into a significant conflict between the society weights, goals, and measures that reflected our investment policy and the design practice that has been involved under context-sensitive design. Context-sensitive design is great, and it is what we need, but I hope we all realize that many of the design standards do not particularly assist in achieving the performance measures that we can easily measure.

I will just leave it at that. I think you all realize that in designing facilities, if you use the 85th percentile speed and the 85th percentile speed is 10 mph over the speed limit in a community that is pursuing a quality of life, the measures are mutually incompatible. Yet the follow-through—system performance, measuring, monitoring, decision-making investment, down to design operation—all has to be integrated, or we lose the battle.

The Minnesota Experience

David S. Ekern

These comments may not be reflective of the Minnesota DOT in our overall approach and may be more some personal observations as they relate to what Steve Pickrell has done this morning. I think he has done an excellent job of weaving together a lot of lessons learned from a lot of experiences around the country.

We tend to portray the process of this business of performance measures and performance management as very logical. It is not. It is extremely messy. It starts ugly, and it stays ugly in the process. Only when you have been through it can you look back, draw a neat picture, and say "That is what we were doing: we were aligning customer needs, outcomes, strategic objectives, targets, and measures; we went through it in this process; it took us 2.5 years, and it was really cool."

We are not doing that. We have allowed, in Minnesota, the perception or the encouragement that all performance measures linked to investment management and investment decision making should be done through the department. It started in lots of different places, and everybody used the wrong terms to start with. This is one of the key issues that we need to deal with, this lexicon of terminology. I understand that one size does not fit all. But that does not change the fact that what confuses our customers greatly is that they can go from area to area, region to region, and hear different terms used to describe the same thing. Maybe that is something that is inherent in our society, and we need to accept it. However, it does cause us problems, I suspect, and as professionals in the business, we need to address this issue, perhaps through the Association of State Highway and Transportation Officials (AASHTO).

The Minnesota approach emphasizes connections among goals, policies, and budgets at the different planning levels: strategic plans, systems plans, and business plans. It integrates three or four different processes developed at three or four different times. It allows us to educate people about their place in the overall management of government.

In talking about strategic plan systems and business plans, they are either the same or they are different, depending on where you are in the organization and what their purpose is. We believe that our strategic plan is our overall framework, our overarching document, the piece that we always carry with us. It is small, easy to follow, quick to read, fewer than 500 words, and has lots of pictures. Yet it has withstood the test of time for us over the past 5 years. Why is that important? Because one of the other lessons that we learned as we work through this is that you need to be able to weather changing administrations. Each administration put into place in the transportation arena has a different mission and set of objectives that it intends to achieve.

We have gone through that change over the past 2 years, from a very conservative, non-transportation-oriented administration to an administration that is characterized by a governor who is very clear in his points of view. He published them, gave them to everybody: "Our job is to be accountable. Our job is to remember [that] it is the people's money we are spending. And our job is to remember that government is a limited function of society."

So how did that view translate? In fact, he put transportation as an agenda item in his first year in the administration. It also translated into

- Becoming multimodal;
- Developing 2,000 miles of interregional corridors;
- Focusing on program delivery, both construction and maintenance; and
- Making information a key.

The test for us was when we tested this agenda against our strategic plans. We worked hard to make sure that there was a fit or that our strategic plan needed to change to respond to that change in direction. Therefore, it had to affect the performance measures we use.

That turned into linking strategic planning, performance measures, and investments. There is a $177 million program investing in 33 projects on the key 2,000 mi to be completed by 2003 or under contract by 2003. Those projects, theoretically, were not on the books 2 years ago. That is a rapid turnaround time. We had decentralized our project selection process from a very traditional, technically oriented, internal system to a decentralized system. We did that under the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991. This program to establish interregional corridors is under a centralized management system established for unique programs.

Let me make a couple more observations. Adjusting to leadership was key in some of the processes I have talked about. We tend to want to talk about the precious few performance measures that we need. I personally am not an advocate of that because I think it drives people away from the table, including some key professionals that you need at the table. We have catalogued around 700 performance measures within

our agency. We do not expose all those to the public, obviously. I subscribe to the philosophy of shaping performance measures to your audience. If someone is proposing that everybody needs to be driven by only six to eight performance measures, then you will spend the rest of your life searching for those six performance measures. In Minnesota, we have six strategic measures, I can tell you, throughout the organization; we may not all buy into those six and may not see ourselves in them, and that is a key.

The last point I want to make is about customers and what we have learned from customer service. We have done a lot of customer research through omnibus surveys to establish performance measures. Many states and entities are doing that, coordinated with other organizations. We have run our own focus groups for various purposes. We completed a $300,000 survey this spring to identify market segments. One of the key conclusions coming out of that customer research (it is not the primary focus of it, but it is important) is that customer research can help prioritize and shift resources to products and services that the customer currently believes should have higher value. However, we also learned that customer surveys alone cannot replace vision. That was really clear when my boss looked at the results of that survey. He said there is no future piece to it. That is critical as you talk about performance measures and linking them to the investments you are going to make in the future.

Three years ago we did not talk about light rail transit (LRT) and what it could contribute to the metropolitan area. If you did customer surveys, I guarantee you that in the Twin Cities, LRT would not be the highest-rated product and the service that they would like to invest $100 million in. That is a vision that has been brought to the table. It has taken courage to bring that vision to the table and link it to a longer-term performance measure of economic vitality and the softer kinds of measures that we have talked about here this morning.

Balancing Performance Measurement with Real Life

Pilka Robinson

Steve has put together an incredible combination of research and interpretation that I found very useful. It gives us some ideas for applying performance measurement to what we do.

I am going to go right into my own personal observations about performance measures and how they apply to the industry and my work. They do not reflect the views of our metropolitan planning organization (MPO), the state DOT, or anybody else. They are how we, at the Sacramento Regional Transit District, see how these things affect our organization.

How does the Sacramento Regional Transit District use performance measures? That performance measures allow us to measure accountability, efficiency, and effectiveness in addition to supporting communication and clarity is a really great concept. In actuality, it gets somewhat cloudy. For one, we find that determining truly identifiable measures and applying them is difficult. We find that the research required to collect all the data to do these performance measures is often given short shrift because we, as an operating agency, have many other issues to deal with. Do you have four planners collecting data, or do you have two drivers providing service? Trade-offs are made because data collected for the sake of collecting data does not really help. Then you have got to have people to analyze the data, people to read the results and understand what to do with it, and people to apply the analysis. Practical problems arise as you try to use the measures. I am not saying they are not important, but that is the reality of things.

So how do we apply them at all? As staff, providers, and management of the transit system, we see that we have to sell what we are trying to do but with very limited resources. Rather than trying to explain why these resources should be allocated the way they are, it is important and useful to be able to throw up a few slides, show a few bar graphs, and say, "This is why." Well, we try to do that, but then again, that decision-making body called the board of directors comes through and says, "It does not show social equity." Mr. So-and-So here has to take his kid to the doctor, or Mr. So-and-So there has to get to a job, and the whole well-put-together performance measure and what you are trying to do with it are pushed aside. Decisions are made on that kind of basis.

I do not mean that performance measures have no place. They give us a beginning point. They give us a focus. If we are operating several transit routes and we take those routes together and analyze them in a zero-sum game, which go and which stay? Some have to go if new ones have to come in. Here, performance measures such as ridership measures (what we call passengers per revenue vehicle mile) certainly help. So performance measures do have a place as they specifically measure only system performance.

You could call this a form of the trade-off analysis that Steve suggested. But I am taking the concept of trade-off analysis and trying to apply it to a much wider selection, not only within the agency but also without the agency: an intermodal, trade-off selection. As you all know, the Transportation Equity Act for the 21st Century (TEA-21) provided a lot of flexible funding. Although it was good, it also caused us real conflict, often with the state DOTs and the roadway lobbies. We thought, "Wow, we have a chance to get some highway money." But it was not that easy. One of the factors used in this type of trade-off analysis to make an intermodal decision was called *mode split*. From my perspective, that term is bad—you should not use it. Let me tell you why I believe that it is not often a good measure of what we do.

Mode split is applied in terms of what the system carried and what it can be expected to carry with this type of investment. What is often missed is the availability of or the accessibility to the system. The highway mode, in most cases, provides 100 percent accessibility. Everybody has access to the roadway system, everywhere. Accessibility to the transit system does not always exist. It exists in some areas but not as commonly as to roadways. Therefore, applying a performance measure like that used to make decisions is often not a very good approach. But there really are not other measures we can use. When there are flexible funds to distribute, having good objective performance measures can be very useful. Otherwise, there is a lot of political—not decision making but actual—weighing of objectives, and billions of dollars are assigned in that way.

In the transit industry, thankfully, the Federal Transit Administration has now come up with more measurable criteria that are applied as projects are selected to assign what is called "new-starts money." Although this practice is good, it also has created a problem for transit agencies in trying to collect data. Collecting data for performance measures is a real key point; it must be collected constantly and analyzed consistently, so that it is done the same way throughout the number of years we do it.

In summary, several practical issues arise in applying performance measures. Maybe studies and research papers like what Steve put together will bring us all some focus and common ground on which we can really apply them. Maybe they could lead us to think about how to better make judgments based on performance-based criteria.

General Discussion

Issue: What is the appropriate number of performance measures? Is 700 too many?

Discussion: Minnesota has some 700 measures, but only a few are corporate strategic measures. Most of the measures are at the operational level.

Issue: What are the benefits of creating performance measures for nonquantifiable factors? How can these measures be used in the political decision-making process?

Discussion: Including nonquantifiable measures is useful to political decision makers because it gives them a feel or indication for issues that are important to the public.

Issue: Can we use multimodal performance measures to make trade-offs between different modal programs and projects?

Discussion: We are not there yet in our ability to make multimodal trade-offs with performance measures. A National Cooperative Highway Research Program project is under way that may be of some help. At some point, we might recognize that we are comparing apples and oranges and allow the decision-making process to work with the best information available.

Multimodal issues can be addressed through the long-range planning and investment strategy process, including both quantifiable and nonquantifiable measures. Investment strategies need to be unbalanced in the early years to achieve a different balance in future years. The plan and measures must be updated periodically to account for changes in technology and public values.

Issue: How do you incorporate performance measures in a multijurisdictional framework?

Discussion: California has developed an approach to provide information on performance measurement to the different agencies involved in transportation decision making and periodically meet with them to discuss needs, impacts, and so forth. Minnesota has developed area transportation partnerships. Arizona is developing its long-range state transportation plan as a joint effort of the state DOT, the councils of government, and the MPOs. The most important first step is to establish a good working relationship between the multijurisdictional agencies.

Issue: How do you weigh societal measures against engineering measures?

Discussion: There is no easy answer. It is a messy process. The key is to involve the various stakeholders in a dialogue, within a framework in which the participants trust the process and have realistic expectations of what is and what is not possible.

Issue: How do you draw the line between system stewardship and customer preference?

Discussion: Properly segmented market surveys can be used by stewardship agencies to calibrate their decision processes to include customer viewpoints. However, they still need to make the stewardship decisions based on many factors.

Workshop Summary

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Daniela Bremmer, *Washington State Department of Transportation*
Peter Plumeau, *Wilbur Smith Associates*
Kenneth Sadeckas, *Metropolitan Area Rapid Transit Authority*
Robert Winick, *Motion Maps, LLC*
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State of the Practice

A growing number of transportation agencies are embracing performance measurement as a management tool, but few agencies use performance measurement across the full range of their activities, and the existing measurement systems have not been externally validated. The practice of performance measurement is more art than science, and the development of performance measurement systems is a dynamic, incremental process that is still early in its evolution. There is neither one right set of performance measures nor one right process to develop a performance measurement system. However, the structure of performance measurement systems appears to be most effective when it is tiered from broader to more detailed measures for use at different decision-making levels.

Most performance measures relate to traditional engineering areas such as pavements, bridges, and traffic flow. Some agencies are being challenged to consider broader measures, such as sustainability and quality of life, creating a wide range of practice in the field. This diversity reflects the unique social and political environments that affect agencies. "One size fits all" does not apply to the field of performance measurement.

Performance measures are very useful in strategic planning and in systems and operations planning for state and regional transportation agencies and authorities. Mutually agreed-on performance measures hold promise for coordinating the plans and operations of the public agencies, service providers, and stakeholders involved in transportation decision making. The process of developing these measures can start a dialogue that generates significant synergistic benefits.

The use of performance measures to inform decision making is inconsistent from agency to agency; few agencies pursue aggressive programs. Transportation agencies tend to be focused on the development of measures and less so on processes for using the measures in decision making. Too often, measures lack a link to a clear decision structure. Performance measures should be part of an overall decision-support process, and much remains to be learned about how to use measures to make investment decisions, including how to balance their use with the political dimensions of many investment alternatives. Performance measures have been most successfully applied in decision making related to day-to-day operations.

Issues

The establishment of performance measures and their tie to decision making should be driven by customer information. This is difficult because different sets of customers may have conflicting objectives and because customers seldom have a vision of the future. They respond to current issues and needs, and they

relate best to projects rather than broad policy issues. For these reasons, the model that seems to make the most sense is a strategic planning process that uses input from a range of sources (including the general public, political leaders, executives, and professionals) to establish visions, goals, and measures.

Another issue is accountability. The public expects more of its political leaders. If we have a good measurement system, we may be able to engage our leaders in serious discussions about programs and performance. Through this discussion, we can become more accountable, and we can enable our political leaders to become more accountable as well.

Communication is very important. How can we translate complex issues and data into information that makes sense to the average citizen or elected official? We must move away from jargon and obscure measures and deal with issues that have meaning and are understandable to our many audiences. This also means that material may have to be tailored to specific audiences. Elected officials and citizens may not want the same information as the transportation professionals. We must meet their needs.

The factors involved in decision making must be understood. We must understand the process used in decision making as well as the quantitative and qualitative information and judgment that are used in making decisions. This understanding will prevent us from providing useless, superfluous information and allow us to provide helpful, needed information.

The data and information used in decision making must be of high quality. They must originate from reliable, consistent sources and meet the needs of the decision makers. The decision makers must have confidence in the information, or it will not be used.

A host of organizational issues are related to the use of performance measures for decision making. They include achieving buy-in from lower levels of the organization on the benefits of a performance measurement system, including a hierarchy of measures to ensure that every person within the organization can see himself or herself in the "big picture"; the misuse of performance measures that create an environment for "gaming" instead of improved performance; the ability of performance measurement systems to react to change in customer demands or adapt to change in measures or technology; the need to maintain specialists, such as economists, market researchers, data analysts, and report writers; the establishment of reliable trends for performance measures; and the development of measures that are outcome-related rather than output-related.

Opportunities and Constraints

With the establishing and maintaining of an ongoing process of performance measurement, there is a need to recognize constraints and seize opportunities, such as the following.

Internal Decision Making and Support

Relate Decisions to Consequences

Staff needs to understand and better enable decision makers to understand the consequences of their decisions. What effect will the decision have on the performance measures used in the decision? It may mean establishing performance measures to identify the success or failure of actions. Performance measures can be used to document or justify decisions.

Establish Nested Hierarchy of Performance Measures Linked to Decision Making

Agencies need a comprehensive set of performance measures to ensure that all facets of issues are addressed and rolled up into key overall system performance measures. They should show linkage throughout the organization, help as a communication tool, and foster the understanding of roles and responsibilities within the organization.

Close Gaps in Decision-Making Coverage

Performance measures should be selected to close internal gaps in decision-making coverage and so the decision makers, managers, and personnel can apply the measures at each level.

Get Internal Buy-In to Support Measures of External Performance

Reporting and linking to external decision makers about performance results can be hampered unless there is sufficient internal support from operations-oriented staff whose cooperation or resources are needed to gather or summarize measures. Thus, marketing may be needed internally to improve the availability or reliability of particular measures.

Maintain Staff Morale

Lower-nested performance measures should be supportive and encouraging to front-line staff to maintain high morale and a sense of contribution.

Decision-Maker Agreement or Consent

Work Within Constraints of Limited Resources

Often, limited resources are available to collect performance data, analyze it, report it, and use it in decision making. These resources are often the first to be cut during budget reductions, making it difficult to sustain a performance measurement process.

Measure Value

Use performance measures to communicate the value delivered using the funds available to the transportation agency and to identify the increased value that would be secured by making increased funding available.

Foster Proactive Approaches

The reporting of performance measures can provide opportunities to be more proactive with decision makers and to be less frequently in a position of being reactive to events or circumstances.

External Support

Embrace Involvement of More Organizations and the Public

Opportunities can be found when people are involved in the decision processes and want meaningful ways to measure and understand what is happening. It is true at political and public levels. Measures may find fertile ground if they are well done and well communicated.

Enhance Credibility of Performance Measure Results

Including the perspectives, assessment, or "audit" of independent constituent or "watchdog" groups can increase the credibility of performance measure results with decision makers. However, it also can create an opportunity to criticize and focus on shortcomings, so be cautious. Other ways to better ensure credibility include standardizing measurement and data definitions, establishing "accounting rules," and submitting results to independent reviewers (internal or external). There also may be a need to be vigilant so that such groups do not misuse or misinterpret the performance measure results.

Interorganizational Coordination

Link Access to Performance Results Across Modes and Jurisdictions

It is often in the best interest to share data and results, but it can also be threatening and costly to do so.

Build on Federal Performance Monitoring Systems

Although the focus of such programs (e.g., highway performance measurement system, National Transit Database) is to have measures applicable and consistent at the national scale, there may be opportunities to use those processes to better serve state and local needs, perhaps by including available detail through a bottom-up effort.

Public Support and Involvement

Increase Understanding of Factors Beyond Agency's Control

The concerns of the public often extend beyond what an agency can control. Having a measure that directly relates to an issue of public concern can open an agency to criticism when the agency can do little or nothing about it. An agency may not be able to deliver on an issue that the public feels is important. Early recognition of a problem can provide opportunities for partnering with other organizations to increase control.

Seek to Listen to and Understand Public and Decision-Maker Concerns

Early on, and on a continuing or periodic basis, seek to listen to and understand the concerns of the public (customers) and of various levels of decision makers.

Change

Maintain Ongoing Working Relationship with Decision Makers

Seek opportunities for outreach, and be willing to share performance results with different external audiences to establish a "track record" or "batting average" with decision makers.

Foster Understanding of Longevity Issues

Many performance measures are intended to capture long-term effects; they may not provide instant gratification to current decision makers who may have a short-term focus.

Anticipate Need to Change Some Measures over Time

Discover and stay on top of the information the decision makers want to use. This approach will provide timely and effective information for high-quality decisions based on facts.

Maintain Consistent Leadership

We live in a political world where leaders change and the values of society change, and thus our processes need to be flexible and responsive to changing and perhaps inconsistent decision-maker interest.

Next Steps

Best Practices

Produce a synthesis of best (current) practices. Include case studies that show how measures are being used in decision making. Include case studies that show the successful implementation of a performance measurement system. Establish a library or "menu" of performance or evaluation measures segmented by market groups, geographic corridors, areas, or regions. Describe different methods and processes of decision making (ways to accomplish shared decision making). Research applicable practices from more private-sector, business, or industry groups, including successes and failures using performance measures in ongoing and periodic decision making. Revisit *NCHRP Report 446*; update and validate the state of the practice among agencies included in this report. Expand TRB peer group participation on this issue.

Communications

Gather examples, case studies, and tools to effectively communicate performance measures to policy makers, legislatures, and the public. We need information on how performance measurement is effectively communicated to decision makers to allow them to make informed decisions. This information can provide others with the options to improve their communications systems by providing quality information to decision makers in a usable format.

Terminology

Clarify (standardize) terminology and differences between organizational or managerial measures and system measures. Align the definition of goals across the industry to the extent possible, then standardize the measures used. Create consistent standards, so that performance measures can be reliably compared across agencies. Recharacterize data collection as "performance monitoring."

Training

Develop training for managers and policy makers to apply and use performance measurement systems. Provide tools for managers and policy makers in applying and using performance measures. Develop a web library of samples of communicating, summarizing, and presenting performance results to decision makers and the public, especially ones that use graphics and other visual aids rather than tables and heavy text. Educate performance measurement implementers and users. In addition to executives, those doing the measuring need to be involved early in the process.

Societal and Intermodal Issues

Gather information on how to incorporate community or society goals (or "soft" measures) into the performance measurement process. Create quality-of-life and sustainability performance indicators. Provide techniques for measuring, and include case studies of successful results. Increase the understanding of how to use performance information to make informed intermodal and other cross-discipline decisions. Develop performance measures for cross-model investment decisions.

Systems Approach

Research the integration of strategic planning and performance measurement, including ways to make the total process faster and more responsive. Provide guidance on how to assemble a range of performance measures into a tiered system that logically links measures from an operational decision level (internal productivity) through a policy decision level (external stakeholder satisfaction). Connect performance measurement to business planning. Outline the feedback loop—How are measures used? What decisions did they influence? What process was improved as a result of performance measurement? Include a discussion of the limitations of performance measurement tools—How do they fit into a total decision-making process? What are the other desirable or essential tools that must complement performance measurement? Recognize the need and utility of disconnecting or separating organizational measures and system measures. Identify the link of operations-type performance measures with high-level policy-type performance measures—What are the gaps?

Data

Develop strategies for using existing data sources. Synthesize data available at regional and state levels —What are states and metropolitan planning organizations collecting and measuring? Increase the understanding of the current use of market research in decision making and how it can be improved to provide decision makers with important outcome information and better information for priority setting.

Agency Implementation of Transportation System Performance Measures

Implementing Performance Measurement in Transportation Agencies

Panel Discussion

Workshop Summary

RESOURCE PAPER

Implementing Performance Measurement in Transportation Agencies

Hal Kassoff, *Parsons Brinckerhoff Quade & Douglas*

> Measurement alone does not yield good data[;] . . . it requires rigor.
>
> Data alone is not information[;] . . . it requires interpretation.
>
> Information alone is not knowledge[;] . . . it requires context.
>
> Knowledge alone does not yield results[;] . . . it requires action.

A few years ago, a landmark meeting among transportation planners was convened by the Transportation Research Board to contemplate the future as we prepared to pass the millennium milestone. Several speakers were asked to offer their perspectives. I had the opportunity to read their eloquent and insightful submissions. Among the many excellent themes that were discussed, three in particular stand out in my mind: the need for strategic thinking, focus on customers, and measuring performance.

About a year after that meeting, I was asked to give closing remarks at a meeting of state department of transportation maintenance engineers convened by Association of State Highway and Transportation Officials (AASHTO) and the Federal Highway Administration (FHWA) to discuss the future of highway maintenance for the 21st century. I felt that I had been given a golden opportunity. Having come from a planning perspective, having served in the top position of a state highway agency, having worked as a consultant on various progressive and innovative assignments, I was going to help these wonderful but somewhat narrowly focused participants stretch their thinking and broaden their horizons.

I prepared part of my presentation in advance, and it rang with the themes I had gleaned from the meeting of transportation planners: strategic thinking, customer focus, and performance measurement. But to my surprise—and I must tell you, it was a pleasant surprise—by the time I spoke at the very end of the meeting, after their debates and deliberations, my talk had been transformed into little more than a summation. The maintenance engineers had covered it all, and they had covered it well. There was little that I could add. I decided afterward that I would much rather give the keynote address than the closing remarks.

What was particularly fascinating to me was that from very different vantage points, maintenance engineers can be heard articulating themes that are in complete harmony with what I picked up from the meeting among planners: strategic thinking, customer focus, and performance measurement. Most of us would agree that between transportation planners and maintenance engineers, we pretty much span the range of functions and philosophies within our organizations. The fact that these two groups, whose day-to-day responsibilities and ways of looking at their professional worlds are so different, would articulate similar themes about the future indicates a dramatic transformation that has been taking root in recent years.

Change is happening in our transportation organizations—state departments of transportation, transit agencies, and metropolitan planning organizations (MPOs). It is having a profound impact on the way they do business. And the debate is less about

whether there is a need to change and more about how to do it.

Sea Change in Government

Government bureaucracies have existed since humanity's first attempts at building organized society. Yet only recently have they begun to change in ways that require the perspective of millennia to fully appreciate. In the United States, early in the third millennium, we are experiencing dramatic changes in how government employees view their roles, how they interact with the public they are supposed to serve, and how they and others assess their effectiveness. The common characterization of government bureaucrats as indifferent, intransigent, and inertial is no longer applicable to a rapidly growing number of agencies at all levels of government. We still have a long way to go, but we can see and feel the difference. Increasingly, indifference is yielding to responsiveness, intransigence is giving way to flexibility, and inertia is being overtaken by strategic direction.

This is a sea change in the history of governments. Until relatively recently, there was no evidence of government bureaucracies striving to be responsive to customers, flexible in their methods, and strategic in their outlook. Yet here in our time, it is beginning to happen. At all levels, government is becoming more concerned about the validity of its role, the scope of its mission, the effectiveness of its programs, the efficiency of its delivery systems, and the satisfaction of its customers.

It is not coincidental that during this period of transformation, the customers of government (otherwise known as taxpayers and voters) have been gaining the upper hand. They expect results. Government is being held accountable to deliver those results. Accountability has been driving the change. It is that simple.

We are unable to attribute the entirety of the movement toward greater accountability in government to an internally generated desire to be more responsive to demanding taxpayers, although I do believe that this desire is a part of it. These changes have resulted largely from an external motivation, a motivation that has blurred the boundary between public and private enterprises and has penetrated the consciousness of public agencies. That motivation is competition, particularly from the threat of privatization and outsourcing. The expanding interest within the private sector to provide services and perform functions previously assumed to be the exclusive domain of the public sector has been a key driving force in this historic transformation of government bureaucracies.

Interestingly, not all of the competitive forces confronting the public sector involve the private sector. Competition among agencies, within agencies, and between levels of government has been an added deterrent to complacency and an added incentive to the growing interest in the performance of public agencies.

Is this truly a sea change, or is it a transitory phenomenon? Can we imagine that this competition and accountability will prove to be fleeting trends? Can we imagine that future customers (i.e., taxpayers and voters) will be less demanding of results? Can we imagine the withdrawal of the private sector as a source of competition? Can we imagine that the need to evaluate successes and failures and to measure efficiency and effectiveness will fade?

Clearly, performance measurement is not a fleeting trend. We are not going to have less-demanding customers holding us less accountable for our public-sector actions. And our ability to collect and analyze data and to convert such data into useful information is not going to diminish. So we may as well take serious stock of the issues we confront when implementing performance measures in a transportation agency.

Introducing Performance Measures

Increased customer expectation and accountability in the public sector have helped to focus attention on performance measurement as one of the essential tools at our disposal. To be held accountable, we need a clear understanding of what we are trying to accomplish and how to assess the results in such a way that we can continue to improve. Indeed, this is why performance measurement in government has become such a hot topic. Osborne and Gaebler (1992) summed it up well in their landmark work, *Reinventing Government*:

- If you don't measure results, you can't tell success from failure.
- If you can't see success, you can't reward it.
- If you can't see failure, you can't correct it.

We work to achieve results. Performance measures are indicators of work performed and results achieved. We have been using some form or another of performance measures since the beginning of time. All of that experience has provided us with useful insights. Like any tool or instrument, used with skill and finesse, it can be a powerful force in bringing about intended and desirable changes. But if applied

in a clumsy and ineffective manner, it can bring about unintended and undesirable consequences.

A useful way to begin thinking about how to effectively implement performance measures is to raise questions such as

- Who are the principle advocates for implementing performance measurement?
- What are the driving forces?
- How will the results be used?
- Who will be affected by the process?
- Do the key stakeholders (including everyone in the chain, from data collector to end user) share an understanding of what is to be measured, how it is to be done, and how the results will be used?
- Have the right measures been identified?
- Will the benefits gained justify the added burden —the cost to gather, process, analyze, report, and interpret the data? Is there a simpler and less costly way to achieve similar results?
- Will the information developed be relevant and used as a basis of some action?

Recognition of the need for and the initiation of performance measures may come from any part of an organization. There is no cookie-cutter approach. Performance measurement may emanate from

- Front-line people asking for better tools to measure and achieve consistency and quality in the products and services they provide,
- First-line managers searching for ways to evaluate the productivity of their employees,
- Midlevel managers seeking to gauge the effectiveness of their programs,
- Senior managers who want to assess the efficacy of their policies and strategies,
- Elected officials evaluating the impacts of legislation and budgets, or
- Constituents or customers who are concerned about how their tax dollars are being spent.

The possible pathways to the introduction of performance measures are almost limitless, which is both an opportunity and a challenge. There is no standard recipe.

It does not take long for the seemingly simple idea of measuring performance to become complicated. One of the great dangers as we strive to streamline our organizations is that we might create cumbersome procedures and new bureaucracies to manage the process of change, thereby potentially impeding the very improvements we are striving to achieve.

Consider the case of a major company as a beacon to warn against such unintended outcomes. The company was one of the early pioneers in applying the principles of total quality management, which embraces the need to carefully measure results. In a decision to compete for the coveted annual Baldridge Award, the nation's highest honor in recognition of quality organizations, it became necessary to document and measure in detail not only the results of their product and service improvements but also the very processes by which these improvements were being achieved. The net result was that while the company was winning the Baldridge Award, the seeds of decline were sown. By focusing so rigorously on the internal documentation processes required to win the award, the employees of the company lost sight of the external focus on their customers that sparked their quality journey in the first place. It took a change in leadership, not long after winning the Baldridge Award, to help the company regain the clarity of purpose that had led to its earlier successes.

A sense of perspective is vital in thinking about how to embrace the idea of performance measurement without becoming crushed by that same embrace. Performance measurement is a means to an end, not an end in itself. Clarity is needed about the purpose, the true driving forces, the intended audience, and the use of the information. Instituted in an ill-conceived way, performance measurement can cause more harm than good. On the other hand, when introduced in a supportive environment and handled with sensitivity and common sense, performance measurement can help organizations and individuals succeed and be perceived as successful.

Introducing the process of performance measurement is by no means a benign or neutral step. In fact, one of the precepts is that what gets measured gets done. This can be a powerful motivation for positive outcomes, but it can cut both ways. (Beware the perils of unintended consequences.)

In my own case, in Maryland, one of the first applications of performance measurement was to report each year to our elected officials on the percentage of projects put out to bid as promised in our latest program and budget. We had in the past managed to dig a deep hole for ourselves by systematically overpromising and underdelivering. Our track record for on-time project delivery was under 30 percent throughout the 1970s. That dismal record cost us dearly in lost credibility and a resulting lack of financial support for our programs. Who would want to commit funding to an agency that had a two-to-one chance of not delivering what it promised each year? Not too many, as it turned out.

We set out to change that track record. And we succeeded, helped in large measure by the use of a few key performance measures. Several key steps

were involved, including defining clearer objectives, providing the necessary resources, and measuring performance in terms of a strict adherence to project schedules. We posted the results in our main conference room, where we held weekly meetings that focused on our letting schedules. We celebrated successes. Very quickly the organization got the message: the schedule is sacred.

The widespread attention within our organization to this easily understood target, "no slips," became a unifying force that lent credence to our overall team-building efforts. Teamwork was essential. Projects could not get out the door without the orchestrated activities of many individuals and groups. We had a clear goal and a scorecard that would openly reflect our collective successes and failures.

The results were impressive. Within 2 years, our success rate was nearly 100 percent. Several factors were involved, but the two most important were

- Intensely focusing the energy of the entire organization on the letting date for a project as an inviolable pledge and
- Tracking our progress through the use of one simple measure: "percent of projects advertised for bids within the budget year as promised."

Our newfound progress in meeting schedules was well publicized internally and in our dealings with elected officials. The use of this key performance measure was a key factor in gaining critically important increases in funding. Legislators were willing to support such increases when our agency could be counted on to deliver the projects they were promised, on time.

Some time was spent on self-congratulation before we noticed that our focus on schedule had come at a price—literally. Our costs were increasing, largely because our blind adherence to schedules too often led to a decline in the quality of the engineering plans we were producing. This decline, in turn, led to costly field adjustments, extra work orders, and claims. Thus, in focusing our management and measurement systems on solving one problem, we had inadvertently triggered others. We had neglected to measure, analyze, and address all aspects of the problem, and we had failed to grasp the complex dynamics at play when measurement systems place disproportionate emphasis on some factors at the expense of others. If what gets measured gets done, then what does not get measured may not get done, or may not be done as well as it should be—a serious lesson for us all as we contemplate performance-based management.

It is vitally important to recognize from the outset the two sides of the performance measurement coin. The impacts of implementing performance measurement can be purposefully enabling or inadvertently counterproductive, enlightening or confusing, unifying or divisive, beneficial or burdensome. The bar must tilt sharply in the direction of net benefits if performance measurement is to make sense. This is usually, but not always, the case. It has a lot to do with how implementation is handled.

Implementing Performance Measures

Although there is no single recipe, not even a cookbook for the successful implementation of performance measures, many common ingredients, issues, and challenges are worth discussing.

Driving Forces

The driving forces, motivations, and characteristics that typically govern how performance measures are introduced range widely, from

- Strategic to operational initiatives: strategic policy (e.g., smart growth and the measurement of changing accessibility to critically important areas or groups) or efficiency (including operational measures, such as maximizing the number of transit revenue passengers per seat mile of transit service);
- External to internal response: to outside mandates from governors, legislatures, or commissions or to management initiatives from within;
- Comprehensive to selective processes: broad based and systematic, cutting across the entire agency, or focused, targeted to certain key areas;
- Top-down to bottom-up approaches: driven down into the organization by front-office leadership or percolated up into the organization from front-line staff or first-line managers; and
- Voluntary to mandatory participation: invited, for those who are willing and motivated, or required, to achieve cross-cutting consistency and completeness.

Leadership

Notwithstanding the driving force, implementing performance measures cannot be a casual, off-to-the-side process if it is to succeed in the short run and be sustained in the long run. It requires sustained leadership. Certainly, the vision, energy, and commitment of the chief executive officer are essential if the effort is to take hold across an entire organization and be-

come a vehicle for constructive change. Just as essential is the leadership that must emerge from advocates and champions at all levels and across all functions who grasp the possibilities and choose to jump in with both feet. Finding and unleashing these advocates and champions is a crucial responsibility of the leaders of an organization.

Buy-In

Implementing performance measures will eventually affect just about everyone within an organization, and many who are outside. Understanding what is important to them—their perspectives, needs, concerns, and priorities—and fashioning an approach that gains their acceptance and support is vital. Nothing can deflate an initiative faster than intransigence or indifference.

Within the organization, stakeholders will undoubtedly be asked to invest time, energy, or other resources. They are likely to respond by asking (either explicitly or rhetorically), "What's in it for me?" From the front office to the front line, internal stakeholder buy-in ultimately depends on the intuitive application of a simple equation:

benefits − burden = positive value

When the net benefits to individuals and organizational units are not perceived as being worth the effort in terms of value gained, buy-in will not be long lived, no matter how strong the initiative may be. Conversely, even when factors such as inadequate communication or burdensome processes diminish the effort, if the value gained at the destination is worth the price of getting there, your colleagues are likely to get on board for the trip.

Gaining buy-in from external stakeholders is different. External stakeholders, with some exception, typically will not bear the direct burdens of implementing performance measures. For them, it may be a matter of why they should bother paying attention.

For sponsors and overseers (such as governors and legislatures), buy-in may be preordained if they were, in fact, the initiators of the effort (as has been the case in several states). Gaining even stronger buy-in under these circumstances is possible by making a convincing case that the sponsors and overseers have been heard, that the agency is responding, and that the questions that were raised will receive valid and useful answers. However, if the initiation of performance measures did not emanate from sponsors and overseers but their receptivity and response are crucial to a successful effort, they will need to be brought on board in a more deliberative manner. Buy-in under these circumstances may be best accomplished by providing interesting and useful results at the first appropriate milestone as opposed to creating advanced expectations that may not be completely fulfilled.

Most end users cannot be expected to exhibit great interest in the process of implementing performance measures. However, if it is clear that what is being measured is of direct concern to them as users and that it will provide the basis for some action that will improve services on which they depend, then they can be expected to show some interest. The level of engagement by end users can be strengthened by effective public involvement and public information processes in which it is evident that the citizen input really matters.

Gaining buy-in from "peer" entities can be the most challenging. Peer entities are individuals or organizations whose voluntary cooperation and involvement are essential to success. (For example, to an MPO attempting to implement transportation system performance measures in a region, the voluntary cooperation of the state transportation agency, the public transit operator, and the local traffic engineer can be vital to success.) The issue here is how to create a mutuality of interest that has a reasonable chance of leading to a cooperative effort and a win-win outcome. This is easier said than done, requiring insightful strategies, skillful negotiation, and boundless good will, all of which are typically in short supply.

Internal Ownership

Setting up the organizational framework for implementing performance measurement can spell the difference between success and failure. The strategic and policy implications, the technical processes, the need for consistency, and the value of champions all seem to imply some degree of central direction. Yet if performance measurement is to become a permanent way of doing business, it must be ingrained in the day-to-day business practices of the entire organization in a manner that is highly decentralized. Finding and instituting the appropriate balance is not easy.

The most successful customer-focused organizations do not rely on a centralized customer service office to handle all complaints. Instead, every employee interaction with a customer is viewed as an opportunity for that individual on the front line to enhance satisfaction. Similarly, the "kiss of death" for performance measurement is to concentrate owner-

ship and directive authority for implementation in the hands of a centralized team. The inevitable result among those responsible for implementation is to perceive that performance measurement is primarily needed to satisfy "them" (in the "ivory tower") and that there is really little or nothing in it for "us." Such perceptions, which are not uncommon, are not indicative of a thriving system that is likely to be sustained over the long run. Sooner or later, the front line prevails.

It is not uncommon for the organizational focal point of such initiatives as performance measurement to be housed in an administrative, planning, finance, or information technology office. That, in and of itself, is not the kiss of death, particularly if those charged with the responsibility see their role as facilitative, supportive, and training oriented, with the real ownership vested in the functional area (e.g., the bridge staff "owns" the bridge performance measurement system, the pavement staff "owns" the pavement performance measurement system).

On the other hand, it is not uncommon, particularly in large organizations, for such support staff to assume a more directive and controlling role. This is usually a very fundamental mistake (except under the most dire circumstances). It invariably diminishes the sense of ownership, the level of creative energy, and the long-term commitment that can be forthcoming when the functional experts own, place value on, and put to effective use the information and insights gained from implementing performance measurement.

Technical Capabilities of Staff and Systems

It is important that initial efforts at performance measurement be commensurate with the level of technical capability of the staff and the level of sophistication of current data acquisition and information technology. Neither postponing the implementation of performance measures nor embarking on a crash effort to improve technical capabilities seems as prudent as starting modestly, within the limits of available resources. This approach will ensure that the energy and efforts can focus on applying and using to advantage a first generation of performance measures that can be expected to improve through a building-block approach that builds on experience.

Because measurement of performance—particularly that focused externally on the transportation system—is so specific to unique geographic locations, the value of a geographic information system cannot be overstated. To the extent feasible, building databases using common geographic referencing and containing current information about particular assets, features, and characteristics of the systems will greatly facilitate the implementation of performance measurement.

Right Measure Selection

At some point, the process of implementing performance measures boils down to deciding on the specific measures to be used, a process that requires more thought than is often given. The price of selecting poor measures, or even the wrong measures, can be fatal to the overall effort, going well beyond wasting the money invested. The price includes the loss of technical credibility vital to making the process a success and the failure to gain the benefits that were anticipated.

In selecting measures, an array of questions must be addressed:

- Do the measures get to the heart of the key issues?
- Are the measures readily understood by all affected parties?
- Will measures be interpreted with consistency?
- Are the measures too complex, at the expense of being comprehensible?
- Are the costs to collect, validate, and update the underlying data within reason, particularly when weighed against the value of the results?
- Can easier, less costly measures satisfy the purpose, perhaps not as elegantly, but in a way that does the job?
- Are the measures too simplistic at the expense of offering useful insights?
- Do the measures assess outcomes that reveal key results, or do they assess outputs that measure level of effort, which may not be the best indicator of results?

Looking at the work of some of the pioneers in performance measures, some lessons are worth noting. All too often,

- Too many measures have been introduced in too short a time frame.
- Measures tend to be overly complex.
- Definitions, applications, and interpretations are not consistent.
- Time involved and the costs to collect and update the data were underestimated.
- People involved in the collection and compilation of data were not consulted, fail to see the value, and have not bought in.

- Measures reflect the process but not the results.
- Measures are not aligned with stated policies, strategies, and goals.

Most transportation organizations have undertaken some initiative to implement performance measures in some manner. Their experiences provide the best lessons.

System Measures Versus Organizational Measures

The so-called balanced scorecard, developed by Robert Kaplan and David Norton, addresses the distinction between internally oriented performance measurement, which focuses on business processes and employee perspectives, and externally oriented measurement, which is characterized by a strategic perspective and an orientation to the customer. Although the distinction between internal and external seems distinct, it also seems clear that the two are inextricably related in that the former typically exists only to serve the latter. Organizations generally exist to perform a function and provide a service. We can measure the internal functionality (e.g., revenue per employee) or external functionality (e.g., customer satisfaction) of an organization, or both. In most cases, the functionalities reflect different facets of the same stone, that is, whether the organization is successful in achieving its purpose.

Positive internal indicators do not ensure positive external indicators. For example, it is possible to be very efficient about doing the wrong thing. Similarly, positive external indicators do not necessarily mean that successful results are being provided in the most efficient, cost-effective ways. Clearly, both are needed to gain the most complete view of organizational effectiveness.

For transportation agencies, measuring system performance can be more challenging than measuring internal functionality. So there may be a tendency to initiate measures that consider effectiveness from the inside looking out, rather than from the outside looking in. But there is no substitute for taking the perspective of the end user: measuring pavement smoothness by running an instrument over the road, measuring mobility by looking at travel times, measuring reliability by verifying transit schedules, or measuring safety by looking at crash frequency.

External measures should be driven by both customers and the agency. Smoothness of pavement, level of congestion, reliability of transit service, perception of safety are all real and visible features to end users. Therefore, they must be important to an agency that is seriously interested in the degree to which it is successful in providing the products and services that represent the reasons for its existence. Additionally, the agency must draw on its technical expertise in looking at measures that, while ultimately important to end users, may not be readily visible or understood. For example, indicators of structural adequacy for bridges and retaining walls and indicators of reliability for traffic control systems may be less visible than others but certainly no less significant to monitor and measure.

Interagency jurisdiction and collaboration can represent unique challenges in implementing external system performance measures. For example, in a case of shared responsibilities, such as running buses over a highway network, both the scheduling and operational skills of the transit provider as well as the traffic engineering skills and priority status afforded transit by the highway agency are reflected in the same measure of overall bus travel speed. Similarly, measuring overall regional highway performance might be a mission undertaken by an MPO but that also involves local streets, state highways, and possibly toll roads, all under multiple jurisdictions. Simply gaining agreement on what will be measured, how, how frequently, and at whose expense can be an enormous challenge.

Jurisdictional issues also arise in terms of the relative roles of sponsoring agencies versus operational agencies. Particularly challenging is sorting out roles between the agencies that provide funding and are involved in overseeing and monitoring, and the agencies that receive funding and are on the line to implement and operate. Implementing agencies typically react negatively to a report card that compares them unfairly against peers, which may be substantially different in ways that can profoundly affect the results of comparative measures.

It is difficult to conceive of useful and productive measures of transportation system performance when there is controversy or conflict among agencies over turf issues, areas of responsibility, or the selection of particular measures and how they may be used. Under such circumstances, more effort and energy may be wasted in manipulating, maneuvering, and defending than in applying and using the performance measures themselves. It is therefore essential to anticipate and resolve amicably the contentious issues that are likely to arise when interagency jurisdictional issues are involved.

Omnidirectional Alignment

Identifying performance measures sends extraordinary messages throughout an organization. By infer-

ence, what gets measured is viewed as being more important and what is not measured as less important. For performance measurement to thrive, indicators of what is important in an organization—goals, strategies, policies, programs, and projects—must be aligned in all directions: vertically, spanning the hierarchy; horizontally, spanning the functional specialties and geographic turf; and diagonally, spanning horizontal and vertical dimensions simultaneously. It is surprising how often this alignment simply does not occur. It is not good for headquarters to focus on key measures of critical importance to the leadership while the field, where much of the work gets done, is on a different page. It does not help if one or more of the essential organizational units responsible for working together on a particular initiative fails to understand the effort required and the results expected. Yet how incredibly common is this occurrence in our collective experience?

At one end of an organization, polices, strategies, and goals are articulated. At the other end, operational activities produce outcomes. The need to define those outcomes in the context of performance objectives and measures that align with policies, strategies, and goals is fundamental. Clear and focused communication and teamwork among all affected organizational units, as well as strong and sustained leadership and commitment, are keys to achieving omnidirectional alignment. It is a never-ending process of sensing differences, responding constructively, and developing a clear consensus.

Survival

One of the major questions we face in introducing organizational change is whether the changes will be sustained over the long run, whether they will be unceremoniously dropped at the next change in leadership, or whether they will simply fade away over time.

The common goal of champions of change is to institutionalize what they perceive as new positive practice. Certainly, this is what would be expected among the sponsors of performance measurement. Barring a conscious effort to the contrary, the hope would be that performance measurement would become so deeply ingrained in the culture of the organization and the benefits so apparent that it would be unthinkable to stop. The tendency at all levels would be to continue the practice because it works well.

The key is to address the issue of ingraining such changes in the fabric of an organization at the very outset. The manner by which the first seeds of performance measures are sown will have a strong bearing on whether the underlying philosophy and day-to-day practice become firmly rooted. It depends in no small way on whether there is a well-thought-out strategy for implementation developed with the involvement of the people who will be affected, from data collectors to decision makers.

- Is there a well-thought-through plan of attack?
- Is the plan being discussed openly and often?
- Is the plan well understood?
- Is the plan widely supported?
- Is the plan taking root in a systematic and deliberative manner?
- Is there provision built into the plan for refinement and continuous improvement?

Implementing performance measurement is not a cakewalk and is not to be taken lightly. It demands strong leadership coupled with sensitivity, skill, good will, and intuitive common sense. If it seems right, it very likely is. However, if it seems wrong, it likely is too.

U.S. Department of Transportation Experience

In 1992, the then-new administration in Washington initiated the National Performance Review under the leadership of Vice President Al Gore. In 1993, the U.S. Congress enacted the Government Performance and Review Act. The legislation required each agency to develop a 5-year strategic plan; define its missions, goals, and objectives; establish annual performance plans and budgets; identify performance measures; and prepare an annual performance report.

Within the federal establishment, the U.S. Department of Transportation (DOT) has been praised for its work in establishing national performance objectives and measures. However, the response from state and local transportation officials has been quite different. From their perspective, federally developed measures applied to highway and transit systems owned and operated by the states and localities have been inappropriate and intrusive.

This dilemma is fraught with difficulty. The federal government finances a significant share of capital investment on the nation's arterial highways and transit systems. From that perspective, it makes sense for Congress and U.S. DOT to seek ways to measure the effectiveness of these investments in terms of safety, service levels, and structural integrity of the nation's principal transportation infrastructure. However, the states and local areas own, operate, and maintain these arterial highways and transit systems. Many of

them recoil at the idea that national performance standards could be imposed that might not be relevant to their unique situations but that could be perceived by some as reflecting unfavorably on them. They argue that decisions on performance objectives to adopt, investments to make, and projects to pursue are the responsibility of state and local governments in response to circumstances that the federal government is incapable of dealing with and that are neither consistent nor comparable from location to location. They point out that local differences are so great across the country that any attempt to measure performance on a national scale is inappropriate. They cite the largely discredited Hartgen report as evidence of the difficulty in drawing legitimate comparisons among transportation agencies with divergent characteristics and goals.

The dilemma has not yet been resolved. In theory, a compromise might involve dividing performance objectives and measures into national, regional, and local categories. National standards could apply to universally accepted measures (such as federally mandated bridge criteria, or adherence to uniform traffic control standards). Regional criteria might apply where sufficient consistency exists among such factors as climate, terrain, traffic characteristics, materials, and subsurface conditions. Regional comparisons could be valid for pavement and bridge performance, for example. However, it would clearly depend on eliminating the underlying variation in factors that are beyond the control of the agency but have a significant impact on condition. Some measures, such as level of congestion considered acceptable and levels of transit service provided, might be relevant strictly in relation to individual state and local area policies and objectives. Whether such a hybrid approach can be developed to the general satisfaction of federal, state, and local officials remains to be seen.

State DOT Experiences

Most of the state DOTs have initiated or experimented with performance measures to some degree. A few states, including Florida, Minnesota, and Oregon, have been at it for some time. In no two cases have state DOTs undertaken performance measures for identical reasons and implemented them in the same way.

Florida

Florida represents a particularly good long-standing example of the power of performance measurement. In 1984, after a revenue increase, the legislature made its policy direction to the Florida Department of Transportation (FDOT) unmistakably clear: it was not satisfied with the level of maintenance statewide and wanted system preservation to take priority over system expansion. For the first time, FDOT defined performance standards for bridges, pavements, and overall quality of maintenance. The measurement systems were easily understood by practitioners and politicians alike, and they turned out to be effective.

Annually, using clear and comprehensible charts, FDOT graphically displays these adopted performance objectives and its progress for the year and for preceding years in relation to that standard. Therefore, it is possible to ascertain at a glance what the objective is, whether it is being achieved, and what the year-to-year trends are. It also is possible for the legislature, the governor, the Commission on Government Accountability to the People (the so-called GAP Commission), the Florida Transportation Commission, MPOs throughout the state, and FDOT staff from senior levels to the front lines to confirm that the legislature's mandate is being heeded, with performance standards set and steady progress being made. The value of such an approach to an agency's credibility is incalculable, particularly when continuous improvement can be easily demonstrated.

Minnesota

Minnesota's initiative, known in its early days as the "Family of Measures," has received a lot of national attention. In contrast to that of Florida, its roots lie within the state DOT itself, although later on, the legislature began requiring it. It also was a broader, cross-cutting approach, embracing about 40 measures in three general categories: system performance, organizational performance, and societal values (e.g., social and economic factors, the environment).

More recently, the focus in Minnesota was moved to an emphasis on business planning, using measures to assess performance with respect to strategic objectives drawn from the agency's strategic plan. Many of the original measures remain in use, so it seems fair to say that the Minnesota DOT performance initiative continues to refine and adjust based on a solid foundation. The four key categories of strategic objectives are

- Level of service in interregional corridors (i.e., specified percent of miles achieving a threshold average travel speed),
- Multimodal options,
- Program delivery, and

• Information flow between department and customers.

Minnesota also has full-time staff engaged in conducting customer satisfaction surveys. The Minnesota approach has been generally well structured and seems to have evolved through changes in leadership.

Oregon

The impact of leadership changes in Oregon has been different. The state DOT's initial foray into the world of performance measures was intensive, focusing heavily on individual and organizational efficiency and effectiveness; it penetrated to the level of work units and employees. A pay-for-performance system was attempted for a while. The entire system, which was geared to the leadership style in place when it was instituted in the early 1990s, changed direction dramatically with a subsequent change in leadership.

Transit Agency Experiences

The use of performance measures by transit agencies was recently given a boost with the publication of the Transit Cooperative Research Program Report No. 47 (Morpace International and Cambridge Systematics, 1999). The report provides detailed guidance based on a proposed approach and research conducted at transit agencies in Chicago, Illinois; Albuquerque, New Mexico; and Lynchburg, Virginia.

San Diego, California

The San Diego Metropolitan Transit Development Board is among the nation's leading public transportation agencies in the application of performance measures to guide its most critical decisions on deployment of service. A formal board policy governs most decisions on adding as well as retaining service. Existing transit routes are routinely evaluated on the basis of four critical measures—subsidy per passenger, passengers per revenue hour, passengers per revenue mile, and passenger miles per seat mile—and compared with statistical means and variations in one of six stratified categories. Appropriate actions are triggered when performance dips below set thresholds.

A similar set of measures is used on a predictive basis to guide decisions on new service. A unique "sunset" provision will terminate new service after 2 years unless positive action is taken by the board on the basis of demonstrated performance.

The system of performance measurement to guide service and resource allocation decisions is an outgrowth of a well-established organizational culture that began with the application of performance measurement in a more strategic context, relating to agencywide goals, objectives, and system performance criteria.

Dallas, Texas

Dallas Area Rapid Transit (DART) is another public transportation agency that embraced performance measurement. The impetus came from management within the agency, and performance measurement has become an instrument of board policy in determining the cost-effectiveness of existing service and evaluating internal efficiency. DART uses measures such as subsidy per passenger and cost per mile to evaluate the cost-effectiveness of current bus routes in four separate categories. A key internal indicator of management efficiency and relationships between management and labor is the "pay-to-platform ratio" of operator hours in the seat compared with total number of hours paid.

DART also has used performance measures to benchmark against other transit operations on an aggregated basis but has encountered some difficulties because of differences in criteria, definitions, and cost-allocation method. One key to the success of performance measurement in this agency is the working relationships among staff in the planning and finance offices who make it all happen.

MPO Experiences

The Metropolitan Washington Council of Governments (COG) is the MPO for the National Capitol Region. COG uses advanced technologies to measure performance on the region's overstressed highway system. Arial photographs are used periodically to measure traffic density on freeways and parkways. From mathematical models, speed, travel time, and level of service are calculated and compared for the same segments over time. Similarly but with a different technology, the speeds, travel times, and levels of service are derived on surface arterial streets from sample traffic probes using vehicles equipped with Global Positioning System receivers.

Although Washington-area commuters do not need this system performance data to tell them what they already know from their day-to-day experience with traffic, the periodic release of this information cap-

tures the attention of the press and the public to a remarkable extent. These performance measures thereby become a vehicle for stimulating public interest in regional and local policy issues involving land use, growth management, financial resources need, and political will to tackle difficult traffic congestion issues.

Synopsis of Experiences

Performance measures are used in a variety of ways. Clearly, at their best performance measures become critical policy and operational parameters that can both gauge reality and guide possibilities.

Several lessons summarize experiences gleaned from two major sources: the several hundred transportation professionals who participated in a 2-h seminar on performance measures over 3 years (as part of AASHTO's National Transportation Management Conference held five times each year) and interviews with and review of materials from the transportation agencies cited in this paper:

- Most transportation agencies have implemented a form of a performance measurement system.
- Performance measurement among transportation agencies varies in every conceivable way.
- There is little dispute about the long-term desirability of performance measurement from a philosophical viewpoint.
- Some participants view performance measurement initiatives as an add-on, a burden, and not integral to their normal functions.
- In some agencies, the emphasis is on measuring the process, not the end result; in others, the focus is exclusively on the end result, without much regard for the process.
- In some agencies, the emphasis is on the performance of individual employees as opposed to organizational units or the transportation system itself.
- A variety of measures are being applied; some are well thought out, and others are ill conceived.
- Agencies' measures focus on inputs (such as dollars spent on resurfacing), outputs (such as tons of asphalt placed), outcome (such as road smoothness achieved), and value (such as level of customer satisfaction).
- In the majority of agencies, there is the tacit belief that in one way or another, performance measures are not a fleeting trend but have become a permanent way of doing business and that under the right circumstances, they can be vitally important in contributing to achieving positive change.

Other Key Lessons

- Adopt a limited number of important measures with clear purposes.
- Measure only what you are sure you need.
- If you measure too much, costs will soar while focus fades.
- Measures and presentations should be as simple and straightforward as possible.
- Make the system to implement performance measures simple and supportive.
- There is no perfect measure, so do not waste time and money in an effort to find it.
- If you measure the wrong things, they are what you will be held accountable for.
- Avoid the unintended consequences that can result from imperfect or incomplete measuring systems.
- Be wary of misinterpretation and misuse of information.
- Performance measurement may not survive a significant change in leadership priorities unless it has widespread and deep-rooted support, so
  - –Involve stakeholders in deciding what to measure, how to measure, and what to do with the results;
  - –Use measures to tell the true story, while focusing on opportunities and not allocating blame;
  - –Question everything; and
  - –Continuously improve.

Reasons for Optimism

About 150 managers a year, mostly from state DOTs and a few from U.S. DOT, participate in the AASHTO conferences. These conferences are major sources of the lessons listed above. The participants typically are senior managers or are within one promotion of occupying a senior management position within their agencies. They are an excellent indicator of what the future holds for our transportation organizations. On that basis, downsizing and bureaucracy-bashing notwithstanding, I can say with confidence that the outlook is very promising.

These participants generally represent a new generation of public-sector professionals. They are sophisticated and smart. They question everything. You can sense that they would be successful working anywhere, but they are with the state DOT for the right reasons: the satisfaction that comes from providing services vital to the basic needs of our society. The vast majority of these transportation professionals are comfortable with the concept of defining strategic objectives, meeting customer expectations, and mea-

suring performance. They accept—indeed, many embrace—the idea that they and their organizations are accountable for their performance and that their performance will likely be compared with that of the private sector and of other agencies. This emerging generation of managers does not seem to shrink from competition. They simply insist that the playing field be level.

You cannot help but be impressed. These future leaders are here to do a job and do it well. Most agree that performance measurement is the vital scorecard they need to get the word out on just how good they are while they focus on where to improve. They are the future captains who will guide us through the historic sea change that is transforming the public sector.

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Panel Discussion

Jennifer Finch, *Colorado Department of Transportation*
Darwin Stuart, *Chicago Transit Authority*
Mark Pisano, *Southern California Association of Governments*
James Glock, *City of Tucson Department of Transportation, Moderator*

Integrating Performance Measures into Management Systems

Jennifer Finch

I will be talking about how we look at our transportation investment strategy in Colorado, linking it to performance measures and trying to get alignment from a top-down approach to a certain extent and a bottom-up approach. We definitely have had a lot of discussion at the commission level on what our investments are. We also have performance-types of issues that are working at the lower levels.

The Colorado Department of Transportation (CDOT) selected five investment categories:

- Strategic projects,
- Program delivery,
- System quality,
- Safety, and
- Mobility.

These categories are at different stages of development within themselves. Right now we are reporting our budget out in terms of our investment categories. Not all of the decisions have been made for the financial resources based on these performance measures yet, but that is the direction we are heading. It survived a change in administration, change in executive director, and several changes in commissioners—who, instead of slowing the process down, said "This is good; let's do it faster." So we are quickly trying to get at an investment strategy and investment decisions that are based on performance measures.

One of the first steps after defining our major business functions (the five that I mentioned above) was to determine what the transportation commission wants to accomplish for these five areas. The commission has been 2 years defining business categories, goals, and objectives for each of these categories but wanted to get something that the customer could understand. So the definitions do not stick with organization units in any way, shape, or form. They definitely are cross-cutting, so no one organizational unit is responsible for safety or for system quality. But that is the way the public perceives the different areas. The commission wants to be able to be responsive to the customer and provide a balance between some of the technical measures and some of the quality-of-life types of measures that people bring forward.

There has also been a legislative mandate to set up a pay-for-performance system. This is something that is, to some degree, creating conflict within the organization in implementation. In terms of trying to have a clear mission for the department, we have worked very hard with our investment categories, setting the goals and objectives. Just this last summer, the transportation commission adopted the following investment category goals and objectives:

- Safety: reduce transportation-related crashes, injuries, and fatalities as well as the associated loss to society.
- System quality: preserve the transportation system and keep the system available and safe for travel.
- Mobility: improve mobility and increase travel reliability.

• Strategic project: accelerate the completion of the projects and increase investment in the program.
• Program delivery: deliver high-quality products and services in a timely fashion, attract and retain an effective and qualified workforce, and foster an environment that respects workforce diversity.

The commission did not yet adopt performance measures though. The commission sees performance measures as more of an evolving type of system that may need to change based on the data we have available and on the reporting for those performance measures as to whether they are helping us get at the objectives and goals that we want to see. They are trying to focus on the key areas shown in Figure 1.

There are a multitude of performance measures. We tossed several of them out and said we can only do a few of them, focusing on what type of information we already have, what types of management systems we have in place, and how we can best make use of them before we start filling in the gaps with additional data that we need to provide. We divided these measures into three key levels or tiers (Figure 2).

The desire is to focus the commission at an investment level, where a few key performance measures can be tried to give a snapshot of the entire department. There is a broader range that focuses on our core service areas and program types of levels, such as pavement management. That is where upper management and middle management are going to focus a lot of their attention. Those measures get aggregated and rolled up to the investment level. Then we have tools and services, or service delivery. That is the front-line people—what makes sense to them; what the measures are that they need to know they are doing well within their department, unit, or program that they are working in.

The organizational structure of CDOT, like a lot of state DOTs, is decentralized, as illustrated in Figure 3. On the right are the different divisions and offices that are going to be working on some of their own data collection. They have some of their own performance measures and will report them upward, as shown in Figure 4. My division aggregates those measures to report them back to the executive director, the commission, the legislature, and the government.

We are in the process of going out to our regions. So far, this effort has been primarily top-focused. The commission has defined the mission, objectives, and goals. We are going out to the regions and trying to get them better acquainted with what performance measures are, what they do for daily decisions, and how they impact what the commission is interested in seeing. One of the major impetuses for this within CDOT was the commission asking, "So we set the policy and direction; how do we know whether staff is actually carrying it out?"

This process (illustrated in Figure 5) was a way to make sure that there was alignment from commission direction through all three levels of the management systems. We are looking at management systems that provide input into several different types of our performance measures. The training that we are going through right now is trying to make it work and say, okay, the commission has set some goals, objectives, and strategies. CDOT engineering regions and some of the major divisions that we have at headquarters are asking

• What are your core service areas?
• What performance measures do you need?
• What tools do you need to make better management decisions?

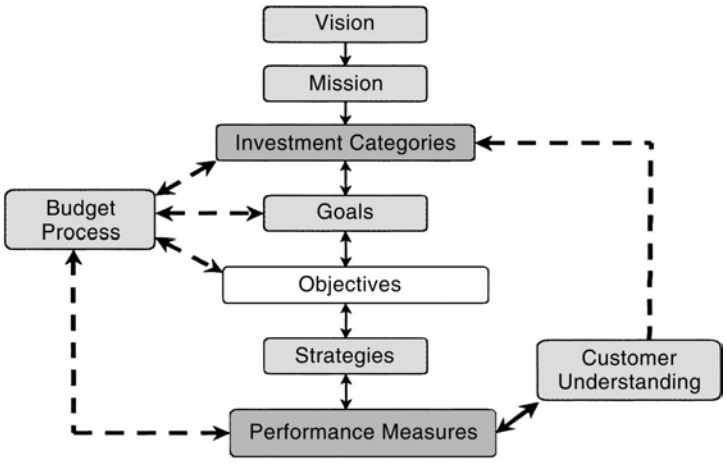

FIGURE 1 Investment strategy model.

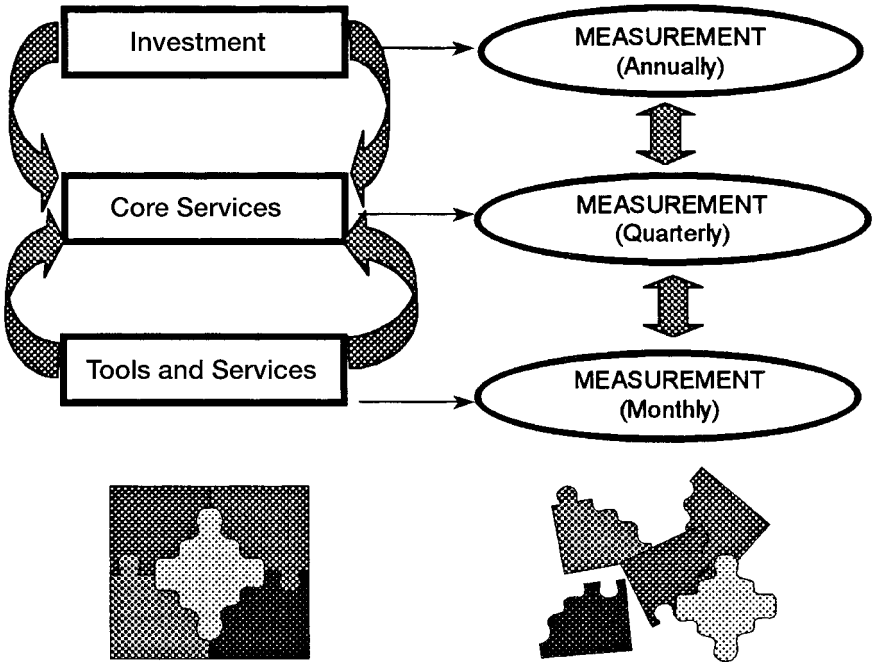

FIGURE 2 Level of measures and alignment.

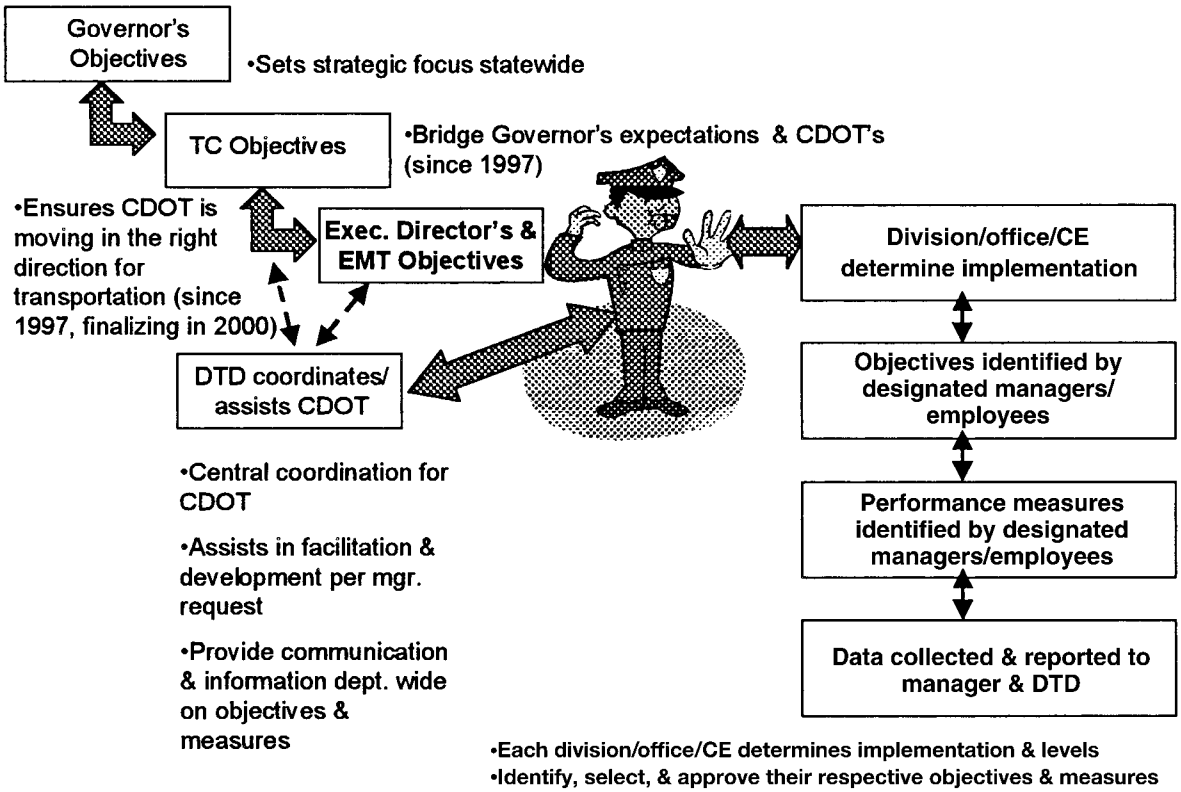

FIGURE 3 Roles and responsibilities for development and implementation of CDOT objectives and performance measures. (TC = transportation commission; EMT = executive management team; CE = chief engineer; DTD = division of transportation development.)

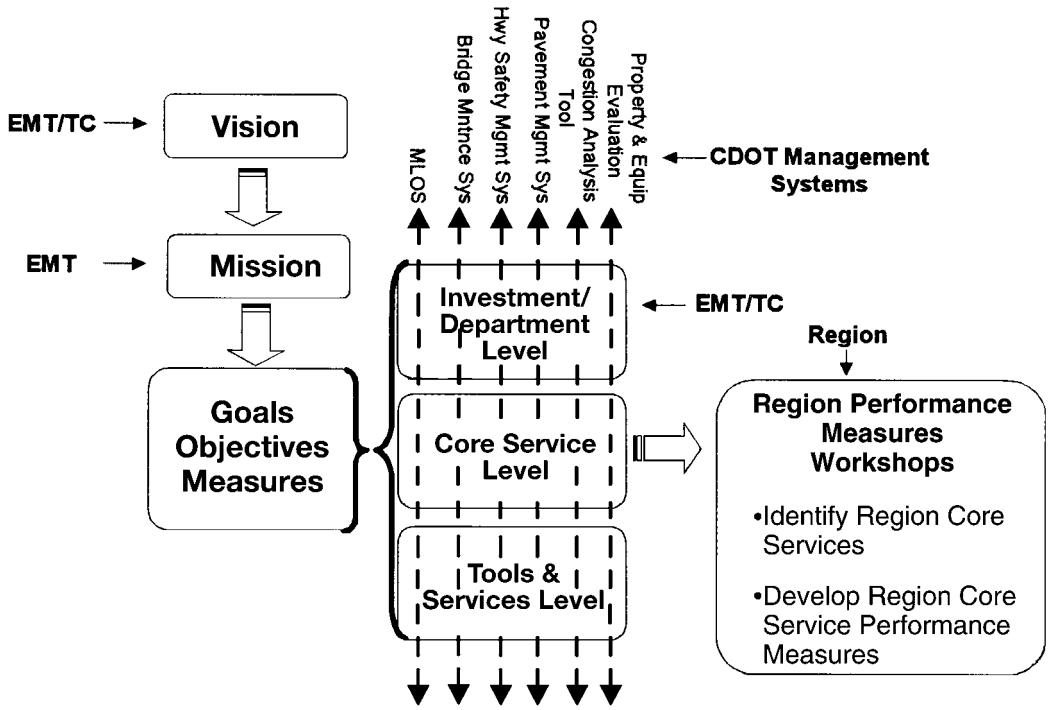

FIGURE 4 CDOT performance measures. (MLOS = maintenance level of service; Mntnce = maintenance; Mgmt = management; Equip = equipment.)

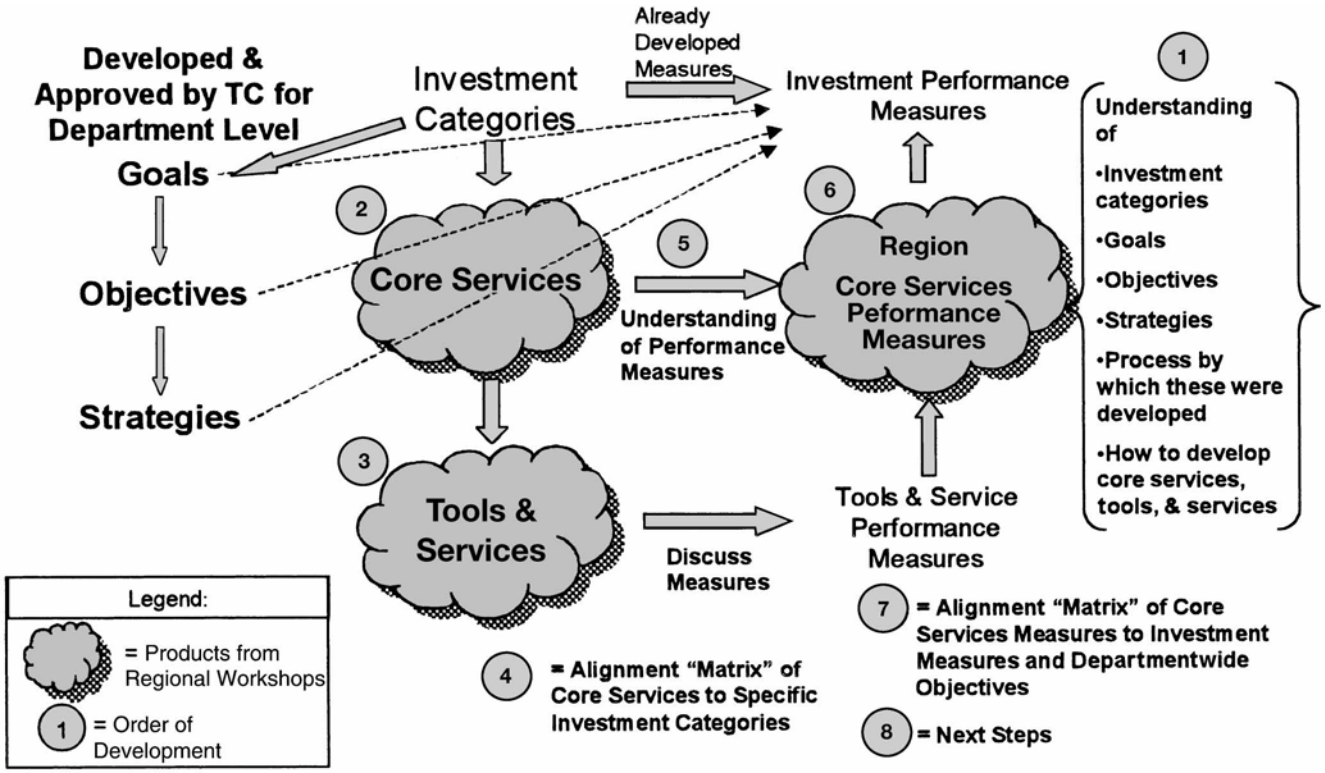

FIGURE 5 Region workshop flow and objectives.

So we are dropping down into that core service area, knowing that certain elements of what the regions are doing are going to feed up into those investment levels. But it also helps to provide feedback for the commission on the validity of some of the measures. They have selected some as we drop down: Do we have the data? Do we have everything we need for it? Are there better measures that some of our own employees can come up with that will give us a better, easier tool to measure performance?

We have found as we work with our regions that there has been a focus through several concurrent efforts. Our budget doubled, and we got the ability to do bonding, which made schedule and budget much more important for all of our projects. That emphasis on budget and schedule has thrown us out of whack with some of those softer-side environmental community impacts that were not getting measured. So we are trying to bring the balance back.

Here are a couple of examples. We have maintenance levels of service (Figure 6) and are currently rated overall for all of our eight major maintenance areas at a B− level. It is scored on a scale of A through F, just like a report card, as part of an annual survey. What we have and are using as a budget tool is a projection that we are at B− now. To get to a B, it would take additional funds to raise that level of service just 0.005 percent. Part of what we found is that there is a lot of deferred maintenance out there that we are paying for with major repairs instead of keeping up with it as an asset management type of scenario. We also have used these maintenance levels of service to project what would be needed to keep us at an A, B, and B+ area to have resources allocated to it as part of our 20-year planning process.

We did the same scenario with pavement; it is one of our oldest management systems, and it has gone through a lot of changes. We changed from a rideability index to remaining service life (RSL; Figure 7). The public understands "rideability" but has no clue what RSL is. But we can relate to the commission and match that with some of our customer survey information to ask the following: "How does the RSL correlate with customer satisfaction for the department overall, and how can we meet those objectives?" Again, we were able to make projections with those different funding levels for different goals that the commission might set (Figure 8). It has a 60/40 goal—60 percent in a good to fair condition, which they struggle with, saying "Surely you should be able to do better than that." But coming back to the balance of measures, they cannot put more money into pavement management without affecting other programs in the department.

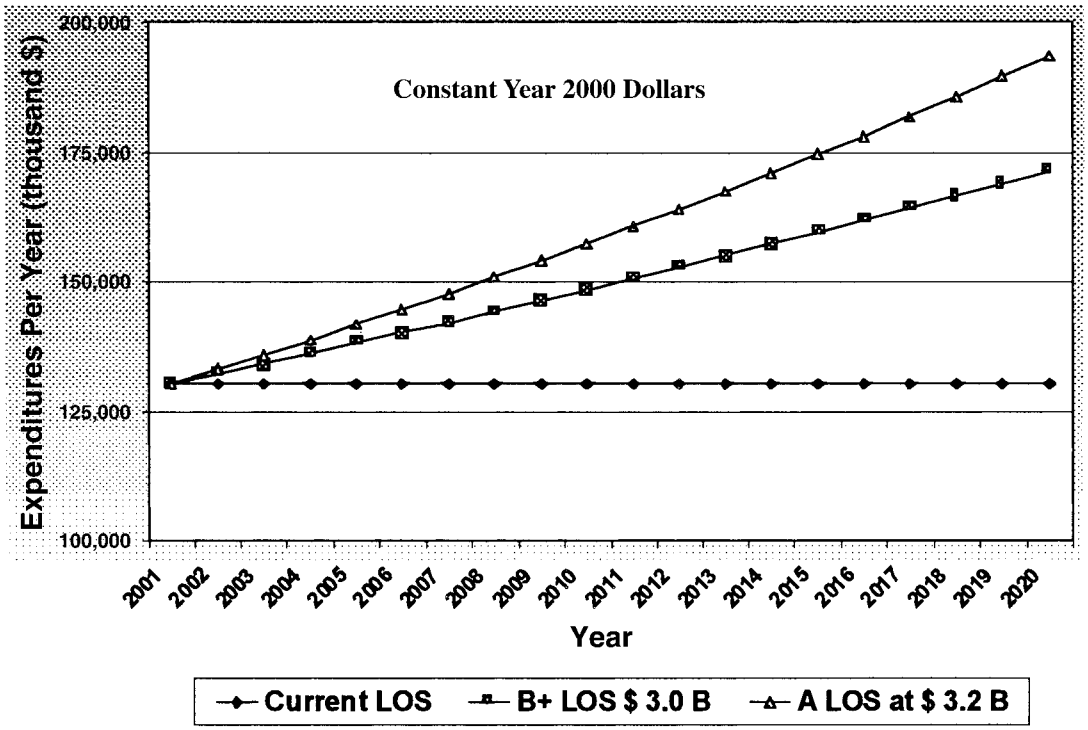

FIGURE 6 Maintenance level of service: condition projections by level of funding. (LOS = level of service.)

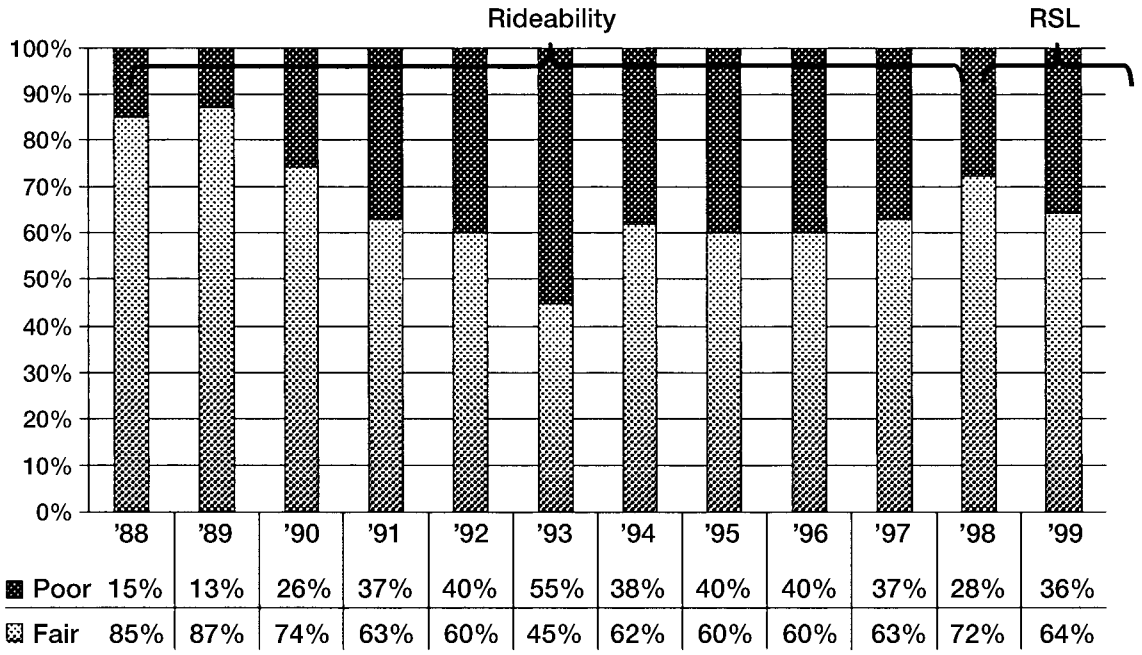

FIGURE 7 Statewide pavement condition. (RSL = remaining service life.)

We are integrating and incorporating our various systems with management systems. One of the key areas is trying to involve our employees. We have been doing a lot of outreach with our metropolitan planning organizations and our transportation planning regions to get them comfortable with performance measures and to get them to understand what they are. They are taking a "let's wait and see" attitude, not having a whole lot of resources. But they know that eventually it will affect resource allocation in the planning process and therefore are following it to the degree where they will be able to see where it is heading and where we are going.

No measure stands alone in this process. You cannot take just one measure and make all your budget decisions. Performance measures have to be balanced and used as a set to provide a complete picture of where your department is or what your program is doing.

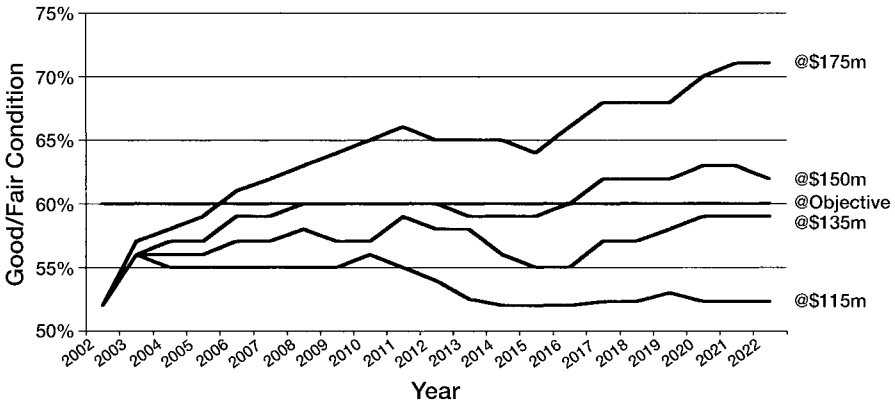

FIGURE 8 Pavement management program: long-range condition projections by funding alternative.

Role of Customer Input in Implementing and Using Performance Measures

Darwin Stuart

I will discuss two of the eight topics that Hal Kasoff discussed and go into them in a little more depth in terms of public transit agencies and how those topics might be important from their perspective. The two areas are

- Measure selection—from a transit perspective, customer input is an important part, even to the extent of seeing customers as stakeholders in the performance measures process, in terms of what and how to measure, and even perhaps what to do with the results—and
- Decision-maker buy-in—as part of the organizational culture, that is, getting commitment to use performance measures.

A couple of examples from our experience at the Chicago Transit Authority (CTA) might stimulate some questions in our breakout groups. In general in the transit business, customer satisfaction has become a more serious goal among an increasing number of transit operators. In Chicago, we have conducted customer satisfaction surveys three times now, biennially, and we appear to be committed to continuing that.

Let me start with customers as stakeholders and as sources of measures. The customer satisfaction survey that we completed in fall 1999 involved about 2,500 random-digit-dial phone calls to customers, with separate but related surveys for bus and rail, covering about 50 specific quality-of-service measures for each. In the course of trying to use the results of these surveys, we found that it is very important to let the customer define what is or is not service quality and then measure how much of it they are receiving. We have been successful in improving the customers' perception of service quality in several areas where we have taken initiatives to improve service. This includes, for example, service improvements related to fares, with the implementation of our automated fare collection system. We also reduced the price of the 30-day pass, and we introduced the 7-day pass in 1998. In 1999, customers told us that the two areas where we improved the most were the cost of the pass and the cost and ease of transferring. Service quality improvements, as defined by the customer, also were observed in vehicle cleanliness for both bus and rail. This is perhaps mundane, but it was among the factors examined. We also improved on schedule availability, operator courtesy on buses, and customer assistance on rail—all areas where, to some extent, we improved training and saw a positive result.

However, in other areas, work lies ahead. For example, customers continued to tell us that we were not doing as well as they might wish in bus on-time performance. We do now have a small pilot project under way on operator empowerment. For a sample of routes, bus operators are being given the discretion to take such actions as running express to get back on schedule, doing short turns to get back and replace a missing bus at the start of a route, and so forth.

In the course of working with customers on these kinds of performance measures, in the last survey, we also tried to define a three-part loyalty index as a summary measure that could relate to some of the other performance aspects of the transit system. This three-part loyalty index reflected overall satisfaction; willingness to continue to ride; and willingness to recommend the system to friends, relatives, and colleagues. We did find a significant performance increase in this summary measure of loyalty that matched up with ridership gains we have observed over the past 3 years. For example, our overall ridership gain of about 8.5 percent is made up of a significant increase in choice riders from 50 percent to 60 percent over the 2-year interval and a significant increase in the number of infrequent riders, riding only 1 to 4 days per week, from 37 percent to 49 percent. Both of these measures indicate an increasing ridership base. We also concluded that we need to continue to learn more about the hard-to-please choice rider as a major input to any continuation of ridership growth.

My second topic is decision-maker buy-in. After the first 1995 customer satisfaction survey, CTA was able to develop an interdepartmental task force to look at the results of that first survey and come up with corrective actions to address at least some of the areas where customer satisfaction needed to be improved. Task force work was strongly supported by CTA's top management. A couple of these action areas were fairly small, but they worked—customer satisfaction subsequently increased—and, more importantly, we did get buy-in from the interdepartmental participants, including operating and maintenance personnel at the line level.

Enhancing timetable availability, including station-specific timetables on rail, was one of these areas. We found increased customer confidence in the existence of reliable schedules and our ability to meet them. Another area involved improving on-board rail announcements, where again, some positive steps were

taken. In fact, we now have an automated rail announcement system.

The roll-out of a couple of major ongoing initiatives was tailored to respond to some of the concerns that customers gave us in our customer satisfaction survey, particularly the automated fare control system, which was modified after more than 2 years of implementation with regard to ease of fare payment and simplification of the system.

In the ongoing annual work on next year's budget, one of the guidelines for areas of discretionary budget allocation has been to reflect any potential to influence ridership increase, which in turn, reflects some of the customer satisfaction results that we have been looking at. One of the frustrations for some of us involved has been that the original interdepartmental task force that was put together sort of fell apart. We have not been able keep that kind of working group active as a tool to interact more directly regarding the results of the customer satisfaction survey. Instead, discretionary budgeting has been at the more general level of interpreting budget options in terms of how they may influence rider growth.

There are probably two key areas in which we need to pay particular attention to how we handle the process of implementing and using performance measures. The first is getting adequate customer input. Part of this depends on who exactly we feel the customer is going to be. The second involves the steps necessary to get adequate decision-maker buy-in and commitment to the use of performance measures in an ongoing process.

Transforming Bureaucracies

Mark Pisano

Thank you very much for inviting me and my organization to participate in an area that I consider extremely important. Let me also commend Hal Kassoff on his paper. It really is excellent. We can take our thinking even farther than Hal brought us in his paper.

Hal observed that government bureaucracies have existed since humanity's first attempt at building organized societies. Historically, we probably had organized activity for approximately 5,000 years before bureaucracies were invented. The Neolithic communities and the Paleolithic communities that Mumford talked about in *The City in History* (1961) indicate how well society operated without bureaucracies. The first society to really introduce bureaucracies was the Romans. We know what happened to that civilization. As we study Rome, we know that bureaucracy was at the core of why Rome fell: not because it lost military might, but because it could not deliver what the people wanted.

Then the world continued for another 1,500 years without bureaucracies. They did not come into existence again until the latter part of the Greek city-states, when we introduced double-entry bookkeeping and could keep track of trade flows. All of a sudden, we created bureaucracies for trade, and they evolved during the period of the nation-state, and the Baroque period, as Mumford called it, in the 19th Century.

Bureaucracies came into existence at that point in time and are alive, well, and kicking. We are also going to observe their downward slide and their demise because we are now in a different world. We are in a world of information, and everyone has the same amount of information. It is driving our political leaders and those of us who manage bureaucracies to a point of utter confusion, almost to disarray. As a result, you find that the public will not pay more money, people do not vote, and our democratic institutions are threatened. Performance indicators and performance standards are the vehicle to help us translate, transfer, and use information for bureaucracies to evolve into what they are supposed to do. The reason why those civilizations that did not have bureaucracies performed so well is that they had humanity at the center of all activity. They responded to the needs of the human individual.

Our task in the whole field of performance indicators is to understand what our societies want and

to develop vehicles through which we can measure, monitor, and evaluate, so that we can be responsive. If we do that and allow the entire field of performance indicators to truly humanize us, then bureaucracies themselves will evolve.

The theory that I am talking to you about has been in practice for the past 15 years. We began 15 years ago on a voyage of discovery relative to the whole notion of how we move the decision making within our region. My region has 186 cities, 17 million people. We have more debates, conflict, and fragmentation, and we have more ethnic and racial mix within our population than probably anywhere else on Earth. In fact, I do not think there is another place that has the degree of confusion that southern California has, and those of you who are not from here probably thought that before you even arrived here.

So what have we done? We began in the late 1980s and early 1990s with a comprehensive plan in which we took our region through a 4-year process of identifying the fundamental goals and what people really want. Our need to get input from individuals is at the core of performance indicators. We cannot develop them independent of what human beings within our respective jurisdictions think and want. I urge you to spend as much time and effort as possible on that process. By the way, your policy makers will love it. I have a board of 76 elected officials, and I have never seen my policy makers more animated or more engaged than when we went through the community dialogues that helped drive goals.

Then we focused on how we translate the myriad activities that we perform in transportation in a way that we can relate to those goals. We developed performance standards. We set up a peer review process. We had many individuals in this room and at universities participating in about a 3-year-long process of identifying performance indicators. The process measured activity relative to the outcomes of what people wanted and what we heard through our goal-setting process. We came up with this basic list of indicators:

- Mobility,
- Accessibility,
- Environment,
- Reliability,
- Safety,
- Livable communities,
- Equity,
- Cost-effectiveness, and
- Transportation sustainability.

I am not going to go through all these performance indicators. I prepared a paper that gives detailed definitions, the algorithms for them, and the databases that support them. We have a database of 356 geographic information system data overlay on our analytical and modeling capacity to translate these particular indicators into concrete outcomes or measurements. For example, mobility is the speed of getting to points, and accessibility is the ease of opportunity of getting to where you want to go. We have real, concrete explanations and measurements of these indicators.

We then went through a process of saying, okay, we have good performance indicators. Now, how do they relate to our current decision-making process or to the current comprehensive, continuing, and cooperative planning process? Let me tell you, in a complex society, it does not work. When you overlay the environmental impact study and review processes on it, it gets even more confusing. We have the public befuddled. They cannot understand whether we are coming or going in our planning processes. We basically asked, "How do we begin?" or "How do we frame this in such a way where we can understand and we can present hard, concrete information in terms that they understand so that they can begin to have confidence in our decision-making process?" We start off with goals right at the top, and then we formulate the problem; we have proposed solutions, and through these performance standards, we select from the whole range of activities: projects, programs, initiatives, and strategies. We subject them to a performance review, then prioritize solutions, and identify those that move us toward our goal. It creates a logical progression to make sense of the transportation decision-making process.

So that you do not think this is all academic, Table 1 shows some of the alternatives that my board was faced with in the first transportation plan in which these measures were applied. We looked at individual corridors in Orange County: SR-60 is an east-west route, and SR-10 is a diagonal route through the region. There is a whole set of different modes—truck lanes, commuter rail, mixed flow, light rail. Then we have the cost of these projects, the amount of the emissions reduced by the projects, the net present value of the benefits of each of those projects and the hours of delay. Included is an indicator that we use to help people sort these out—what the value of a dollar is and what the benefits are if you took a dollar and invested it. You see that we have some pretty unconventional results from this kind of analysis, where truck lanes clearly outperformed anything else we could do in our region. Investment in truck lanes is more beneficial than investing in light rail, buses, and so on according to these indicators.

All of my myths and predilections about transpor-

TABLE 1 Value of Corridor Improvement Alternatives

Corridor	*System*	*Estimated Project Cost (million $)*	*Emission Reduction (ROG tons)*	*Net Present Value of Benefits (million $)*	*Annual Delay Saved (million hours)*	*Value of $1 Invested ($)*
SR-60	Truck Lane	1,840	1.91	10,900	571	5.92
SR-60	Commuter Rail	112	0.32	124	0.32	1.11
SR-60	Mixed-Flow Lane	1,300	0.93	6,330	46.5	4.87
OC	Light Rail	1,700	0.25	1,904	0.21	1.12
SR-710	Blue Line	1,100	0.25	1,232	0.22	1.12

NOTE: ROG = reactive organic gas; OC = Orange County (Calif.).

TABLE 2 User Subsidy by Mode

Mode	*System*	*User Cost ($)*	*O&M Subsidy ($)*	*Capital Cost ($)*	*Total Cost ($)*	*Subsidy (%)*
Transit	Light Rail (Blue & Green Lines)	0.07	0.26	0.22	0.55	87.27
Transit	Heavy Rail (Red Line)	0.16	0.64	1.94	2.74	94.16
Transit	Commuter Rail	0.14	0.14	0.21	0.49	71.43
Transit	Bus	0.16	0.35	0.17	0.68	76.47
Auto	Auto/Gasoline	0.14	0.00	0.34	0.48	0.00

NOTE: O&M = operations and maintenance.

tation were thrown out the window when my staff brought this analysis forward (Table 2). My board absolutely loved it. Boy, did they debate it. It enabled us to address some real fundamental policy questions. We found that in our region, we are spending 64 percent of every dollar in transportation over the next 20 to 25 years on transit to handle 2 percent of the trips and 4 percent of the work trips. Furthermore, we had the "modal-maniacs" (i.e., "My mode is better than your mode") along with all these different properties and interests at each others' throats in the process. This analysis enabled us to truly evaluate some of the differences among the various modes.

Performance standards transformed the way we thought about decision making. They enabled us to combine information with the political dialogue and debate. This performance analysis was used as one of the cornerstone pieces of information in the debate we had on whether we should build more heavy rail in Los Angeles County. Whether you agree or disagree with the issue, we had concrete, objective information. Should we spend more money on commuter rail, or should we spend more money on other alternatives? Hard evidence about how we should invest money relative to what people want and need became the cornerstone of decision making.

Let me just conclude by restating my earlier concern for transforming and humanizing our bureaucracies. Peter Drucker warns us that in the 21st Century, with the information revolution, the greatest dilemma we have in our societies is fragmentation because we now have information. We are all going in our own directions, and the civilization that figures out how we can bring people together will be the civilization that survives. Remember, bureaucracy has had a difficult time historically. We bureaucrats have not only an opportunity but a responsibility to define this field of performance standards, so that we can truly humanize the work that we are engaged in.

REFERENCE

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General Discussion

Issue: Did the truck lane in Orange County get built? Will it be built? How did you include community values and environmental factors? What caused the leaders in Los Angeles to go to this type of performance-based process?

Discussion: A reanalysis shows that the cost will increase by 25 percent, but the benefits will increase by 50 percent. The trucking community is amenable to paying a portion of the cost through tolls. The remainder of the cost must be funded through the transportation improvement plan. That has not happened yet. You can create a framework for analysis for all the different factors that will help decision makers. Political leadership is at the core of an effective performance-based process. Political leaders wanted simple facts that they could relate to in a very complex region.

Issue: In doing market surveys, is it important to survey different market segments, users and nonusers?

Discussion: It is important to survey the different segments of the market—geographic, income based, choice and nonchoice, rider and nonrider—because marketing strategies and responses to survey findings differ for the different segments.

Issue: After you have done a series of customer surveys, how do you sustain the effort over time, especially if the surveys bring bad news to the policy makers?

Discussion: These surveys and analyses need to be institutionalized within the organization so that they can withstand short-term bad news. Measures need to be flexible, but in an environment where there is a call for increased accountability and where needs exceed resources, the political heat from bad news can be sustained.

Issue: What is the climate in the rest of the country for sustaining performance-based planning?

Discussion: The climate is good now, but there will be some diversions, some peaks and valleys in the support for performance measurement. Agencies need to plan how to deal with the valleys without disbanding the performance measurement infrastructure. As more and more information is available, the debate on issues will continue to increase, especially among advocacy groups. Performance measurement will be at the heart of these debates.

Issue: The processes discussed here have customer feedback loops. How do you present information to the public and the political decision makers so that they can react effectively?

Discussion: Keep the presentations simple, graphic, and easily understandable; use terms that have meaning to people. The design of the customer survey in simple, meaningful terms is also important.

Issue: Does the increased public involvement, driven at least partly by readily available information, mean that bureaucracies will need to expand to handle this increased public expectation?

Discussion: Experience in the private sector has been to do more with less bureaucracy and increased responsiveness. The key is effective information systems that allow for an ongoing and continuous dialogue with constituencies and other interest groups. The issue is not the demise of bureaucracies but the transformation of bureaucracies to customer service, performance measurement, and so on.

Workshop Summary

David Busby, *Colorado Department of Transportation*
Jeffrey Ebert and Sandra Straehl, *Montana Department of Transportation*
Leonard Evans, *Ohio Department of Transportation*
John Falcocchio, *Institute for Civil Infrastructure Systems, Polytechnic University of New York/New York University*
Charles Knowles, *Kentucky Transportation Cabinet*
G. Wayne Parrish, *Mississippi Department of Transportation*
Doug Wentworth, *Sacramento Regional Transit District*

State of the Practice

- The state of the practice varies widely among states and is generally seen as evolving.
- In some states, initial development is closely aligned with the "quality" movement and was undertaken because of a general desire to improve internal business processes. In other states, performance measures were developed to respond to legislative or statutory initiatives.
- Even in agencies without a formalized system, measurement of various attributes is continuous and used at a level to inform decisions or to communicate to customers.
- Customers, stakeholders, and local governments increasingly require accountability of their transportation agencies. Consequently, the use of performance measures for funding decisions is expected to increase. Also, greater participation by customers in setting performance goals and interjurisdictional discussions regarding mutually supported performance goals is expected.
- Performance measurement can be applied at all levels within an organization, from operational to strategic. There is strong agreement on the need to align performance measures at all levels to ensure that the agency is pulling in one direction. However, the number and definition of measures may be different at the operational and strategic levels. How this alignment is achieved, how measures are communicated, and how the measures are defined vary significantly among agencies.
- Some agencies are taking a wait-and-see approach, whereas others (especially those required to do so through mandates) are moving ahead.

Issues

Communication and Coordination

- There should be interjurisdictional coordination and agreement on performance measures to ensure that agencies are not working at odds with each other or duplicating data collection. However, this is difficult to achieve.
- Providing internal and external customers and stakeholders full input at all levels is seen as desirable but difficult.
- Performance measurement may be especially difficult to implement if the value is recognized only by top management levels. Performance measurement should be seen as something that assists the work units.
- There is no common lexicon understood by all practitioners, let alone by all those that need to be involved to achieve buy-in.
- The public may not respond to the measures that transportation professionals thrive on. This dichotomy has to be recognized and accommodated.

• Validating and communicating through surveys, focus groups, expert panels, and so on must be continuously improved.

Data

• The reporting period (monthly, quarterly, annually, or real time) should be appropriate to the purpose.
• The pros and cons or appropriate and inappropriate applications of different measures are poorly understood. For example, averages, target goals, trends, rankings, and groupings may have merit in different performance measurement approaches. Most transportation agencies do not have skilled statisticians, so understanding these distinctions is often a problem.
• There is so much data in most transportation agencies that it is difficult to create a usable product.
• Reliability and sustainability of the performance measures over a long enough time to matter—even coming up with a baseline—can be a problem, given the lag time between plans and implementation.
• Data consistency and comparability in different regions of a state or in different agencies will probably be an issue. Detailed training, cooperatively developed documentation, and resource sharing may be needed.

Resources

• Performance measures are often seen as an added burden that takes resources away from the "real" mission.
• The benefit of any individual performance measure should be greater than the cost of maintaining, analyzing, and reporting the information.

Balance

• How is the right balance achieved between giving public officials discretion and empowering customers?
• How should competing performance goals be balanced within the agency's resource allocation decisions?
• How should customer surveys be properly weighted to avoid setting long-term goals from short-term perceptions? Customer surveys may reflect public perceptions of performance only under current conditions. If conditions change (e.g., seismic events, air-quality emergencies, severe storms, or economic downturns), public perceptions are likely to change. How should they be balanced?

Customization

• The approach to performance has to be unique for each transportation agency based on the issues addressed; one size does not fit all.
• External, systems-oriented measures may differ from internal, management-oriented measures. If they differ, how can they be aligned?

Causality

• The time required for effects to occur can limit the agency's ability to measure performance. Perhaps different units are needed (e.g., short-term outputs and long-term outcomes).
• Broader societal measures need to be developed, but there is often only partial causality between transportation and these outcomes. There is concern that a transportation agency could be held responsible for things beyond its span of authority.

Results and Unintended Actions

• How can the agency ensure that success in achieving measures actually improves the system? How should actual decisions made because of the measure be tracked?
• Could the performance measures be used against an agency by a legislature or through peer-to-peer comparisons of "apples and oranges"?
• Are feedback loop and commitment to continually improve the process necessary?
• Has Baldridge total quality management (TQM) become an end in itself?

Opportunities and Constraints

• Linkage to decision making is essential.
• Institutionalizing performance measurement within an agency cannot succeed without support from top management.
• The ability of an agency head to articulate and advance performance measures can be a determining factor in the successful application of the measure.
• Developing the "right" set and "right" number of performance measures as consistent with goals and needs of the agency is important; these goals and needs will change over time.

- "Pay for performance" and other ways to provide incentives for implementation may assist with institutionalization.
- Performance measures must be periodically reassessed with decision makers. Reassessment can reconfirm utility, provide an opportunity for upper management buy-in, and create a basis for rationalizing data-collection activities.
- As concerns periodic reassessment,
  - –Is there a need to change data-collection cycles?
  - –Are there cheaper data proxies available?
  - –Could and should data collection be privatized?
- What performance measures are and are not should be understood:
  - –They are a tool.
  - –They are not a magic bullet.
  - –There is no "universal" set of measures.
  - –They will necessarily change over time.
- Customer surveys and focus groups are useful in determining whether transportation services are meeting expectations and in ensuring that efforts focus on the most important issues.
- Communicating system goals and performance to customers is challenging but presents an opportunity to explain what public funds are used for and to build support. Also watchdog groups can use performance measures to challenge agency decisions.
- Internal organizational alignment may flow out of implementation of performance measures because the entire agency should move toward the same overall goals.
- The agency's culture may inhibit the development of performance measures if there are penalties for taking risks or resisting change.
- Opportunities may exist for data sharing through intergovernmental cooperation and information technology (e.g., geographic information system, Global Positioning System).

Next Steps

Research

- Compile information on how different transportation agencies use performance measurement to achieve "balanced" decision making.
- Research organizational frameworks that promote the implementation of performance measures.
- Research mode-neutral performance measures.
- Research what "proxies" can be used to link transportation outputs to broader societal outcomes.

Synthesis and Case Studies

- Synthesize actual internal processes or mechanisms used by transportation agencies to link agency mission and goals to project investment decisions.
- Prepare a synthesis of different organizational approaches to safety performance measurement.
- Compile case studies on pay-for-performance approaches (or other accountability processes) by a public-sector transportation agency.
- Survey and compile TQM–total quality initiatives and organizational development literature regarding how to implement performance measures within transportation agencies.
- Develop case studies that show benefits and long-range payoffs from using performance measures for transportation decision making.

Training

- Provide instruction on implementing the research of *NCHRP Report No. 446* on performance-based planning.
- Offer a National Highway Institute course on transportation statistics and measurement.
- Educate on communicating performance to customers, stakeholders, and the public.

Selecting Measures, Data Needs, and Analytical Issues

Transportation Data and Performance Measurement

Panel Discussion

Workshop Summary

RESOURCE PAPER

Transportation Data and Performance Measurement

Doug Dalton, Joseph Nestler, John Nordbo, Bob St. Clair, Ernest Wittwer, and Mark Wolfgram, *Wisconsin Department of Transportation*

Transportation agencies have a wealth of data available related to the services they provide and the infrastructure they maintain. The challenge facing managers is to gather and analyze data in a way that provides timely information on whether they are consistently meeting their strategic goals. Whenever the goals are not being met, management must use information to identify changes. This paper describes how to develop a performance measures program; how to identify the customers and their needs; and how to identify, collect, and analyze the necessary data.

Program Development

The development of performance measurement process takes place in four stages (Figure 1): identification of goals, development of performance measures, collection of data, and analysis and reporting of results. Although these stages imply a linear process (beginning with goal identification and ending with the reporting of results), transportation agencies should incorporate feedback loops between the stages as they design and implement their performance measurement systems.

In practice, each stage of the performance measurement process is accompanied by common problems. By understanding and anticipating these problems, transportation agencies should be able to move quickly toward a stable system that meets their needs.

Performance measures are an essential tool for focusing agencies on their strategic goals and ensuring continuous improvement. But of all the system performance measures an agency might develop, which ones are most important? Although a specific answer to this question will differ to some degree for each agency, several observations can be made. Performance measures should

- Address the concerns of three groups affected by the agency's vision and goals: customers, stakeholders, and employees. The interests of these three groups must be balanced in the measures selected. Management must avoid narrowly concentrating on measures of concern to only one group.
- Have relatively few measures so that attention is focused rather than scattered. Performance measures are often likened to the gauges of a dashboard. Several gauges are essential, but a vehicle with too many gauges is distracting to drive.
- Have a clear and definable relationship to the agency's goals. The best measures provide a direct link from business unit performance plans to the agency's vision. Measures that are indirectly related to the agency's vision and goals are less effective tools in managing the agency and improving performance.
- Obtain buy-in from customers, stakeholders, and employees. If these groups do not consider the measures appropriate, it will be impossible to use the results of the analysis process to report performance and negotiate the changes needed to improve it.
- Change slowly as the goals of the agency change in response to changes in the concerns of individual groups and as process improvements enhance performance in particular areas. In other words, once established, performance measures should be in place long

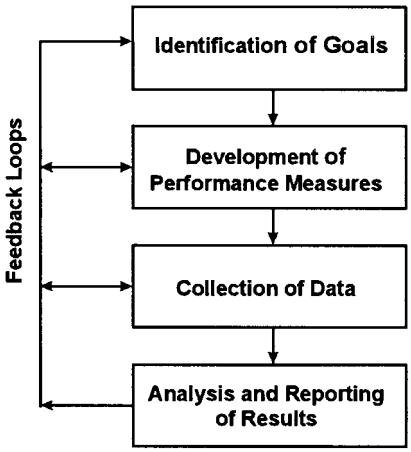

FIGURE 1 Four stages of performance measurement.

enough to provide consistent guidance in terms of improvements and monitoring to determine whether the objectives are being met.

- Facilitate improvement. If performance measures are not clearly for the purpose of improving the products and services of an agency, they will be seen as mere report cards and games will be played simply to get a good grade.

Reliable data, intelligently used and presented, are essential for the success of the type of measures described above. The availability and character of such data must be considered at each stage of a measure's development and use.

Identifying Goals

Long-range strategic goals must be translated into specific annual performance goals. A common goal for transportation agencies is to reduce highway congestion. Although this goal is easily stated, how should it be expressed? If the agency wants to achieve a 10 percent reduction in congestion over 10 years, how much of a reduction is reasonable to expect in any given year? Is the agency off track if it doesn't achieve a 1 percent reduction each year? Unless an agency has specifically developed a schedule of investments to address a uniform number of congested roadways each year, then it should expect its progress toward its goal to be uneven over time. In this case, the best short-term goal might be to forecast the expected improvement, given an approved multiyear program of projects, then measure whether the improvement was realized.

This example illustrates two points. First of all, goals must be reasonably attainable. The agency must have a plan for making them real. Simply stating "congestion should be reduced" without putting the resources in place and taking actions to make the reduction is an exercise in wishful thinking, guaranteed to frustrate people associated with the organization. Second, goals can be established either *prospectively,* whereby the goal is established and plans are put in place to achieve it, or *retrospectively,* whereby the plans are in place and the goals are derived from the existing plans (Figure 2). Although the prospective approach could better link plans to strategic goals, the retrospective approach tends to ensure that goals are attainable and realistic.

Another example related to internal process efficiency is a goal of having final designs available on schedule. In this case, the agency might take a snapshot of the design delivery schedule at the beginning of a year, then measure whether the schedule is met. As in the congestion example, the challenge will be in setting an appropriate target. A goal of designing 100 percent of the agency's plans to meet a fixed schedule is unrealistic given the environment in which designs are developed. Setting a goal at this level would simply frustrate design staff. It would be appropriate to do a benchmarking study to determine what percentage of projects are designed on time in a well-run agency. This percentage would be a reasonable long-term goal. If the current agency performance is well below this level, a series of short-term goals might be set rather than an objective than attempts to achieve too much in a short period.

These two examples demonstrate that performance measures are often complementary. Achieving the expected reduction in congestion each year depends on having the anticipated final designs complete so that the scheduled projects can be built. High performance for on-time design is critical to meeting the agency's goals for reducing congestion.

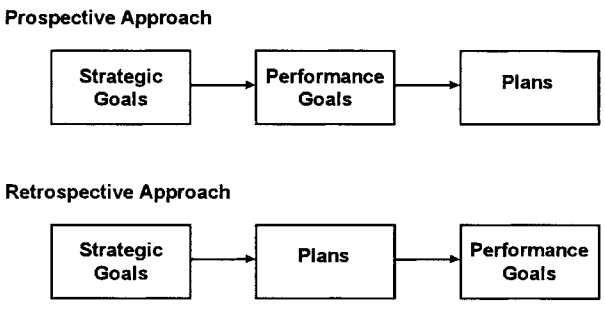

FIGURE 2 Alternative approaches for setting performance goals.

Developing Measures

Performance measures are often described as input, output, or outcome measures (Table 1). *Input measures* look at the resources dedicated to a program; *output measures* look at the products produced; and *outcome measures* look at the impact of the products on the goals of the agency.

Meaningful goals must go beyond a mere summary of program activities and define the outcomes of those activities, that is, whether performance is improved. Outcome measures are preferred because they directly relate the agency's strategic goals to the results of the activities undertaken to achieve them. Illustrating this issue and building on the congestion example given above, an agency with the goal of reducing congestion might measure the miles of capacity expansion it implements on congested highways during a given year. Miles of capacity expansion is a measure of activity or output in terms of system condition. A related outcome measure would be the change in the number of hours users spend in congested conditions.

Although outcome measures are generally preferred, transportation agencies need to consider data availability, cost, and validity when developing their system measures. The relationship between data collection and performance measure development is one of the critical feedback loops in the process of designing a performance measurement system.

Implementation of the outcome measure in the congestion example would require significantly more information than would implementing the output measure. An agency would need to know which congested highways were improved, and how congested they were; which congested highways were not improved, and how congested they were; how congestion translates into hours of delay; and how the highway improvements completed will reduce congestion. In deciding which measure to use, the agency would need to consider whether data can be collected to allow a measure to be calculated accurately and with sufficient frequency for it to be a useful tool in guiding agency decisions.

Hours of user delay may be a measure that captures customer concern, but measuring hours of delay in the field may be impossible. Even if it is technically possible to collect the data, limits might need to be placed on either the frequency with which the data are updated or the extent of the highway system covered. Such restrictions would limit the usefulness of the measure in evaluating agency performance. Another approach might be to estimate delay across the entire highway system using the *Highway Capacity Manual* procedures, but the uncertainty inherent in such estimates may negate their usefulness.

Another issue is to ensure that the measure selected is capable of capturing the impacts of the agency's activities given the underlying cause-and-effect processes. For example, another goal of most transportation agencies is to maintain pavement conditions at acceptable levels. A measure of pavement condition is, therefore, necessary. One measure an agency might select is the average pavement roughness or distress index. Would this be a good measure? Arguably, it would not for at least two reasons.

First, use of this measure implies that good pavements can offset bad pavements so long as average roughness does not increase. This explanation is at odds with the concept that highway users (the customers in this case) would prefer to minimize the number of bad miles of highway on which they must drive. Second, average roughness could increase even if the agency were successful in reducing the number of bad miles. The exact result would depend on how much the good pavements declined in average roughness, how much bad pavements improved, and what are the relative number of miles of each. Third, a decline in average roughness is appropriate for a pavement during its life cycle. The use of average roughness, then, could penalize an agency for doing the right thing. In this instance, the use of the number of bad miles would be a better measure because it relates to the cause of customer dissatisfaction.

Complexity and ease of understanding are also important to consider when developing performance measures. In the pavement example just discussed, one of the points made was that use of an average

TABLE 1 Types of Measures

Input	*Output*	*Outcome*
Dollars spent	Miles of pavement placed	Discernible improvement in pavement ride
Materials consumed	Miles of lanes added	People carried to jobs
Staff time consumed	Hours of bus service added	Reduced travel time

ignored the distribution of pavement conditions, that the issue was really the number of pavements toward the bad end of the scale. A statistician might suggest a skewness statistic as a method of measuring which way the distribution of pavement conditions is leaning. A decrease in the skewness coefficient from one period to the next would indicate that the distribution of conditions was moving toward lower (i.e., better) scores. Reporting a decrease in skewness to the public and to agency management, however, would not elicit the same level of understanding as reporting that the number of bad pavements decreased. The latter is a concept that can be easily understood, making it a very powerful measure.

Collecting Data

The examples presented in the previous section demonstrate that a direct relationship exists between the performance measures selected and the data needed in the performance measurement process. The most common data problems are in ascertaining the quality of the data and in acquiring it in the exact form desired.

The "garbage in, garbage out" concept applies to the data used in a performance measurement system. If the data gathered are highly uncertain, then the conclusions drawn by converting those data into performance measures also will be highly uncertain and will have reduced value in managing the agency. For this reason, great care needs to be taken in data collection. Investments in accurate, high-quality data-collection systems are essential to successful performance measurement and, by extension, to achieving the overall strategic goals of the agency. In reality, however, some things are important and either cannot be measured accurately or cannot be measured accurately at an acceptable cost. Transportation agencies need to consider the uncertainty introduced by inaccurate data when taking action based on their system of performance measures. More specific issues related to data collection and manipulation are discussed below.

Analyzing and Reporting Results

Once the desired data are in hand, the focus shifts to the analysis and reporting of results. In this stage, the most challenging problem is often separating the impact of the activities of the transportation agency from the impacts generated from beyond those activities. For example, highway crashes are influenced by many factors besides highway design. If an agency uses the total number of highway crashes as a performance measure, does an increase in crashes indicate that the agency's safety programs are ineffective? Before that conclusion is drawn, the impact of changes in the weather and other factors clearly needs to be understood.

The necessity of separating the impacts of external factors has direct implications for data collection, another of the important feedback loops in developing a performance measurement system. Even though statistical techniques might be available to allow the impacts of several factors to be isolated, the techniques require large numbers of observations to be used reliably. Thus, it is necessary to have a data-collection system that increases the number of observations by maintaining data with some degree of desegregation in both time and space. It also is necessary to gather data on relevant factors outside the agency's control. For example, if highway crashes are a performance measure and are influenced by severe weather conditions, then data need to be collected on severe weather across the agency's jurisdiction. It is also necessary to record crashes on an hourly or daily basis by location to determine how many occurred during periods of good versus bad weather.

Another aspect of the analysis of performance measures with a direct impact on data collection is the frequency with which the analysis is needed. The time period covered by an agency's goals and the time period for which current data are maintained must be consistent. In determining frequency, the agency should consider the nature of the processes underlying its activities. Consider pavement roughness, for example. Highway construction takes place over several months, and the schedule of work over the course of the year varies for many reasons. In this case, it would be of little use to measure, analyze, and report changes in pavement conditions less than annually. Poorer conditions early in the year do not necessarily imply the agency will end up with poorer conditions after all construction work is complete. In other cases, the underlying process may be much shorter than the frequency of analysis and reporting. If the process can be redirected on short notice, it may be useful to monitor the results of the ongoing process so that midterm corrections can be made if it appears that the agency's goal might not be reached.

As mentioned in the discussion of data collection, performance analysis results are often uncertain because data are difficult to collect accurately. This uncertainty often can be addressed in the analysis phase. One approach is to desegregate the performance data and determine whether all levels of aggregation perform similarly. This might be done by

looking at conditions in varying geographical areas within the jurisdiction of the agency. If all areas perform similarly, the result conveys more certainty. If only one or two areas have poor results, then additional analysis can focus on those areas to determine whether there is reason to believe data accuracy issues are causing them to stand apart. Another approach is to look at related measures, which the underlying process suggests should be correlated with performance in areas prone to inaccurate data. If each measure points in the same direction, then the agency can be more confident of the results.

Analysis of performance also should consider combining feedback and performance data for a more complete picture. Data on changes in miles of bad pavement, for example, could be combined with customer feedback gained through pavement satisfaction surveys. One result can help verify and explain the other, and when results vary, it can point to the need to reevaluate the measures used.

Finally, analysis must consider the impact that the measures have on each other. Three goals have already been suggested for a highway organization: smooth pavement, reduced congestion, and fewer crashes. Success in increasing the smoothness of pavements may encourage higher speeds, which will increase crashes. A heavy commitment of resources to capacity projects may reduce resources available to pavement renewal or to safety improvements. An analytic process must be sufficiently complex to allow the policy choices to be highlighted and the relative impact of each to be understood. If competing goals cannot be analyzed, the results achieved will be haphazard.

Managers of highway systems are not alone in facing such challenges. Transit operators usually are forced to balance the need for efficiency with the need to provide mobility for people in low-density areas. Efficiency measures would tend to lead the operator to discontinue less-used routes. However, the demands for access to jobs in less-dense suburban locations might lead the operator to add more such routes. Policy makers and managers must be able to understand the interaction of these two goals that may be polar opposites in terms of their implementation. If policy makers determine greater mobility to be the primary goal, they must either accept a reduced emphasis on efficiency or adopt a system of performance measurement that is sufficiently complex to differentiate the efficiency of various types of services or routes.

Both of these examples of competing goals require reasonably sophisticated analytic processes that allow for various policy options to be considered in iterations, so that the interplay of those options can be understood.

Accepting Performance Measures

As transportation agencies move through the stages of the performance measurement process, it is important for them to keep in mind that a system will fail unless it has buy-in from customers, stakeholders, and employees. Agencies should view the development of a performance measurement system as an art, not a science. If performance measurement were a science, there would be one best way to do it. There is not. Given that performance measurement is an art, an agency's top managers must view themselves as artists who find creative ways to bring the brush strokes of all interest groups into a coherent form. Top management needs to set the agency's strategic direction and goals as well as broaden involvement in developing the performance measures that the agency uses. If done successfully, each group will believe in the results and be willing to act on them to achieve real improvement.

To ensure buy-in, an agency must consider not only what it does but also how it is done. Many of the points made in discussing the performance measurement process bear repeating because ignoring them will hurt the buy-in process. First, management must keep the measures few and simple. Second, management needs to ensure that the measures are directly related to agency strategic goals and directly influenced by agency activities. Third, performance measures must be developed and used as tools for improving critical processes, not as report cards. Finally, management must invest staff and resources in reliable data-collection systems and in the analytic methods required for timely analysis and reporting of results. A significant breakdown on any of these points will lessen the effectiveness of the performance measurement process and reduce the ability of the agency to successfully accomplish true process improvements.

Customer Identification

The earlier discussion focuses largely on measures that come from a transportation agency's standard data systems. Pavement quality, congestion, and crashes can be reduced to hard numbers and are routinely reported in most agencies. These are the traditional transportation measures. Customer measures provide another view of many of these traditional measures; they may provide a subjective overall as-

TABLE 2 Traditional and Customer Measures

Traditional Measures	*Customer Measures*
Quantitative measures	Qualitative measures
Routinely collected	Capture perceptions
Define condition or use of facility or service	Define priorities
One measure for each feature	Define how much is important
	May result in conflicting answers

sessment of quality, help to assign a priority to various issues, or help define how much of a given item is important (Table 2).

Customer measures are an important component in an organization's family of measures. They differ from traditional measures in that they are based on people's perceptions of the products and services delivered to them. Because no two people are the same, perceptions of the same thing can vary widely. Also, one person's perceptions about something can change from one point in time to another. This is quite different from traditional measurements. Fortunately, valid and reliable methods for measuring customers' perceptions allow organizations to use this valuable information to improve performance.

Who Is the Customer?

When an organization is using customer measures to help define its performance successes and improvement needs, a clear understanding of its customers is vital. A customer can be defined simply as the user or recipient of a product or service. Because there is likely to be more than one user of a given product or service, users are often referred to as *customer groups*. It is important to look for similarities in and differences between customer groups because they will affect the findings.

As the number of customers in a customer group increases, more and more differences between individuals in the group become evident, resulting in even more distinct customer groups or subgroups. Thus, a transportation agency with many products and services could have many customer groups, each of which has different needs, expectations, and perceptions.

In agencies with many products and services and a wide range of customers, different customers probably have competing or even opposing needs. How does an organization determine which action to take when two customer groups have opposite opinions of the service they have received? It might be possible to accommodate both groups, but if not, what then? As discussed above, the understanding of the differences between the customers and customer groups and having a clearly defined purpose will greatly help in the making of this determination. Also, factors such as resource capacity and economies of scale will affect the actions the organization can take. It is important to point out here that all customers are not created equal. Some key customers may be frequent users of the highway system (commuters); others may be large-volume users (truckers); others may be important because they have political or some other type of influence. Key customer groups should always be measured for their needs, expectations, and levels of satisfaction.

In many organizations, simply defining the customer can be a challenge. For instance, when a state trooper stops a motorist for speeding in a construction zone, who is the customer—the stopped motorist, the construction workers, the residents nearby, other drivers, the taxpayers, or the legislature? The answer could be any or all of these. It depends on how the agency defines what is being provided and what the goals are. The agency must clearly understand what is provided, how it fits into the overall objective, and why it should be measured before a performance measure can be developed with customer input.

How Does the Customer Relate to the Measure?

A *customer* is a user of the system or someone who benefits from the system. A *product,* then, can be defined as anything you provide to a person or group of people. Using this definition, a product can be one of two types: a tangible, visible thing, such as a license plate or a highway interchange, or an intangible thing, such as information about traffic laws in a construction zone or an analysis of how legislation affecting commercial trucking affects highway use. In the construction zone example, if the product is the state trooper's speeding ticket, then the customer is the driver, and the desired outcome is the driver's altered behavior when driving through work zones in

the future. If the product is work zone safety, then the customer is the construction worker, and the desired outcome is a safer workplace.

Another aspect to providing a customer with a product is the experience itself. This is the interaction between the provider and the customer before, during, and after delivery of the product. The common phrase used to describe this aspect is *customer service*. A customer's perceptions of the experience (i.e., of obtaining and using a product) are as important as their perceptions of the product itself.

When one is measuring products, the intent is to determine the customers' perceptions of the attributes of the products themselves. When one is measuring the experience, the focus is on customers' perceptions of the people they deal with, their attitudes, professionalism, willingness to listen, knowledge of the product, understanding of the customers' concerns, and other characteristics. As an organization determines what to measure, keeping these differences in perspective will help determine the role that customer input should have in your primary system performance measures.

What Is Needed from the Customer?

What are you measuring and why? Before you start to develop your questions for customers, determine and be able to explain specifically what you hope to accomplish with the information you obtain. This knowledge will keep you focused as you develop and work through the process of developing a questionnaire, survey, or other customer-input device. If the purpose is unclear, inadequately developed, or not specifically related to the corporate measure, you will struggle to come up with questions that truly address the concerns that matter the most to your performance measure.

Consider the following questions as you begin to develop customer measures of performance:

- What is the primary issue or problem that we want to address?
- What will the results help us do differently?
- How would this information aid in the decision-making process?
- What specific actions do we intend to take after we have the results?
- Why do we need this information now?

As with all performance measures, differentiate output measures from outcome measures. Also if your product requires you to take something from a customer and work on transforming it into something else before you give it back, be sure to consider input measures.

Output measures are evident as soon as you have delivered the product. Outcome measures might not be evident until months after product delivery. Although output measures are usually easy to define, developing good outcome measures can be difficult. Outcomes in organizations often can be attributed to several different activities. It can be challenging to determine what portion of a customer's outcome is based on your product and what portion is based on products the customer received from other providers.

One potential risk that must be considered as you analyze your information needs is that your customers may not be familiar with your product or service. For example, consider the public's perception of pavement condition. If people are unaware of the department's policy or are aware of it but cannot relate to the engineering jargon nor understand the cost of different improvements, then it will be difficult for them to respond to questions about the policy. In these cases, separate questions may be needed to determine customers' awareness and understanding of the policy before determining satisfaction and using it to influence investment decisions.

Customer information is critical to any complete performance measurement system, but getting informed input from customers can be difficult. It must be done deliberately and with an understanding of the customers themselves.

Data Identification and Use

Collecting the right data depends on understanding what is to be measured, why it is being measured, and who will use the data.

What to Measure

Data often are collected for a performance measure without truly understanding what is to be measured. For example, many agencies have annual goals for improving pavement ride. To measure this goal, the agency might measure the number of miles that fall below an established ride standard (i.e., the number of "bad" miles). However, if resources were dedicated to meeting this goal and a program was implemented that should have met the goal but the goal remained out of reach, would the single program level measure be useful? In this case, the simple measure might not be useful because it would not allow the situation to be well understood.

To understand the issues, data and measures would be required at several levels. Some of the questions for which data and goals would be required include the following:

- Are pavements performing in the manner expected by the pavement management systems?
- If pavements are not performing as expected, is the problem with all pavements or with a particular pavement type?
- If asphalt pavements are not performing to standard, is the problem in a particular type of mix?
- If it is a specific mix, is the problem in materials, construction, base, or other factors?

These questions suggest a hierarchy of measures (Table 3), all of which are needed to understand the program.

Obviously, not all of these measures need to be or should be reported generally. Policy makers in a legislature or governor's office will probably be interested in only the highest level measurement. In addition, the highest level of agency management will probably have limited interests. Lower-level managers and technical staff will want and need to know the details that underlie the global measure.

Even this short hierarchy suggests a complex system. Although it is complex, it is not new to most highway agencies. Most agencies have some type of pavement management system. Such systems contain many assumptions about performance at different levels of detail that are effectively performance measures. Similarly, many design standards contain performance assumptions that can be used as performance measures. If they are understood to be measures and are used to better understand an issue, they can help to improve agency performance. Moreover, they can be used without creating complex new systems and, probably, without collecting significant new data.

Defining and Standardizing Data

For data to be used with confidence, they must be consistently defined. Standardization strives to define data to a degree that minimizes subjectivity and maximizes objectivity with respect to establishing a data item to promote accuracy and repeatability. Standardized data also are necessary for successful data integration. For example, how much has an agency spent on a given program? This is a frequently asked question, a question for which there can be many answers that are different but all correct. An accountant probably would answer in terms of dollars that have left the agency, on an expenditure basis. A federal program manager would probably answer in terms of the dollars moved to federal agreement, on an obligation basis. A program manager might answer with the amount contracted, on an encumbrance basis. Within their limits, all of the answers are correct, but they are different. If such information is reported as a part of a performance management system, the agency must determine which answer is most relevant to the audience and standardize this basis for answering. Another simple example, determining the length of a highway ramp, illustrates the point in the physical inventory world (Figure 3). Where does the ramp start and end? There is no right answer, but the answer must be consistent.

To standardize data, the data element in question must be understood. Data modeling efforts that include users or potential users of common data may prove useful for establishing and defining data to a detail that facilitates standardization.

Quality control is also necessary to standardize and use data with assurance. The Wisconsin Department of Transportation (WisDOT) recently implemented a quality control data-collection audit of its state highway inventory data. The audit focuses on sampling a percentage of the annual data updates. The results of the first year's audit have already generated benefits. The audit highlighted some key areas where inconsistencies were present in the collected

TABLE 3 Hierarchy of Pavement Performance Measures

Measure	*Use*	*Audience*
Number of bad miles	Overall pavement performance	Policy makers
Performance of pavement type	Measure overall performance	System managers
Performance of specific pavement designs	Measure performance within pavement type	System managers
Performance of specific pavement design components	Measure performance of pavement components	System managers, engineers, contractors

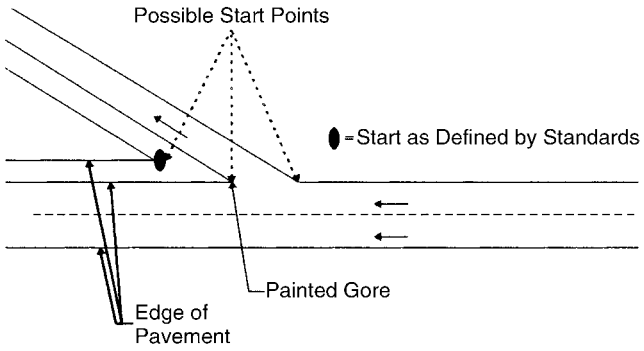

FIGURE 3 Location of ramp along mainline.

data. A follow-up to the audit will occur soon with all data collectors to review what was learned and to incorporate the findings into a revised data-collection manual.

Data Life

Data collection is usually expensive. Therefore, it is important to understand the useful life of data so that it can be leveraged as much as possible before an update is necessary. To determine the data's useful life, the data's accuracy necessary to address business requirements must be determined.

The useful life of data can be derived from the responsible use of the data. For example, highly detailed pavement condition ratings can be used to predict pavement condition for 5 to 6 years from the date of inspection. This means that one can confidently, or responsibly, generate a 5- to 6-year improvement program based on the data. It is tempting to generate long-term [or out-year (6+ years)] improvement programs because pavement deterioration curves can forecast conditions for up to 40 years. Although this forecast is possible mathematically, a responsible user will seek to understand the variables affecting data quality over time; this understanding should be used as the basis for determining the frequency with which to update and use data.

In contrast, some data have a long, useful life. Pavement width, shoulder width, pavement type, intersection location, and median location and type remain the same from the time they are built until reconstruction, so it is not necessary to plan a cyclical collection of such data. It also may not be necessary to collect the data in the field but to use its built plans or a photolog in the office to collect the data.

It is also wise to prioritize the importance of each data item. Although pavement and shoulder width remains static between construction times, it is important to have the current pavement and shoulder widths for doing capacity analysis. Therefore, collecting basic inventory data for new construction might be the highest priority. Collecting new construction data could be more important than collecting pavement roughness data, which changes slowly enough that delaying collection for several months would not affect system-level analysis.

Automatic or Manual Collection

Automation of data collection usually enables data to be collected quickly and efficiently. If the automation equipment is cost-effective and the data can be processed efficiently, then automation is likely to be a viable alternative to manual data collection. However, automated collection methods are not always the best way to collect data. Automation can work well if a large volume of data is collected daily (e.g., automatic traffic count and classification stations) or thousands of miles of road per year are rated (e.g., collecting pavement roughness). However, for data that is stagnant, such as political boundaries, manual collection may be more economical.

Automated data collection usually implies speed and efficiency, but the real value of automation is realized when speed is coupled with increased accuracy, precision, and repeatability of the data. The drawbacks of automated data collection typically relate to significant up-front capital costs and ongoing maintenance costs for equipment.

Defining the benefits of accuracy and precision for data items is a good starting point for the evaluation of automation benefits. Some data items do not lend themselves to accurate, precise, and efficient manual measurement; for example, it is almost impossible to obtain pavement roughness data and standardized, repeatable manual determinations of pavement roughness. Thus, automation is clearly a superior alternative. But for many data items, automation is not so easily distinguished as a superior data-collection method; in fact, automation might not be the best approach. The cost of equipment must be weighed against the benefits of enhanced accuracy, speed, and repeatability when an automated data-collection solution is considered (Figures 4 and 5).

Data may be collected through a combination of both manual and automated processes. Handheld devices that allow collectors to input and store data and then easily upload into a larger inventory system can contribute significantly to consistency and repeatability (Figure 6). Laptops and data boards provide much of the same functionality in other applications.

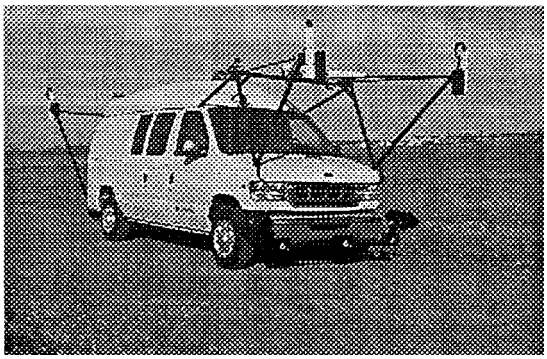

FIGURE 4 Automated pavement distress van.

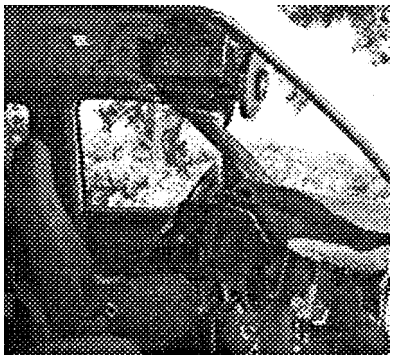

FIGURE 5 Photolog camera.

Location Control

One of the biggest challenges in collecting data with fully automated equipment is to ensure that the location control strategies are compatible. Geographic information system (GIS) technology may provide the location control basis to collect large volumes of data that are compatible with other inventory items. Without the ability to combine data, no matter how it is collected, the primary objective of using the needed data as an input into a performance analysis is lost.

For segment-based location referencing systems, physical inventory data are typically averaged to represent the overall segment. For many applications, this method works well, but there may be a need to establish the location of data more precisely. *On/at methodology* [a linear referencing (location control) system that allows a location address to be given to data] or a similar system allows data items to be located exactly as they exist without the need to average the data for attachment to a segment-based location. For example, a road segment varies in width along its length. On/at methodology allows width data to be located as it exists by attaching the location to each data item rather than forcing the data item to the location of a previously defined segment. Instead of one width attached to a segment, multiple widths can exist, representing actual occurrences.

An on/at method was determined to be the most logical for WisDOT's local roadway database (Figure

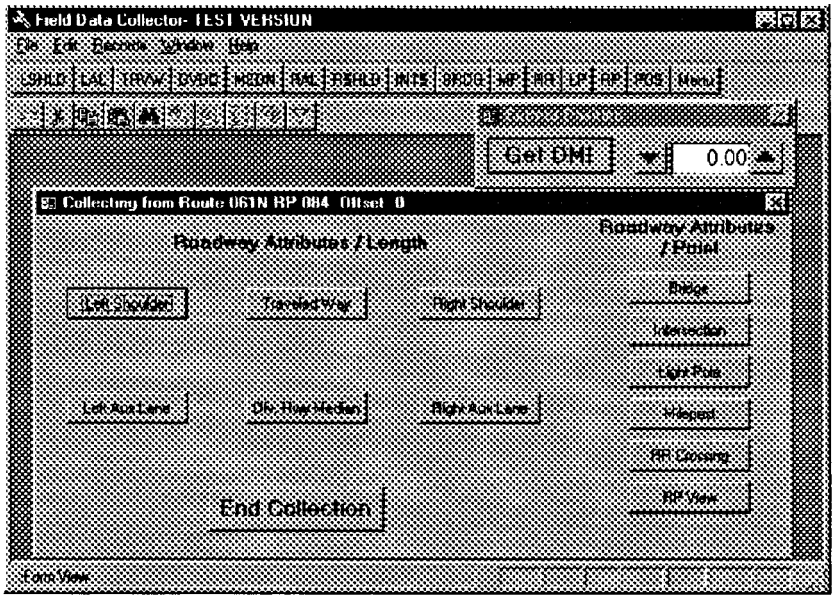

FIGURE 6 Automated field data-collection window.

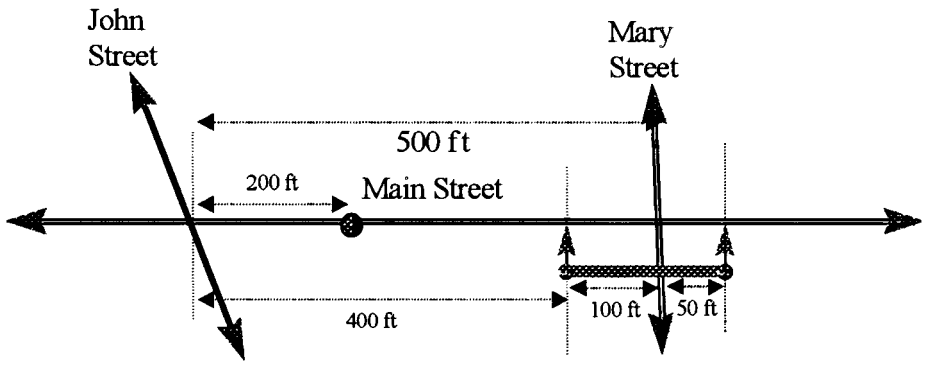

FIGURE 7 On/at location control system.

7). This method uses distance and direction on a road from an at-grade intersection. It can be used for identifying data that are at a point (e.g., bridges, railroad crossings, light poles, or intersections) or that have length (e.g., pavement types, roadway widths). For example,

- On Main Street, 200 ft past the intersection with John Street, traveling toward Mary Street (point).
- On Main Street, 400 ft past the intersection with John Street, continuing to 50 ft beyond the intersection with Mary Street (length).

Integration of Data

Data integration is a popular topic among users of data. A truly integrated database avoids the redundancy in the collection and storage of data common to independent databases. Integration also provides the user with more efficient access to data. Integration is nothing more than the ability to bring together data from various data storage systems effectively in an analysis. For this to happen, the data definitions and the location control systems must be compatible.

Data must have a common definition if they are to be integrated. The common definition is an often-overlooked problem when combining data for analysis. Simple problems such as collecting the data in English units versus metric units can be overcome by building conversion tables. But more complicated issues may hinder or even prohibit the combination of data. For example, if some critical data are collected or analyzed as an average over a segment, whereas other data are collected in extreme detail, rules for combining the data must be developed.

Location control is often an issue in integrating data. Data can be located by reference point systems, milepost markers, coordinate systems, and other ways (Figure 8). If various systems are in use and a translation program is not available, data will not be compatible.

The issue of location control compatibility is a challenge, especially within the context of a large or-

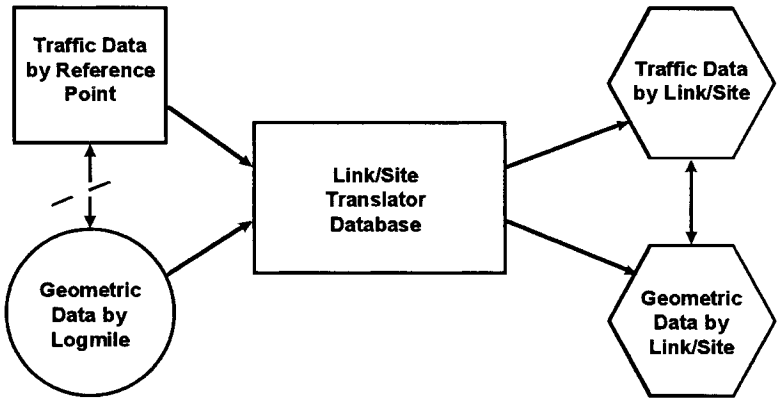

FIGURE 8 Link and site database, allowing integration of different location control systems.

ganization. In this environment, separate departments or units commonly use independent databases with independent location control systems that contain similar data. When data integration is proposed in such organizations, an associated requirement is that there must be a standard way of defining, locating, and managing data. A call for change is often met with great resistance. Units have strong reasons for resisting change. They own a particular data item, and that item is fully functional for their needs, so why should they change their business approach in light of the ever-present resource and budget constraints to satisfy someone else's desire for their data? With such parochial attitudes, data integration is often difficult.

If an organization has a strong mandate for integration or if standardized data definitions and methodologies are in place, then the barriers can be more readily removed. However, it is never inexpensive to convert data systems. Changing the database itself is usually the easiest part of the project. Identifying and converting all the programs or processes that use the legacy data system is the more expensive and time-consuming phase.

Sharing of Data

One unique aspect of data integration is data sharing across levels of government or agency lines. For example, good business practices and federal guidance encourage cooperation among state, metropolitan, and local planning agencies. In most cases, the data required to complete a reasonable planning effort, which should include elements of performance measurement, are common to all three levels of government. In many cases, each level of government maintains data systems that are tailored to its particular needs, which may include specific ways of rating pavement quality, individualized data definitions, or singular location control strategies. It also may include incompatible hardware and software installations. For example, many local governments in Wisconsin have some GIS capabilities, most of which were acquired with assistance from state land information programs. Most are incompatible with WisDOT GIS applications. In some cases, the differences lie in the software and hardware; in others, with location control strategies; and in still others, with the level of detail in the location systems. With all of these differences, how can plans and performance measures be reasonably coordinated? Unfortunately, the answer is usually through a manual comparison of output and the application of professional judgment.

A similar circumstance exists between agencies. For example, natural resources information often resides with the state resource agency. On the surface, geographically located and displayed information on wetlands, endangered species habitat, or agricultural lands might seem to be ideally suited to the analytical needs of the transportation agency. Are the resource agency's system and data compatible? Is the detail adequate for project- or even program-level analysis? In Wisconsin and many other states, the answer is usually no to at least one of the concerns.

These common interagency issues can be overcome only by great and continuing effort. Producers and keepers of data must be sensitive to the needs of other potential users. They must also understand the benefits of sharing information with all the involved agencies. Once that sensitivity and understanding exists, the producers and keepers will have a motivation to find solutions. Until it does, cross-agency sharing will remain a major challenge.

Data Access

At first it would appear that accessing data within a single agency would present little or no problem. The truth is the opposite. Access capabilities usually are not the same across large organizations, especially organizations such as state transportation agencies. State departments of transportation usually have several district offices and a headquarters office at remote locations. Each of these locations could have different computer capabilities. Some may not have desktop workstations that can handle large file downloads from mainframe computers. Others may not have compatible software. If an agency truly intends to improve the business functions being measured, it needs to be sure that the data needed to monitor the performance measure are available at the level within the organization that is fundamentally responsible for the function.

For interagency access to data, network connections to databases can provide common and convenient pathways to data. Web technologies have created an opportunity for external sources to have access to data. However, most agencies are just starting to explore the potential for web technology to address data-sharing issues. At first glance, it appears to be an easy solution to many of the legacy problems of accessing data. However, web technology does not address many of the definition or location issues discussed above. Web technology is also in its infancy and is changing rapidly, causing development and compatibility problems. For example, web technologies might be used to enable local governments to

have access to state databases that contain local data. Security is an even greater concern in this arena because of the number of potential users. Many questions need to be answered before the data can be shared over the web, such as

- Who has access to which data?
- Is there permission to modify data?
- Can data be downloaded?
- Can the system handle the number of users?

Summary and Conclusions

Reliable data are essential to any system of performance measurement. As measures are developed, policy makers and managers need to consider whether a measure can be routinely reported. Are the data available? Can data be collected at a reasonable cost? Are existing sources of data compatible, and if so, can they be used together in a meaningful manner? Can data be analyzed and presented in a way that will be meaningful to their audience? Are the measures themselves meaningful to the needs, interests, and values of the agency's customers? Answering all of these and other questions must be a part of developing performance measures. If they are not answered correctly, then performance measures will be haphazard and may do the agency more harm than good.

Panel Discussion, Part 1

Anita Vandervalk, *Florida Department of Transportation*
Paul O'Brien, *Utah Transit Authority*
Joel Pfundt, *Puget Sound Regional Council*
Tom Brigham, *Alaska Department of Transportation, Moderator*

TRB and Florida Examples

Anita Vandervalk

The goal of this presentation is to confirm many of the points in the resource paper by a comparison with the outcome of the Transportation Research Board (TRB) data committee peer exchange and of the Florida experience.

At the end of July, the TRB data committee held a peer exchange in which nine states gathered along with staff from TRB and the Federal Highway Administration (FHWA). We had a good exchange about the latest developments and performance measures. We focused on data issues. So a lot of the outcome of that peer exchange is similar to the points made in the resource paper. (Note that a copy of the report on the peer exchange is found in Appendix B.)

I will not go into too much detail about Florida's performance measures because we have been doing this for 10 years and much has been written about our program. I want to draw on some examples to validate the points. One of the keys about the performance measure program is that it is closely linked to our planning process, which I will demonstrate in a moment. Then I'm going to propose some additional areas of study, most of which came from the peer exchange.

There was no question-and-answer period for this session. The summaries were prepared by Jonette Kreidweis, Minnesota Department of Transportation.

I decided to break the points of the paper into three main areas: agency performance measures, customer needs and data, and—most important—data for performance measures. For each area, I have chosen a couple of points to highlight and go into detail.

The paper pointed out that agency performance measures should be focused on three groups: customers, stakeholders, and employees. I would like to take that focus a little farther and emphasize that we need to look at how performance measures are used. This is something we discussed at length in the peer exchange. We all realize that there is a flurry of activity. We all think we are doing the right thing in developing these performance measures. But we need some examples of how performance measures have contributed to making decisions in an agency, organizational and institutional changes, and how they relate to operations. We also talked about that in our breakout group.

A second point on agency performance measures is the number of measures. This is one point where I disagree with the paper's authors. They indicated that there should be a few of them. In Florida and Minnesota, where there are hundreds of measures, it is important to have a lot of measures. I do agree that you need to be able to boil them down to a few key ones that you report out with, but to get the buy-in, you need to have measures that cover every area of every agency so that everybody is involved.

When we were mandated by our legislature in 1994 to have measures in place, we looked out into the agency to determine how we could report to the legislature on this. We found that a lot of the areas

(maintenance pavement, e.g.) had been doing performance measures for years; that is how they operated their business. That is why it is important to have hundreds of measures. Again, the focus should be on a few that we can keep our eyes on.

The third point under agency performance measures is to link to agency goals. This point is absolutely critical, and the goals should be aligned. Figure 9 shows Florida's method for linking. One thing we do differently is to link back. First, we establish our policies and plans. We just completed the development of our 2020 Florida Transportation Plan. The plan took 18 months to develop, and we involved several hundred individuals throughout the state—MPOs, county government officials, and the general public. We had several brainstorming groups. It was a huge effort. But we are finishing what I think is a fairly well-supported plan.

On the basis of that plan, we developed our financial priorities. Some of them are based on statute and regulation. For example, in Florida, maintenance dollars are taken right off the top. A certain percentage goes directly to facilities maintenance. Of the remainder, 50 percent of the all the capacity funds automatically goes to supporting Florida's Interstate highway system, our key corridors within the state. The other 50 percent of the capacity dollars is spent based on the policy and plans that we put forth in our 2020 long-range plan. We then implement our adopted work program and measure the performance, that is, how well we are serving the customers in the area of pavement maintenance and capacity improvements. The measures link directly back to the Florida Transportation Plan. We have to report, in the form of an agency strategic plan (a kind of a short-range component of our plan) to the legislature annually on how we are doing on each of our hundreds of measures. We report how well we are doing based on our goal, and what we plan to do if we are not meeting that goal. So we have to demonstrate continuous improvement based on those measures.

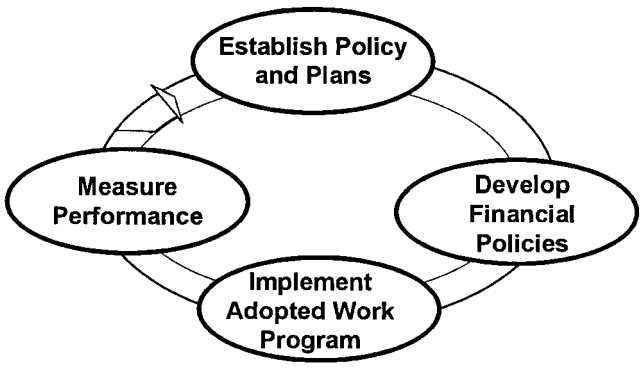

FIGURE 9 Agency performance measures: link to planning process.

The fourth point is that measures should change slowly. From a data standpoint, I cannot emphasize this issue enough. Some trends need to be established before you start changing the measures. In fact, for the mobility area in Florida, we decided to not even set goals and objectives until we have enough data to back us up so that we can set some appropriate objectives. That is a key point.

Fifth, continuous improvement, as I demonstrated, is critical.

The second major area is customer needs and data. The resource paper touched on the need for surveys and what they should look like. One of the things we talked about at the peer exchange was the need for using existing market research, survey tools, and so on. We should not reinvent the wheel in this area. A lot of agencies are already doing market research, and we should latch on to existing methods, maybe tweaking it for our needs.

The third and most important area, of course, is the data. One issue touched upon in the paper is modeled versus actual data collection. This is something we struggled quite a bit with, especially in our mobility measure area. We have determined that model data, when validated with actual data, are an excellent way to get a consistent data source from a network standpoint. We are big on making sure that the data we report are consistent across the whole network, to the point when we will not even map our mobility performance measures because we are concerned about the comparisons that may be made from one urban area to another. Model data have been the answer for us because they provide consistent results. For example, speed is the one thing that we model. We have an extensive program for traffic data collection that gives us our volumes and so on. We have a combination of modeled versus existing.

We used our existing data-collection program extensively. It should be based on what you already have. We had to tweak our programs. For example, one decision we had to make is what we should choose as a peak hour. We chose 5 to 6 p.m. because it seemed to be the peak hour that closely matched the peak time for both transit and roadway. Then, we had to tweak our data-collection processes to give us data in that time frame.

Quality control, integration, and data sharing are key to what we do, and I have linked them together. When we discussed these issues in our peer exchange, we linked them because if you are trying to get qual-

ity data, the first thing you look at is the fact that there are tons of data out there. So let's try to integrate all of this. Let's bring it all together. But the act of bringing it all together results in quality issues with your data. Several other issues were touched on in the paper:

- Location referencing: it is critical and needs to be overcome.
- Standardization of collection techniques: is it worth it, and how do we do it?
- Partnerships with the metropolitan planning organizations (MPOs) and local governments: how do we establish those?
- Privatization of data collection: it may result in better-quality data, but it could also have the opposite result.

We talked about the integration issue as a future issue for peer exchange. Tom Palmerlee and I have been working on it. He is taking the lead on figuring out how we can have another peer exchange to delve into this issue.

To finalize, additional issues are also items that came out of the peer exchange as areas for needed study as they relate to data:

- Market research: where and how are measures used?
- Alignment of state and federal goals: we touched on whether an alignment of goals could potentially result in a standardization of performance measures. It might make sense for agencies that are new and starting to develop performance measures.
- Mobility measures: we decided that there was no need for additional research. A lot is going on with the Texas Transportation Institute (TTI) Study, and several states are looking into this. We are going to keep our eyes on this one as well.
- Intelligent transportation system (ITS) data needs: we need to look at how we are going to get the data from ITSs.
- Safety, freight, and sustainability measures: we talked about these measures in the peer exchange as well; a lot of data issues surround these measures that have not been worked out.

For each of these areas, we plan to develop some research statements to discuss at the TRB national meeting in January 2001 and determine where to go from there.

Transit Perspective

Paul O'Brien

My role here is to provide some of the transit perspective on the resource paper. For any of you who have not picked it up, I encourage you to do so. It is a good read, good information. Even I, a humble operations-and-maintenance guy, was able to get through it and understand some of it. That makes it rank high in my eyes.

I will touch on some of the main topics in the paper and will offer something from the transit side, naturally with a focus on the Utah Transit Authority perspective. I will tell you about Utah to start. Our population is a little over 2 million. Although Utah is a rural state in terms of area, 77 percent of our population lives in what we call the Wasatch Front, from Provo to Ogden. So it makes us an urban state, which presents a lot of challenges for our highway people and transit people.

The Utah Transit Authority is bigger than you might think. We have 23 light-rail vehicles, and we have already ordered 10 more. We have almost 600 buses. We are in the process of moving away from a traditional style of transit agency, which was efficient but was not necessarily tuned in to the community. As the community changed, we did not change with it. We are trying to do that now, so we have articulated buses, 30-ft buses, circulators, all kinds of things going on. Our initial rail line, which opened ahead of schedule and under budget, is the major rebuild of our freeway through Salt Lake County on the same track.

Transportation Data and Performance Measurement

The first item is about addressing the concerns of the groups and getting the right data—one of the things that we have looked at in developing our performance measures. Is it something that is useful, or is it just something that is available? We have it, so let's use it. But does it make any connection to our goals and objectives?

We also needed performance measures that make sense. This point is addressed in the resource paper. The measures need to be understandable and have some connection to our goals and objectives. They also should be understandable to the decision makers. I should not have to go in there and spend half

an hour explaining to a decision maker what a performance measure really means.

Development of Performance Measures

The paper talks about focusing attention rather than scattering it. Regarding the National Transit Database (I believe that is the proper name for its current state), sometimes you see studies and research that are based on this database, but every transit system is different. They have different goals and objectives. The community needs are different. So you start pulling things out, and then it is not necessarily the measure you want for your transit agency.

One of our missions was to develop performance measures that our board of trustees was interested in. Back in the old days, we had performance measures, but we found out that the board was not interested in those things. The board changed; the community changes.

In our breakout group or session yesterday, somebody talked about the hierarchy of performance measures. There were six areas; I noticed that system operation and maintenance was at the bottom, but that is okay. That is something we have looked at too. Traditionally, in the transit industry, we measure miles between road calls. We looked at that and thought, that is kind of interesting, it's easy to measure, and we have done it for a long time. But what are we looking at? We are looking at the effectiveness of our preventive maintenance program. So now we track the percentage of our preventive maintenance that is accomplished on time, because we think if we look at this measure, we are going to be ahead of the curve. We are not going to wait until the bus breaks down to figure out, hey, we need to change the way we do our maintenance.

Analysis and Reporting of Results

Sometimes you do have to be able to explain your analysis to the media or to our board. We have had some issues where it may be apparent to us at the staff level, but we have to explain them to the media or the board. We need to be prepared for that. The paper talks about the need for a direct link from the business unit performance plan to the agency's vision. Sometimes you have to explain that.

How many times have you looked at reports with formats that were hard to work with? We redid the way we did some of our financial reporting of our performance measures because we found out that the board was having to piece things together. It was not how they saw things. It was great for us, but the performance measures were not useful to the board.

Forced Acceptance of Performance Measures

The transit agency is very susceptible to fads. One example is from the 1980s: fare box recovery. The better ratio you had, the better transit agency you were. After a while we found out that although this measure sounds good in an analytical way, it was not how the community measured us. Plenty of transit agencies looked good when they came to the financial conference. But when they went back home, people were saying, okay, that's great—but what about the service in my neighborhood? Why can't you provide a more comfortable bus?

Placing the staff in a no-win situation is one of my favorite topics. In transit, we are faced with this issue a lot, and the paper touched on it. We need to make sure that we do not set conflicting goals (e.g., there is a performance measure for service, but to meet my performance goal, I'm not going to meet my overtime goal). One of our challenges is not to place people in that no-win situation.

Customer Data

We talked about the changing definition of *customer* in a breakout session. In transit, we have a lot of customers. Board, passenger, nonrider, and employee are only four of them.

I have heard again and again that you want radical change, but you get there incrementally. That point is where we are in the transit business as well. In the past, we have been reluctant to change. In a lot of agencies, it takes a major crisis to look at something differently, to stimulate some kind of a change. Then this big change is hard for everybody to accept. Our goal is to keep in touch with our customers and to adapt as they adapt. We need to consider our image; that is something we are looking at now. We have new bus stop signs. We changed our logo. Our light-rail vehicles look very nice. We cannot minimize these sorts of things because our customer base includes the nonrider and the occasional rider—it is a huge market for us.

Somebody mentioned management vision and strategic innovation. The interesting thing is that employees are often the ones who resist this. The key to adapting to change is flexibility. It is easy to say but hard to do. We like to get in our comfort zone and then cruise. That is where the transit industry has been, and we are paying the price. Some have

adapted a little better than others. The employee is also a customer.

Data for Performance Measures

Gathering, is it worth it? If you want data, you have to gather it somehow. We found that we have limited tools. We would like to do a lot of things, but we do not have the tools to do them. We do not have the staff. Is it worth it? Do we want to put all our energy into that? What are we going to get out of it? That is an issue that we are facing all the time. We are under a lot of pressure to perform.

There was talk earlier about modal implications. That is a big deal for us. We have everything from rideshare to paratransit, bus, and light rail. You have to keep measures, such as average fare, unlinked trips, and so on, in a modal perspective. Timeliness is important. For us, it does not do any good to report 6 months down the road.

Integration entails two main items: budget and pay. Our performance measures are integrated into our budget process. When we go through the budget process, we discuss our performance measures as to where we need help and where we need to change our focus. That is a budget issue. It also is a pay issue. A certain component of everyone's pay—from the supervisor to the manager, the director, and the general manager—is linked to performance measures.

Puget Sound's Congestion Management System

Joel Pfundt

First of all, I compliment the authors of this paper. I was in the same boat as the last speaker. I often have trouble wading through information, but I enjoyed reading this paper. A lot of it spoke to what we have been dealing with in our congestion management system (CMS). I have been working on it for a few years, and we have realized that it just is not working and is not doing what we had hoped that it would do. We have been looking at ways to reinvent it. The resource paper dealt with a lot of the issues that we have been struggling with.

The Puget Sound region is made up of four large counties that have 82 cities within the region. It is located on both sides of Puget Sound and deals with two regions of the Washington Department of Transportation. It also has a large ferry system that is part of our national highway system, which is a part of the CMS.

The CMS is supposed to be a systematic process for managing congestion, then identifying solutions to alleviate that congestion and enhance mobility. So when we originally developed our CMS, we came up with a hierarchy of performance measures that were based on our metropolitan transportation plan. We had a couple of primary performance measures that we dealt with, a series of supplemental performance measures, and ones in our work program in this area that we said we would try to get to in the future.

The primary performance measures we used originally were based somewhat on the data that we had available, which was volume-to-capacity ratio–type measures. The work program identified moving to travel time as our goal as a much better primary performance measure.

At this point, we monitor about half of our metropolitan transportation system and the six ferry routes. We have incomplete coverage, even on this partial system that we are monitoring, with some of our performance measures. This causes problems with trying to evaluate and identify the performance across our region, as discussed in the paper.

We have a database that stores all this information and is linked to our geographic information system (GIS) using a linear referencing system. We supply the information that we have within our CMS on our web site. Some comparisons of our CMS and some key areas from the paper follow.

- Key group concerns. When we developed the performance measures that we use today, we had a lot of involvement from the three areas that were identified in the paper: stakeholders; customer bases, which are the public and members of our metropolitan planning organization (MPO); and a lot of internal staff. We used these resources to try to concentrate on coming up with performance measures that went back to the goals and objectives that were identified in our metropolitan transportation plan. The key groups were brought together to address their concerns.
- Relatively few measures. We have a lot fewer measures than the 700 measures that the Florida Department of Transportation has, mainly because of resource issues and data availability. We still have too many measures for what we are trying to do, at least at a basic level.
- Clear and definable relationship to goals. We have a clear and definable relationship to our goals. However, many of the performance measures that we use are more of an output-type performance measure.

We would like to move toward an outcome-based system.

- Buy-in from key groups. We got a lot of buy-in from groups. This is a yes-and-no type of situation in that we got buy-in from a lot of people who said that these were the right performance measures that we should have. But then when we went to collect the information from the people who were needed to supply this information to us, we met with a lot of resistance and had a lot of problems getting the information. Part of the resistance came from the fact that we were talking to one group when we were talking about what the performance measures should be, and they were coming from agencies that would be able to supply us the information. There was no discussion with the people who maintain the information at the different agencies and jurisdictions about whether they would be able to supply it. So we need to go back and reevaluate this key area from the beginning as we are developing these performance measures.
- Slow change. We have changed slowly. We have not changed much at all, and that is what we are in the process of trying to do, make some decent changes and move forward.
- Improvement. It comes down to facilitating improvement. I would say that at this point, our CMS does not do that. It has to do with the facts that I mentioned earlier. We made a decision early on, as part of the stakeholder group that we put together, that we did not want to use model data. We did a lot of reviewing of our model, and the group was just not comfortable with that. So they wanted to take the bold approach of trying to do a sort of "universe collection." In the end, as we have tried to work through that, it does not seem to work. This is something that we are going to have to revisit and try to come up with a type of sampling methodology that they would be comfortable with.

For the future of the Puget Sound CMS, we want to go back and define simple performance measures with complete system coverage. We want to use a set of initial performance measures that focus on the core idea behind the CMS but then use that system to maybe screen and focus more of our very limited resources on areas where we might be able to get into some of the more detailed performance measures. We will look at some of these supplemental performance measures, such as average car occupancy, a more direct measurement of travel time, and a lot more detail on the type of transit information that we collect. For information such as access, we would like to focus on some screening measures.

In our agency, we have not collected much data ourselves. Now, to get at some of those consistency issues and to have more confidence in the data, we are looking at ways that we could collect information and supply it as a service back to our member jurisdictions, so that they can use the data that we have collected. We will continue to use the database and GIS system that we have set up. It has worked pretty well.

We also like to take advantage of many ITS applications. We have an interesting imbalance within our region when it comes to ITS applications. In some of our counties, there has been a lot of ITS implementation, which allows us to get large amounts of good data for some of our region. For example, there is all the information that the Washington Transportation Center uses for the great graphics that they create. The problem is it is in only two of the four counties within our region. As a result, evaluating issues across the region is pretty difficult. So we have to let those measures go because they are not particularly effective when it comes to evaluating across the region.

Panel Discussion, Part 2

Douglas Zimmerman, *Pennsylvania Department of Transportation*
Rick Schuman, *PBS&J*
Michael Hoglund, *Portland Metro*
Jeffrey Arndt, *Houston Metro*
Ron Tweedie, *New York State Department of Transportation, Moderator*

After the first general session on selecting measures, data needs, and analytical issues and workshops on this topic, another general session was held for participants who were interested in the more technical aspects of the subject. The session consisted of four presentations by participants on technical aspects of data for performance measurement.

Pennsylvania Department of Transportation's Closed-Loop Process

Douglas Zimmerman

Doug gave an overview of the closed-loop process for determining the Pennsylvania Department of Transportation's (PennDOT's) performance measures (Figure 10). Principal elements include

- Selection of existing and new data sources,
- Data analysis and synthesis,
- Development of actionable high-level goals and strategic objectives,
- Development of a strategic agenda,
- Identification of measurable performance and improvement targets, and
- Product and process feedback (links back to the first step).

PennDOT developed a matrix that ranks the quality and importance of its products and services as rated by respondents in their QUIK (quality, urgency, importance, knowledge) customer survey (Figure 11). The customer survey data, along with data listed in Table 4, are used for strategic planning. Particular emphasis has been placed on the policies and practices identified as needing improvement (bottom right of Table 4).

PennDOT developed a scorecard of measures for achieving strategic goals. Several opportunities and issues emerged as a result of the performance measurement and strategic planning process. PennDOT identified the need for

- Data warehouse to manage all the data needed for the process,
- More reliance on technical expertise for the development of optimal measures,
- Senior staff training in the use of measures and performance data,
- More time spent considering what are the issues in implementing a performance-based planning process (e.g., determining whether they have the right measures and finding innovative ways to quantify "soft" measures such as quality of life),
- Understanding the consequences of measuring the wrong things,
- Building in flexibility to accommodate changing customer demands and requirements, and
- Better understanding how much information to share and report ("right sizing").

PennDOT is continuing to work on the linkage between the "performance scorecard" (concept and outcome based) and the "dashboard of measures"

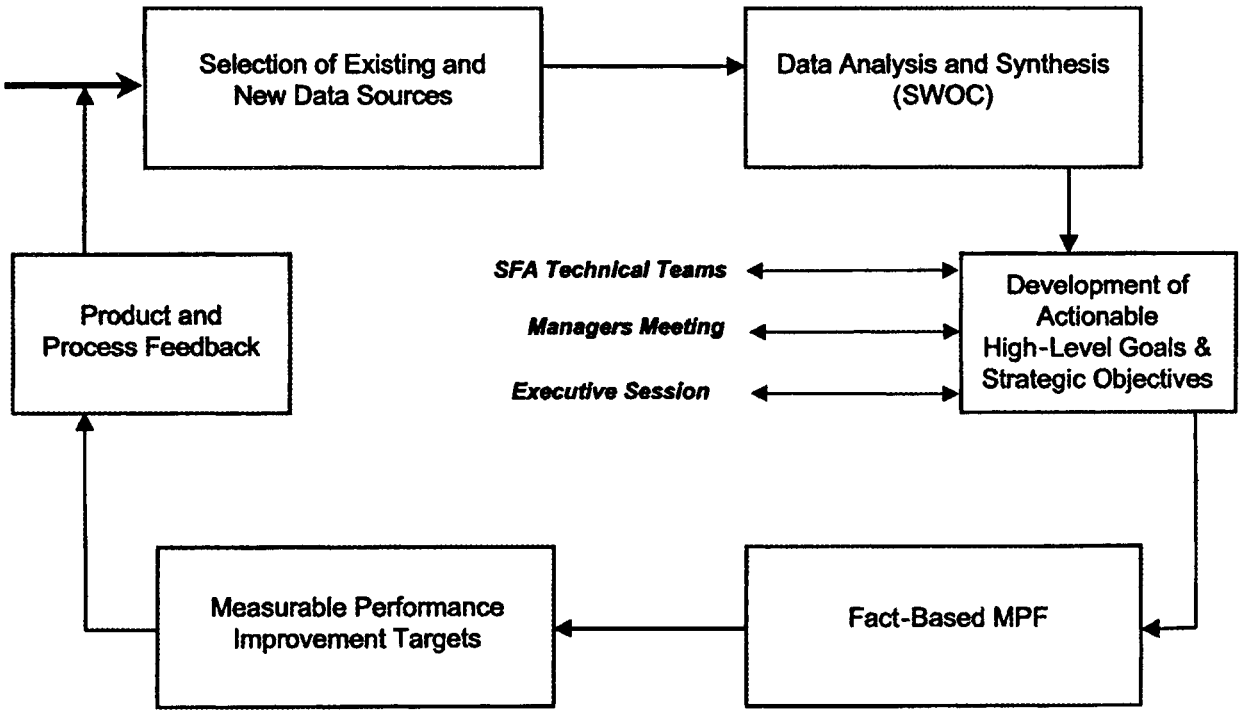

FIGURE 10 PennDOT's cycle for performance measurement system. [SWOC = strengths, weaknesses, opportunities, and challenges; SFA = strategic focus areas; MPF = Moving Pennsylvania Forward (strategic agenda).]

TABLE 4 Data for Strategic Planning (PennDOT)

Opportunities (High Importance/Low Grade)	*Challenges (Risk Factors/Potential Barriers)*
Products and services with potential to exceed customer expectations • QUIK Survey • PennPlan • External Scan • County Maintenance CSI	Forces and factors that will affect our future • PennPlan • Executive Visioning Session • PennDOT/Partner Visioning • Partner/Supplier Focus Groups
Strengths (High Importance/High Grade)	*Weaknesses (Ineffective Practices/Potential Barriers)*
Products and services with high current customer approval • QUIK Survey • PennPlan • External Scan • County Maintenance CSI	Policies and practices identified as needing improvement • Organizational Climate Survey • Employee Focus Groups • Baldridge Gap Closure • Partner/Supplier Focus Groups

CSI = customer satisfaction inventory.

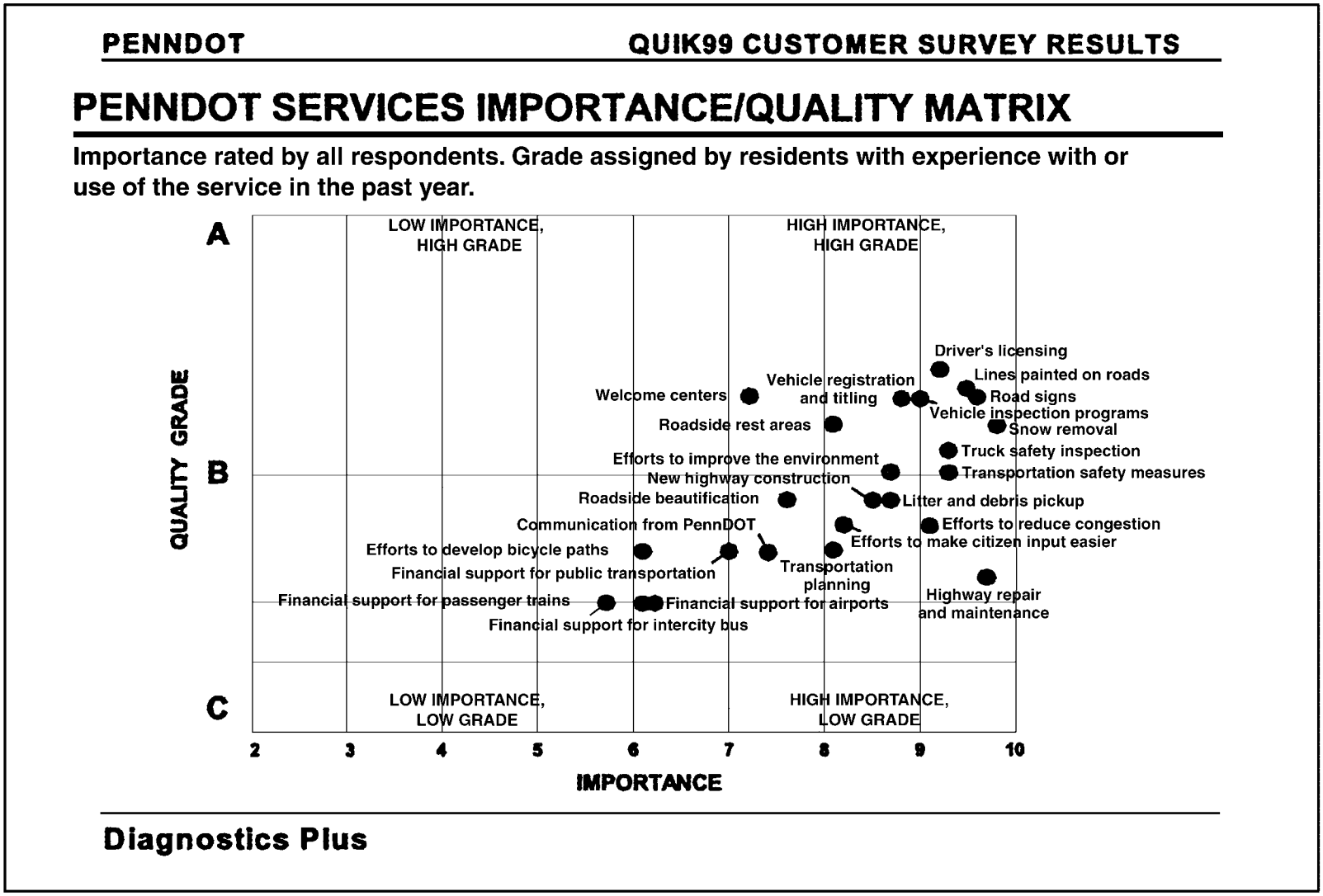

FIGURE 11 Example data

(input and output based). The next steps include the following:

- Enhancing the QUIK survey: conducting customer surveys to rate the importance and quality of products and services and asking customers what would it take to get an "A."
- Improving data management: the current quantity of data exceeds current capabilities for roll-up and integration.
- Looking for methods: to better balance customer data with other technical data in the agency.
- Emphasizing partner and supplier relationships: as part of the performance measurement process.

Intelligent Transportation Systems and Performance Measurement

Rick Schuman

Rick discussed intelligent transportation system (ITS) data applications and performance measurement. He focused on three main issues:

- The data-collection revolution is under way,
- Lessons learned from public perceptions, and
- Challenges for future efforts.

Data Revolution

- We are transitioning from data poor to data rich.
- New types of data are available from traffic sensors, imaging technology, incident event reports, and environmental (weather) sensors.
- Traditional data-collection systems are expanding (e.g., one-third of all centerline freeway miles in many urban areas are under some form of surveillance).
- Travel time measurements are becoming easier to obtain via transponders from toll roads. Soon, it may be possible to obtain location and travel time data from cellular phones and an on-board Global Positioning System.
- Complete trip logs may be possible in the near future; "super probe" devices may enable vehicles to report origin-destination data automatically.
- Travel time data are more reliable from these new detection technologies.

Lessons

- Evidence is growing that the public relates best to pictures and travel-time information.
- Reliability as a measure is key.
- Urban transportation facilities are increasingly expected to be "operated."
- Information on the operation of these facilities is increasingly expected to be provided.
- Concerns about data privacy that may affect future ITS data-collection activities are increasing.

Challenges

- Current technology should not limit how we view data availability. We should use engineering principles to define data needs (e.g., determine what data we need) and not let current technology limit our horizons.
- We need to expand performance measurement development to measures for system operations, management, and improvement.
- Proposed categories for measurement could also be broadened beyond "smooth roads," crashes, and congestion to also consider travel time and public information needs.

Performance Measurement in Portland, Oregon

Michael Hoglund

Not all metropolitan planning organizations have moved as far as the states in performance measurement, especially as they relate to the planning process. Portland Metro's reasons for measuring are to meet legal requirements and to provide information for the public discussion of issues. The organization has adopted a methodology for selecting indicators and measures and is following several principles in identifying performance indicators. The measures must

- Relate to measurable policy goals;
- Be understandable to a broad public;
- Reflect a long-term commitment;
- Be based on credible methodology and credible, real-time data and interpretation; and
- Integrate local and regional indicators.

Portland Metro is measuring the following areas:

- Housing and employment (especially affordable housing),
- Transportation,
- Surface parking,
- Water quality and flood management,
- Fish and wildlife,
- Rural preserves, and
- Big-box retail- and industrial-area expansion.

Transportation measures are tied to policy goals: analytical indicators or measures (primarily historical and forecast data) are typically used in planning studies to evaluate the extent of the potential benefits of a study alternative, whereas evaluating measures (real-time data) are used to monitor systems, usually after a plan or project is in place, to determine whether a plan or project is performing as intended. Reducing vehicle miles traveled is important and is tied to areawide policy.

Geographic information systems are being applied to data and measures in several ways. For example,

- More sophisticated approaches are evolving for tracking and forecasting mode splits (obtaining these data continues to be relatively expensive);
- Transit ridership and coverage are being tracked;
- An accessibility index based on the distance to jobs and households has been developed for transit and autos; and
- Miles of pedestrian walkways and bikeways as well as travel times in key corridors are being tracked.

Customer Is Key in Houston

Jeffrey Arndt

Houston Metro has been in the measurement business for many years. It started back when the *Houston Chronicle* started counting the number of buses that "pulled out" of the transit garage each day.

Four key issues drive performance measurement efforts: safety, reliability, timeliness, and customer satisfaction. In 1998, Houston revisited and fine-tuned its performance indicators. Performance standards were established, and indicators were adjusted for known "events" and anticipated fleet performance. All of Houston's indicators are based on six principal data sources:

- Customer complaints,
- Customer boardings,
- On-time performance,
- Vehicle miles traveled,
- Service interruptions along the route, and
- Accidents.

Every month, the Houston Metro Board members receive a performance report that includes four transit service performance indicators (Table 5). Each of these indicators is further broken down to distinguish between services provided by Houston Metro and services provided by contractors.

Houston Metro is working to improve data integrity, clarify the expected margin of error, and provide explanations and analysis of the performance data. It also has integrated its process into the terms and conditions of employment negotiated with its unions. Employees may receive payroll bonuses of up to 3 percent of total earnings based on their individual performance in meeting the indicators or measures.

TABLE 5 Performance Indicators

Indicator/Measure	*This Month*	*FY 2000*		*Variance from Goal*
		YTD	*Goal*	
On-time VMT between service interruptions				
Accidents/100,000 VMT				
Complaints/100,000 customer boardings				

VMT = vehicle miles traveled.

General Discussion

Issue: Because all surveys have different levels of accuracy or ranges of errors, should agencies report these accuracy limits publicly when they report results?

Discussion: Some agencies report the range of errors, some have caveats, and some do not report error ranges but calculate them internally. There is concern that error limits are not fully understood and that sampling error is confused with survey error.

Issue: If you survey nonriders of transit systems, can you develop performance measures for them? Do these surveys help build budget support?

Discussion: They can indicate how nonriders feel about the organization but not in terms of performance measures. It helps to find out what the broader community thinks.

Issue: Can performance measures be used to pay for performance? How do you protect against skewing the data?

Discussion: Different transit organizations have pay-for-performance programs based on performance measures. Management must continually monitor performance data to ensure that skewing is not taking place.

Issue: Have any agencies looked at full societal cost accounting?

Discussion: Puget Sound Regional Council is required by law to do full societal cost accounting and has done it for their long-range plan. Other agencies have societal measures that are discussed but not monetized.

Issue: Do we need to consider both traditional and customer measures together so that we do not fall into the trap of saying we cannot quantify a measure, so we will not measure it?

Discussion: Both traditional measures with hard data and customers with soft data are needed. But in processes, the customer data are used differently.

Issue: If outcome measures are preferred, why use output measures?

Discussion: Outcome measures should be the goal. However, sometimes it is better than nothing to use output measures while developing ways to collect and analyze outcome measures.

Issue: In a multiagency environment, is it important to have agreement on goals and performance measures to guide data collection?

Discussion: Different parts of a region will have different goals for their areas, so agreement on goals is difficult. When there is agreement on performance measures, agencies should agree on methodologies for data collection and analysis. This is one of the data-integration issues that will be dealt with in an upcoming peer group review.

Issue: Engineers usually are not trained to measure outcomes. Do we need to involve other disciplines in measuring outcomes?

Discussion: Other disciplines must be involved.

Issue: Collecting data is expensive. Is there any experience with agencies stopping data collection while establishing performance measurement programs?

Discussion: Some agencies did in fact reduce or eliminate some data collection by finding surrogate measures or agreeing that the measure was not worth the expense. In another case, additional data were required to fill the gaps.

Issue: Is there any experience with exchanging data with agencies other than transportation agencies? Are there quality issues? Compatibility issues?

Discussion: Many examples of exchanging data with other agencies exist, but there are compatibility issues, such as different geographic information systems. Agencies need to understand the data sources and their limitations before using them. Developing regional models using local data inputs is a good way to achieve data integration and buy-in to the process.

Workshop Summary

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Becky Duke, *Montana Department of Transportation*
Mark Hallenbeck, *Washington State Transportation Center, University of Washington*
Shirley Hsiao, *Orange County Transportation Authority*
Patricia Hu, *Oak Ridge National Laboratory*
David Kuehn, *Federal Highway Administration*
Joseph Segale, *Chittenden County Metropolitan Planning Organization*
Chuck Sonday, *Nebraska Department of Roads*
Ronald Tweedie, *New York State Department of Transportation*

State of the Practice

Traffic data warehousing is being done in several locations (e.g., Wisconsin, Florida, Los Angeles, and Phoenix). Loop detectors are commonly used in California, but a fair percentage are generally out of service, many because of communications failures. It is difficult to find resources to maintain them. Agencies are experimenting with laser detection. Warehoused information is made available in the form of published reports and CD-ROMs.

Some locations, including Florida, are linking geographic and accident information. The First System in Los Angeles will link incident information to a geographic information system (GIS) database. At least one state tried to set up a centralized data system and found it did not work. At least two states now hold the information collectors responsible for storing and providing the data they collect.

Issues

Measure Selection

- There are different perspectives on performance measures, such as customer versus agency (e.g., bus breakdown versus preventive maintenance measures) and national versus local.
- Selection of appropriate performance measures needs to be a combination of top-down (needs-driven) concerns and bottom-up (data-driven) capabilities.
- Performance measures should not be portrayed as the absolute criteria in decision making.
- There is a tendency to overmeasure. It is important to balance data-acquisition costs and data availability.
- Performance measures should be selected to best inform policy makers.
- How do we build effective measures, from conceptual (word based, descriptive) to operational definitions (quantitative) and from input to output, to outcome, to second-order outcomes?
- Performance measures need to be related to strategic goals. Thus, new performance measures should be defined, and obsolete performance measures should be dropped.
- The key is to know how you are going to use the performance measures before knowing whether the measures are the "right" ones. A process needs to be established to determine which measures to ultimately use.
- Performance drives data needs and priorities.
- When communicating data between manage-

ment systems (e.g., in New Jersey through GIS, in California through a central office), where is the format decreed? What is an appropriate level of centralization?

- Segment and collect information by coordinate points versus line segment or shape.
- Level of accuracy and consistency for higher-level (policy) purposes: is the "real" number important? Or is it the trend? the consistency in method?
- Performance measures for policy analysis should be suited for their purpose with the following characteristics:
  - –Have an appropriate level of accuracy (is the "real" number important or is the trend most critical?);
  - –Be measures that are easy to explain and have a level of accuracy that can be explained;
  - –Help in the decision-making process; and
  - –Be flexible enough to respond to a changing decision and policy environment.

Data and Data Needs

- Assured quality of data;
- Integration of data from different sources and different geographic or political jurisdictions;
- Data compatibility (avoid comparisons between "apples and oranges");
- Data consistency;
- Uniform format;
- Standardized definitions;
- Location referencing systems;
- Integration tools;
- Key data elements of bicycle and pedestrian data to evaluate system reliability;
- Resources to support necessary data collection and analysis;
- Hierarchy of surrogate measures for measures that are too difficult, intangible, or expensive to measure (e.g., quality of life, societal costs);
- Use of outcome surrogates (e.g., bike network gaps versus number of riders) from greater to more specific (e.g., quality of life to more train riders to one-time performance, cleanliness) because outcome measures may be harder to assess as they become more general and policy oriented and more subject to external factors;
- Survey of users about qualities that can be affected by the transportation agency and tailored to different markets (locations and demographic groups) because different groups have different needs and priorities;
- Coordination of data collection within a single agency to maximize efficiency;
- Data ownership: Who collects the data? Who owns the data?;
- Understanding the difference between projections and actual observations (projections typically subject to forecast uncertainty; actual observations subject to measurement errors);
- Future data needs (difficult to anticipate);
- Proper data and tools (to justify revenue increases with performance measures);
- Right amount of data: How much data is enough?; and
- Worth of data collection: Does it pay for itself?

Analytical Issues

- We need to understand the variability and errors.
- Do the decisions we make fully appreciate and consider the variability and errors in the data?
- Do we have the right tools (and data) to compare performance among different modes for investment decisions?
- We need better tools to quantify trade-offs among different performance goals.
- Although it is difficult, it is important to measure the relationship between transportation and land use, livable communities, economic vitality, and other broad social goals.
- We do not understand the relationships among commodities, mode choice, and travel characteristics; we could use more research.
- There are a lot of data but not enough analysis. We need to know what the data are telling us.

Opportunities and Constraints

- Enhance data collection with leverage-evolving technologies [e.g., intelligent transportation systems (ITS), imaging, Global Positioning System (GPS), cellular phone, wireless communications].
- Validate the reliability of data generated by evolving technologies.
- Identify the abundant opportunities to integrate these data with traditional data.
- Begin a dialogue with the Archived Data User Service (ADUS) community.
- Decide which and how much ITS data are needed (planners).
- Understand the risks of using these data.
- Use the Internet for data sharing and agencywide coordination.
- Collect data that serve multiple purposes.

- Delegate measures to more local authority (smaller organizational units versus comparability), with an awareness of the appropriate scale (organizational unit and geography).
- Conduct not only cooperative planning but also cooperative data collection and sharing.
- Incorporate performance measures into transportation college curriculums.
- Develop public and private partnerships in data collection and analysis; take advantage of nontraditional sources of data (e.g., American Automobile Association, insurance agencies, and hospital records).

Next Steps

The overarching need is to have the right tools to prioritize investment decisions and to allocate funding. The following activities could help develop the appropiate tools:

- Synthesis report [like those published by the National Cooperative Highway Research Program (NCHRP)] to inventory the types of performance measures that are used, the purposes in using these measures, and their pros and cons;
- Ways to gauge the consequences of using a wrong performance measure;
- Guide to quantify the intangible measures and indicators;
- Guide to measure and understand errors;
- State-of-the-practice report on analysis, data, and tools to compare modes;
- Tool to quantify the effects of performance measures on decision making;
- Best-practices manual on what works and what does not;
- Directory of case studies of private-sector data (goods movement);
- Case studies and effective practices on closing the loop from strategy goals to input, to output, and to outcome, with feedback loops from each;
- Staff capacity and skill sets (new data types change how the job is done; need training and time to allow for adequate training);
- Case studies (Which data are no longer collected and why? Which data has the federal government stopped asking for?);
- More data on demographic stratification;
- Outcomes that influence the causality of broader societal outcomes;
- Development of performance measures for the land use and transportation connection;
- Improved data collection for all modes, especially nonhighway;
- Research to improve planning techniques especially for surveys, use of ITS data, behavior, and behavioral models, privacy, and data quality; and
- Integration with traditional data.

Connecting System Performance Measures to Broader Goals

Measuring That Which Cannot Be Measured—At Least According to Conventional Wisdom

Panel Discussion

Workshop Summary

RESOURCE PAPER

Measuring That Which Cannot Be Measured—At Least According to Conventional Wisdom

Michael Meyer, *School of Civil and Environmental Engineering, Georgia Institute of Technology*

> Not everything that counts can be counted;
> and not everything that can be counted counts.
> —*Albert Einstein*

As a society, we are fixated on measuring and quantifying the economic and social activities that affect our lives. How many of us on a daily (if not hourly) basis watch the Dow Jones Index to determine what is happening to the stock market? The popular press reports much anticipated indicators on the performance of schools (Scholastic Aptitude Test scores and *U.S. News & World Report*'s university rankings), police agencies (crime statistics), neighborhood desirability (house sales and average price), airline performance (on-time statistics), highway performance [the Texas Transportation Institute's (TTI) congestion index], to name but a few. Inevitably on release of this information, pundits often question the validity of the indicator, noting such matters as the impossibility of capturing all of the causal factors that lead to the actual outcome or the important influence of environmental factors or of experimental design that could invalidate the result. Such punditry becomes easier when the issue is so amorphous or broad that arguing about measurement becomes secondary to the debate surrounding what the topic is to begin with.

In transportation, we have seen many of these issues, topics, and goals rise to the top of the public policy agenda in recent years. Nearly everyone would agree that as a society and certainly as a profession, we should strive to enhance community quality of life, encourage sustainability, preserve or improve ecosystem health, promote economic well-being, and seek environmental justice. In fact, many state and metropolitan transportation plans have statements to these effects as part of their vision definitions, goals, and objectives. However, besides our knowing it when we see it, are there ways to actually measure the progress toward these ends in meaningful ways? The purpose of this paper is to examine the role of performance measurement in areas that are inherently difficult to measure. To state the problem in the current parlance of the profession, how do we measure the outcomes of transportation policy decisions versus the outputs? Are there ways of incorporating such measures into the transportation planning process that can provide decision makers with useful understanding of (*a*) the cause-and-effect relationship with transportation system performance and (*b*) how this relationship is affecting the desired outcome over time. How can performance data that are designed to report on facility physical conditions be related to broader societal goals? What are the policy, organizational, and technical issues that must be addressed to accomplish this task?

Figure 1 provides a conceptual framework that guides the approach taken in this paper. If performance measurement is linked to decision making, Figure 1 suggests that there are four important levels of decisions to consider—system operations, planning, system management, and strategic investment. Note that the operations decision level is the largest, reflecting the fact that in most metropolitan areas or states there are many more agencies and actors involved with operations decisions than there are with

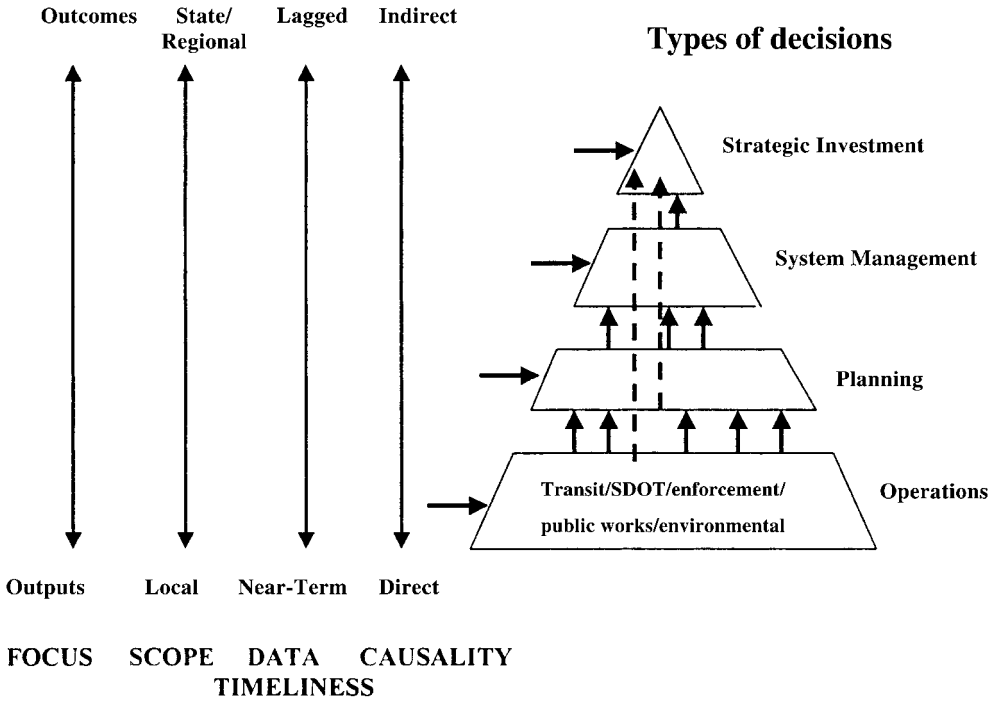


FIGURE 1 Hierarchy of decision making. (SDOT = state department of transportation.)

strategic investment decisions. At each level, performance measures and corresponding data can be used to provide feedback to the relevant decisions. However, the vertical arrows represent data or performance measures that can be used at higher decision-making levels. The dashed arrows reflect such measures or data that transcend all levels of decision making and provide input into decision making at the strategic investment decision-making level (thus, at least conceptually, answering one of the questions previously raised). However, at each level, there could be measures desired by the corresponding decision makers that are specific to that decision context. These measures are represented by the horizontal arrows in Figure 1. At the very highest level, this could imply that decision makers might be interested in issues and performance measures not directly linked to information surfacing from the other levels, for example, impacts on economic productivity, environmental justice, and quality of life. The desire for this type of information would result in a top-down direction to planners and analysts to produce the requested information as part of the decision-making process.

This framework also allows one to characterize performance measurement along several dimensions that become important in the discussion of how credible measurement can take place. As shown in Figure 1, for example, the hierarchy of decision making suggests that at the operations level, performance measurement would tend to occur at the local level, focus more on outputs where the cause-and-effect relationship between changes in the transportation system and resulting performance characteristics is more direct, and where data can be collected and used on a short-term basis. At the top of the triangle, performance measurement would have a much broader scope. It would be likely to focus on outcomes in which indirect cause-and-effect relationships might play an important role, and in which data on resulting changes might have significant time lags associated with it. All of these characteristics become critical considerations in answering the questions posed in the introduction of this paper.

Three important qualifying statements need to be made. First, the types of societal outcomes of interest to transportation decision makers would probably require expertise beyond what can possibly be provided by one individual. Ecosystem health, for example, deserves the attention of ecologists, biologists, and environmental scientists. Similarly, economic well-being is the purview of economists, sociologists, and political scientists—none of whom would be likely to agree on a common definition of well-being. Thus, as transportation planning becomes more closely related to broadly defined policy goals, there

needs to be greater participation by numerous disciplines in defining terms and in designing measurement approaches. This paper lays the groundwork for such a multidisciplinary approach, but it cannot provide the expertise needed to develop these valid performance measures.

Second, although performance-based planning has been discussed and debated in the transportation profession for the past 10 years, there are still some disagreements and discrepancies on how they are perceived and applied. Regarding the concepts in this paper, it is important to understand how performance measures are considered in the context of transportation planning and how they can be used for decision making. The next section presents a framework that illustrates the integration of performance measures into transportation planning. At this point, the following points need to be made.

There is a clear distinction between performance measures and the evaluation criteria used to analyze alternatives, although the literature and practice often blur the distinction. Clearly, an important relationship exists between the two, but each plays a very different role in the planning process. For example, "number of jobs generated" might be an evaluation criterion used to assess the impacts of a transportation project. A more general measure of economic vitality would be the system performance measure. Or the "number of tons of a particular pollutant" might be an evaluation criterion, with a more general systems measure being quality of public health. Many of the more general measures are difficult to measure, perhaps even to define, often leading to surrogate measures such as economic costs.

Another important point-of-departure issue is the use of performance measures in the decision-making process. The performance measures discussed in this paper are not measures to compare the effectiveness of one program with that of another. They are not intended to be used in an audit of a particular program's performance. There has been much confusion about the use of performance measures in such a role. Rather, the performance measures discussed in this paper are intended primarily to monitor the performance over time of the transportation system and to relate that performance to the decision-making process leading to investments in that system. This necessarily leads to a discussion of cause and effect that is the fundamental challenge in using outcome-oriented performance measures in transportation planning and decision making. To use performance measures in such a capacity, we need to understand system performance measurement from a broad perspective.

Third, although performance measures aimed at monitoring the operation of a transportation system are fairly straightforward, those that focus on broader societal outcomes face significant challenges in definition and application. The underlying theory that links transportation system performance and these outcomes needs to be well established and believable by decision makers. For the types of societal outcomes of interest to this paper, such theories will most likely relate to economics, ecology, earth sciences, and human behavior. More importantly, the relationship between transportation system operation and investment will have a time lag associated with the eventual outcomes, thus adding to the complexity in establishing cause and effect. This time lag could also affect decision makers' interest in the performance measure to begin with. It seems likely that whatever set of transportation performance measures is considered for broader society outcomes, it will consist of those transportation-related variables that occur early in the cause-and-effect cycle or precursors to the eventual outcome of interest.

Perspectives from Other Fields

Before discussing the application of performance measures for broader societal outcomes in transportation, it might be instructive to examine briefly the experience in three important fields of study. The literature in each is voluminous and cannot be repeated here in detail. However, putting the transportation experience in the context of these other approaches to a similar challenge can help to better understand how the linkage between transportation system performance and societal outcomes could be approached. At least it will show that our profession is not alone in facing these challenges. Three fields of study are presented: water resources, ecology and sustainability, and economics.

Water Resources

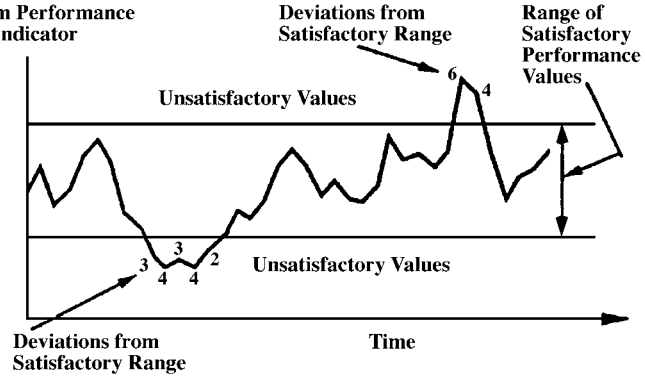
The field of water resources planning and engineering has often preceded transportation planning and engineering in its development and application of state-of-the-art practices and technical approaches. For example, multiobjective analysis was being used for water resources planning long before it was developed in the transportation field. The American Society of Civil Engineers (ASCE) took the lead in developing sustainability criteria for water resource systems and related the management of water resources to much broader societal issues, such as public health, economic development, and environmental quality (1998). In its treatise on the subject, ASCE

combined these issues under the umbrella of sustainability (ASCE, 1998). The approach suggested for societal outcomes is to use net economic welfare as a surrogate value. Use of performance indices is also explored. Figure 2 shows an example of how an indicator can be further disaggregated into three important pieces of information: reliability of system performance, its resilience, and its vulnerability. No specific sustainability measures are proposed, although several guidelines are presented for the management of water resources in a sustainable manner.

Ecology and Sustainability

The literature on sustainability, particularly how one measures it, has increased dramatically in the last 10 years (see, for example, Bell and Morse, 1999; Hohmeyer et al., 1997; Leitman, 1999; Maser, 1997; Newman and Kenworthy, 1999; and Roseland, 1998). The ecology literature, in particular, focuses much attention on ecological performance and the human impact [see, for example, Brown et al., 1999; Goudie, 2000; National Research Council (NRC), 2000; and Schulze, 1999). After an extensive review of current practice and science, NRC (2000) recommended the following national indicators of ecological health: land cover, land use, total species diversity, native species diversity, nutrient runoff, soil organic matter, carbon storage, ecological production capacity, net primary production, lake trophic status, and stream oxygen and—for agricultural ecosystems—nutrient-use efficiency and nutrient balance. Table 1 shows sustainability indicators from three sources. As seen, in two of the cases, transportation is a specific category of measurement.

Some of the indicators shown in Table 1, especially those originating from the United Nations and the World Bank (1994), are aimed at developing country contexts. However, these indicators illustrate how one could measure the types of activities and urban char-



Reliability: $\frac{\text{Number of Satisfactory Values}}{\text{Total Number of Values}} = \frac{31}{38} = 0.82$

Resilience: Number of Times a Satisfactory Value Follows an Unsatisfactory Value / Number of Unsatisfactory Values
= 2 / 7 = 0.29

Vulnerability:

Extent: 6 with conditional probability of exceedance of 0 / 7 = 0.0
4 with conditional probability of exceedance of 1 / 7 = 0.14
3 with conditional probability of exceedance of 3 / 7 = 0.43
2 with conditional probability of exceedance of 6 / 7 = 0.86

Expected Extent Given Unsatisfactory values = (3+4+3+4+2+6+4) / 7 = 2.7

Duration: 5 with conditional probability of exceedance of 0.0
2 with conditional probability of exceedance of 0.5

Expected Duration Given Unsatisfactory values = (5 + 2) / 2 = 3.5

FIGURE 2 Reliability, resilience, and vulnerability of system performance measurement. SOURCE: American Society of Civil Engineers, 1998.

TABLE 1 Sustainability Measures

Newman and Kenworthy (World Bank, 1994)	*City of Norwich, England (Bell and Morse, 1999)*	*United Nations (Leitman, 1999)*
Energy and Air Quality	*Environmental Protection*	*Improve Air Quality*
total energy use per capita	number of good air days	air pollution concentrations
energy cost per dollar output	tons of waste per household	emissions per capita
proportion of alternative fuels	total water consumption	acute respiratory deaths
total pollutants per capita	energy consumed	
total greenhouse gases	quality of water in rivers	*Improve Water Quality*
days meeting air standards	wildlife diversity	percentage of wastewater treated
average fuel consumption	area of green field sites	percentage of BOD removed
vehicles failing emissions test	amount of litter on streets	treatment cost
household noise complaints	number of trips by mode	lowering of water table
	miles of traffic-calmed streets	wastewater recycled
Water, Materials, and Waste		level of treatment
total water use per capita	*Economic Development*	
days meeting quality standards	unemployment rate	*Improve Solid Waste Collection and Disposal*
sewage treated to reusable standards	percentage of skilled employment	solid waste generated
sewage discharged to streams	net increase in jobs	disposal methods
consumption of building materials	number of corporate headquarters	regularity of waste collection
consumption of paper and packaging	number of tourists	biodegradable waste
amount of solid waste		recycling rate
organic waste returned to soil	*Social Development*	cost of waste disposal
	percentage in poverty	cost recovery
Land, Green Spaces, and Biodiversity	number of homeless	industrial waste generation
agricultural land at urban fringe	number within walking distance of social service agencies	
green space per capita	percentage voting in elections	*Ensure Sustainability*
percentage of urban redevelopment	number of sports facilities	energy use per person
number of transit-oriented developments	crime levels	fuel wood use
density of population and employment	number of seats for arts and culture	renewable energy use
	number of historic building listings	food consumption
Transportation	number of art collections open to public	
VMT per capita		*Reduce Effects of Disaster*
nonauto mode split		houses destroyed
work commute time and distance		mortality rate
transit speed relative to auto		housing on threatened land
service miles of transit		fatal industrial accidents
cost recovery for transit		
parking spaces per 1,000 workers		*Improve Urban Natural and Built Environment*
miles of separate bikeways		green space per capita
		number of historic sites
Livability, Human Amenities, and Health		
infant mortality per 1,000 births		
average educational level		
local leisure opportunities		
crashes per 1,000 people		
crimes per 1,000 people		
deaths from crime		
proportion of substandard housing		
miles of pedestrian-friendly streets		
proportion of city with urban design guidelines		
proportion of city allowing mixed use, higher-density development		

NOTE: VMT = vehicle miles traveled; BOD = biological oxygen demand.

acteristics that lead to desirable societal outcomes. The key challenge in almost all of the indicators shown in Table 1, except for those defined for transportation, is that of relating the performance of the transportation system to the actual values of these indicators, that is, the cause-and-effect relationship.

Economics

The perceived positive impact of transportation investment on economic development is one of the most important motivations to transportation decision making. Given the status of metropolitan areas as the economic engines of national economies (see Armstrong, 1999), providing an efficient urban transportation system is considered a necessary precursor for a healthy economy. However, the exact nature of this relationship is often debated. An NCHRP study that looked at the potential for transportation capital investment to be a catalyst in producing productivity gains, economic growth, and improved regional competitiveness concludes that "transportation infrastructure investment is substantially more effective in promoting net productivity growth than it is in stimulating regional economic gains" (Lewis, 1991). The reduction of trip delays, vehicle operating costs, and accident costs has a positive impact on regional economic welfare in areas that are economically strong. Economically weak areas would not likely benefit as much from transportation investment as they might from an educated and trained labor force or competitive market advantages. More interestingly, the study also concluded that although transportation investment can promote local job growth, job creation usually comes at the expense of job growth elsewhere in the region or state. Thus, transportation investment promotes growth through productivity gains rather than net increases in the rate of employment. In most cases, transportation investment by itself is not likely to cause significant change in economic activity. Supportive market forces and public policies are also important to spur economic development.

Some form of economic indicator or set of indicators would be an important component of any approach at measuring the broader aspects of transportation system performance. It is likely, however, that these indicators will incorporate some form of environmental and social accounting of the costs linked to a transportation system (see, for example, Stahmer, 1997; and Delucchi, 1997). The typical measures used today, such as gross domestic product, are adequate to measure economic activity if the broader societal costs associated with resource consumption and impacts are ignored. I suspect that ignoring this broader "cost" perspective will not be acceptable in many metropolitan areas in the future.

Broader Perspective on Transportation System Performance

The primary developmental period for the systematic approach toward transportation planning that characterizes much of current practice occurred in the 1960s and 1970s (Meyer, 1995). Transportation planning then was concerned with many issues, but primarily the focus was on system expansion to meet the growing demands for automobile travel and the corresponding characteristics of high speed and safe use of the road systems. Average vehicular speed, estimated usage of the system or network links (such as volume to capacity), number of crashes, and costs became the most used criteria for evaluating alternative transportation system plans. Because these were the criteria used for plan evaluation, they also tended to be the measures used in monitoring the "effectiveness" of transportation system performance. As the nation's urban road system expanded in response to unprecedented population and employment growth, congestion on this system and the concomitant effects on the environment and on people's daily lives became important issues to system users, decision makers, and analysts. Congestion, the effects of congestion, and measuring congestion levels were thus some of the major system performance issues that drew the interest of transportation professionals in the 1980s and 1990s. However, much of this professional interest focused on measures that had been developed in the mid-1950s by engineers and planners who were interested in the impacts of congestion on vehicle flow.

Suggested measures of congestion during this earlier period focused on three major factors:

- Operational characteristics of traffic flow, which included speed, delays, and overall travel times;
- Volume-to-capacity characteristics, which required a comparison of actual volumes with road capacity; and
- Freedom of movement characteristics, which required a determination of the percentage of vehicles restricted from free movement and the durations of such restrictions.

As Pignataro (1973) noted, several types of congestion indices surfaced from this early attention:

- The ratio of the actual travel time a vehicle occupies a section of roadway to the optimum travel time,
- Simple travel time to traverse a specified section of roadway,
- Reduction in speed that occurs at high volumes without corresponding changes in volumes,
- Relationship of average overall speed-to-speed changes and frequency of speed changes per mile, and
- Relationship of time loss to driver inconvenience and discomfort.

Much of this work resulted in the method of highway capacity analysis and level of service determination that is common to transportation engineering today (although volume-to-capacity measures have given way to vehicular delay-based measures).

Since this early work (almost 50 years ago), others have examined appropriate measures of congestion and have not proposed anything dramatically different. Lindley (1987) used data from the Highway Performance Monitoring System (HPMS) and defined congestion as occurring whenever volume-to-capacity ratios rose above 0.77—the then breakpoint between Levels of Service C and D. In 1989, the U.S. General Accounting Office (GAO) surveyed state and local efforts to determine the congestion level on road networks and found the use of such measures as traffic density, average travel speed, maximum service flow rate, volume-to-capacity ratios, average daily traffic volumes, and daily vehicle miles traveled (GAO, 1989). TTI's congestion index—one of the latest measures of road system performance—is based on vehicle miles traveled per lane-mile of roadway. Similar to what Lindley used, this determination is based on HPMS data (Schrank, Turner, and Lomax, 1993). Others have relied on the U.S. Census or American Housing Survey (AHS) data to gauge trends in system performance. Gordon and Richardson, for example, used census and AHS data to determine aggregate journey-to-work trip characteristics (i.e., average travel time) for the top metropolitan areas in the United States (Gordon and Richardson, 1995). Pisarski (1996) also provided trend analysis on commute travel and the respective performance of the transportation system.

This brief review of the background on performance measurement leads to two important observations on the genealogy of today's interest in monitoring system performance. First, many of the measures proposed today to monitor system performance are similar to those proposed 50 years ago at the beginning of comprehensive transportation planning in the United States. Furthermore, note that those proposing the measures in the earlier times were primarily civil engineers or those with responsibility for facility operation. In many ways, these measures carry a value judgment about what the system user, or perhaps society in general, perceives as acceptable or desirable performance. The measures have become entrenched as current and accepted practice for the monitoring of system performance, even though they were originally used for alternatives evaluation or design standards.

Second, performance measures must necessarily be oriented toward the types of decisions considered and the target markets. For the operators or owners of the road system, there are clear operations-based measures that relate performance to traffic volume and speed and system-based measures that relate traffic levels to system capacities. For the road users, there are different measures that reflect actual trip patterns and trip characteristics. For the users of transit, the transit agencies collect data on route reliability and travel time that can be used to measure the experience of the trip. However, the use of performance measures in transportation planning suggests that those making decisions on plan and program content need a much broader perspective on the role of transportation. If transportation is one of the empowering factors that allows economic development, affects environmental quality, and influences perceptions of quality of life, then decision makers will presumably want to know how system performance over time relates to these purposes. In other words, decision makers will be interested in the outcomes of transportation investment, not just the outputs of a transportation investment program.

Figure 3 shows one concept of how such broader performance measures could fit into a transportation planning process (Meyer and Miller, 2000). The planning process begins with a vision of what a community desires for the future. The vision as portrayed in the figure reflects the interaction among desired states of prosperity, environmental quality, and social equity and community quality of life. This vision can consist of general statements of desired endstates, or it can be as specific as a defined land use scenario. Performance measures reflect this vision and the goals and objectives that flow from it. Measured from the perspective of transportation system effectiveness and efficiency alike, performance focuses on the information of greatest concern to decision makers. This information could reflect efficiency concerns, such as vehicular or people throughput, system delays, average speed, reliability (although this is in some sense an effectiveness measure), and crash rates. All are measures relating to system operations. Performance measures could also reflect the ultimate

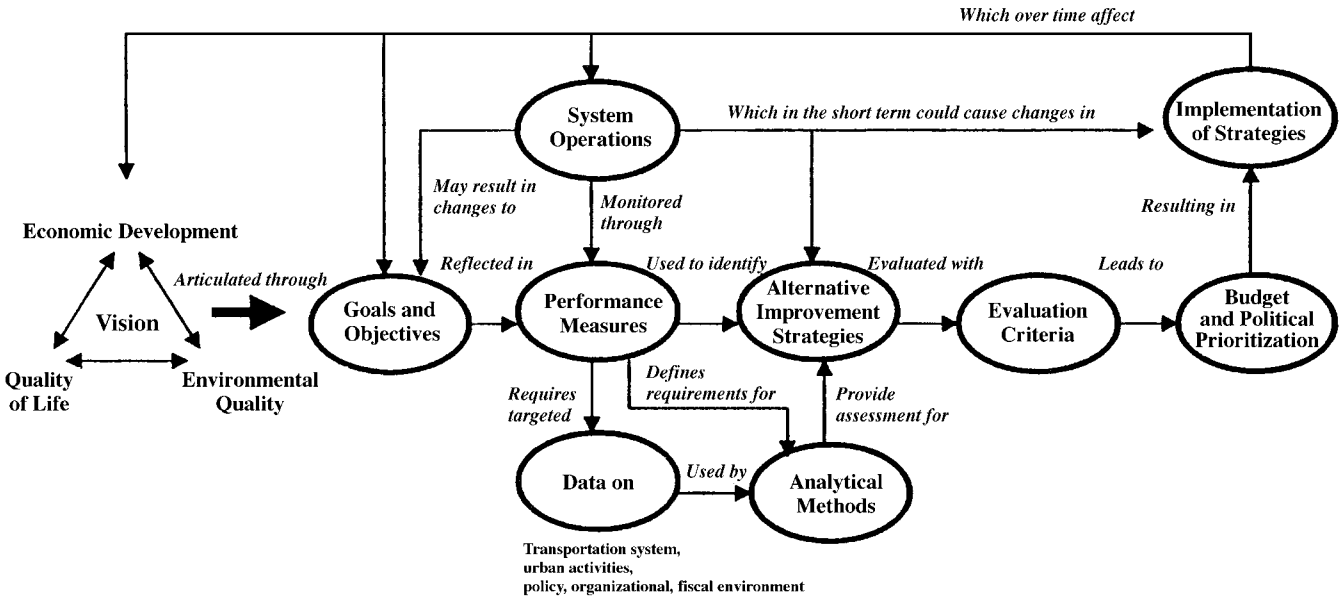


FIGURE 3 Performance-based planning process.

outcomes of transportation system performance, for example, the level of mobility for disadvantaged populations, pollutant levels from mobile sources, and economic development gains. As imagined from the concept portrayed in Figure 3, the use of performance measures becomes problematic if there is no agreement on the goals to achieve. Many types of solutions can be considered when one is trying to meet performance targets. But unless they are placed in the context of overall goals achievement, there is a strong possibility that conflicts over which strategies to implement could lead to a decision-making impasse.

Another characteristic of the planning framework proposed here is the periodic feedback provided to the original vision definition, goals statement, and identification of performance measures. Analysis and evaluation are undertaken not only to assess the consequences of a decision but also to better understand the definition of the problem—and a redefinition may be required, based on preliminary results of analyses. System monitoring, as operationalized through performance measures, serves as a major source of information on the performance of the transportation system and thus is an important indicator of system deficiencies or opportunities for improvement (Meyer, 1980).

Table 2 illustrates the types of performance measures that have been proposed as part of the performance-based transportation planning. These measures are linked to the types of goals that are often part of a transportation planning process. Note that I am not proposing that all of these measures be part of the transportation planning process. The more measures there are, the more likely it is that their use for decision making will be confusing and ineffective. Table 2 is simply an illustration of the different types of measures that could be considered for each goal (for an exhaustive list of performance measures, see Cambridge Systematics et al., 2000). More interesting, these measures reflect a diverse mix of approaches for measuring performance. In some cases, for example, quantitative outputs such as "tons of pollutant" are used; in others, indices (e.g., accident risk and accessibility) are intended to reflect performance; and in still others, costs (e.g., costs of crashes and lost time) are used as surrogates that reflect much broader system performance outcomes.

Examples from Transportation That Come Close

As previously mentioned, transportation planning has been using performance measures for many decades to diagnose problems and to gauge the level of system operational efficiency. Outcome measures have not been used as frequently in monitoring system performance; in fact, it was difficult to find any illustrations of their use. Yet the following five examples illustrate different attempts to incorporate a much broader perspective of system performance into transportation planning and decision making.

The cases are specific to the context in which the performance-based planning approach was developed. Some represent smaller jurisdictions (at least as compared with states), thus, the direct transfer of measures used to other contexts is unlikely. However, each case illustrates how outcome measures can be conceived.

The Barnstable County, Cape Cod, Massachusetts, case was selected based on the premise that more environmentally sensitive areas would have given greater attention in the planning process to the linkage between transportation system performance and the ultimate impacts on the natural environment. The Albany, New York, case reflects the important steps taken in this metropolitan area to develop a planning process that reflects core values and desired system performance. The environmental justice case in Atlanta, Georgia, is still ongoing, but the thinking on performance indicators provides some leads on how such an outcome could be measured. Both the Twin Cities (Minneapolis–St. Paul, Minnesota) audit and the Maryland Department of Transportation (DOT) economic development efforts have been completed. It is unclear how these efforts are currently being used. Nevertheless, they are presented here as illustrations of how the relationship between transportation and other societal outcomes can be approached. The U.S. DOT example shows how a national government could link transportation system performance to economic and social equity measures. The Minnesota and Florida cases illustrate the approach most often used to approximate a measure of impact—linking system performance measures such as accessibility to the system, travel time, and trip reliability to economic activity outcomes.

Barnstable County, Cape Cod, and the Regional Policy Plan

The 1991 Regional Policy Plan for Barnstable County on Cape Cod was developed with an implementation perspective (Cape Cod Commission, 1991). Not only did the plan outline broad goals and system requirements, but it also included "minimum performance standards" that future development and corresponding supporting infrastructure had to meet to achieve the intent of the plan. These standards were to be applied by the county in its own decision making and by local communities that chose to prepare local comprehensive plans. The adoption of these performance standards was in direct response to massive growth that threatened the natural environment and quality of life of Cape Cod. For example, from 1980 to 1990, the population of Barnstable County increased by 26 percent, whereas the rest of Massachusetts grew by only 4.9 percent. The number of housing units on Cape Cod doubled between 1970 and 1989 from 65,676 to 131,660. Citizen surveys showed that environmental quality, rural character of cape living, and proximity to the coast were the major reasons people lived on the cape, but those qualities were being threatened by growth pressures.

Examples of transportation-related performance standards and their corresponding goals are listed in Table 3 (note that only standards relating to transportation are included). Even though the use of the term "standards" implies a forward-looking, design-oriented process of linking a community's vision and infrastructure action, these standards can also be used for ex post–performance monitoring. For example, the performance standard of not allowing "strip" commercial development became a performance measure by asking How much strip development has occurred?

Many additional measures covering a variety of cultural, economic, and quality-of-life issues were presented in the plan. The most important observation concerning these measures is that the transportation system and its performance were an important linkage toward achievement of the community's more global vision of sustainable development and preservation of quality of life.

Albany, New York, Case Study and the Transportation Improvement Program

The Albany metropolitan area has been one of the leading users of performance measures in transportation planning in the United States. Beginning in 1992, when the Transportation Improvement Program (TIP) update process was revised in light of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA), new approaches were adopted for incorporating system performance into planning and decision making. The approach to performance measurement was based on four characteristics of the measures themselves, which were incorporated into the new visions planning process (Cambridge Systematics et al., 2000):

- Some impacts can be legitimately presented in monetary terms.
- Other impacts can be quantified but should not be presented in monetary terms.
- Other impacts cannot be easily quantified but should be discussed in narrative fashion [called "dis-

TABLE 2 Proposed Performance Measures

Accessibility	
Average travel time from origin to destination	Number of bridges with vertical clearance less than *x* feet
Average trip length	Percentage of population within *x* minutes of *y* percentage of employment sites
Accessibility index	Percentage of region's mobility impaired who can reach specific activities by public transportation
Mode split by region, facility, or route	
Percentage of employment sites within *x* miles of major highway	
Mobility	
Origin-destination travel times	Mode split
Average speed or travel time	Transfer time between modes
Vehicle miles traveled (VMT) by congestion level	Customer perceptions on travel times
Lost time or delay due to congestion	Delay per ton-mile
Level of service or volume-to-capacity ratios	PMT per capita or worker
Vehicle hours traveled or VMT per capita	Person hours traveled
Person miles traveled (PMT) per VMT	Passenger trips per household
Percentage of on time transit	Percent walking or using bike by trip type
Frequency of transit service	
Economic Development	
Economic cost of crashes	Jobs created or supported (directly and indirectly)
Economic cost of lost time	Percentage of region's unemployed or low income that cite transportation access as principal barrier to seeking employment
Percentage of wholesale, retail, and commercial centers served with unrestricted (vehicle) weight roads	
Quality of Life	
Lost time due to congestion	Average number of hours spent traveling
Accidents per VMT or PMT	Percentage of population exposed to noise above certain threshold
Tons of pollution generated	
Customer perception of safety and urban quality	
Environmental and Resource Consumption	
Overall mode split by facility or route	Sprawl: difference between change in urban household density and suburban household density
Tons of pollution	Number of accidents involving hazardous waste
Number of days in air quality noncompliance	
Fuel consumption per VMT or PMT	
Safety	
Number of accidents per VMT, year, trip, ton-mile, and capita	Percentage of roadway pavement rated good or better
	Construction-related fatalities
Number of high accident locations	Accidents at major intermodal (e.g., railroad crossings)
Response time to accidents	
Accident risk index	Pedestrian-bicycle accidents
Customer perception of safety	
Operating Efficiency (System and Organizational)	
Cost for transportation system services	Percentage of projects rated good to excellent
Cost-benefit measures	Volume-to-capacity ratios
Average cost per lane-mile constructed	Cost per ton-mile
Origin-destination travel times	Mode split
Average speed	Customer satisfaction

(*continued on next page*)

TABLE 2 (*continued*) **Proposed Performance Measures**

System Preservation	
Percentage of VMT on roads with deficient ride quality	Maintenance costs
Percentage of roads and bridges below standard condition	Roughness index for pavement
Remaining service life	Service miles between road calls for transit vehicles
	Vehicle age distribution

SOURCE: Cambridge Systematics et al., 2000.

tributional effects" by metropolitan planning organization (MPO) planners].

- All three types of measures are vital and should be available for the decision-making process.

The last point was considered critical for the use of performance measures in the planning process. As Poorman (1997) noted,

> objective decision-making will be driven by what is measured. If all we measure is miles of freeway at LOS [level of service] E and F, then investment programs will revolve around freeway congestion. If we force all measures into monetary terms before considering them, we bias decisions away from actions that focus on quality of life, land use compatibility and similar hard-to-monetarize factors.

The manner in which key impact categories for system evaluation were viewed by the MPO is shown in Table 4. The types of impacts include those usually found in transportation planning, but in many cases they are not represented, as in Table 4.

A set of core performance measures, defined in the new visions process, were grouped into three headings, as presented in Table 5: as indicated in the basic approach outlined by Poorman (1997), some of the measures are quantitative; some are represented by indices; and still others are simply narratives. Of greatest interest to this paper are the measures that reflect the broader community character or quality-of-life issues. The Albany approach toward community quality of life is briefly described to show how such an approach can be used within a transportation planning context.

TABLE 3 Goals and Performance Standards Related to Transportation—Barnstable County, Cape Cod

Goal	*Performance Standard*
Encourage sustainable growth and development consistent with the carrying capacity of Cape Cod's natural environment	Extension or creation of new roadside "strip" commercial development outside of designated growth centers shall be prohibited
Limit development in high hazard areas to minimize the loss of life and structures and environmental damage due to storms, natural disasters, and sea level rise	No new public infrastructure or expansion of existing infrastructure shall be made in flood hazard zones unless it is shown that there is an overriding public benefit involved and provided that such information will not promote new growth and development
Locate development to preserve the cape's environment and cultural heritage, minimize adverse impacts, and enhance quality of life	Traffic conditions may be reduced to Level of Service (LOS) E if there is a provision for safe pedestrian traffic
Foster a transportation system for present and future year-round needs	Development and redevelopment shall not degrade existing LOSs of surrounding roads and intersections below LOS C, except as noted above
	Developments of regional impact shall make provisions for alternative transportation modes to offset at least 20 percent of their projected traffic volumes

TABLE 4 Types of Impacts Considered in Transportation System Evaluation—Albany, New York

	Impact Type			*Primary Impact*		
Impact	*Monetary Expense*	*Abstract Value*	*Distributional Effect*	*Direct User*	*Direct Gov't*	*Indirect Social*
Private vehicle ownership*	X			X		
Private vehicle operation*	X			X		
Transit fares*	X			X		
Parking cost	X			X		
Accidents—full cost*	X			X		
Time spent in travel—commercial	X			X		
Congestion—commercial	X			X		
All infrastucture—maintain or replace*	X				X	
New infrastructure*	X				X	
Operating cost transit*	X				X	
Transportation—police and fire*	X				X	
Regional air pollution	X					X
Global air pollution	X					X
Vibration damage	X					X
Energy—security and trade effects	X					X
Water quality damage	X					X
Waste disposal	X					X
Impacts above can be considered monetary; impacts below are significant but nonmonetary.						
Time spent in travel—personal		X		X		
Congestion—personal		X		X		
Access (travel opportunity)		X		X		
Accessibility (time proximity)		X		X		
Flexibility and risk		X		X		
Noise exposure		X				X
Aesthetics		X				X
Equity			X			X
Property value			X			X
Land use			X			X
Economic development			X			X

*Care must be taken so that costs are not double counted in other cost categories. Gov't = government.
SOURCE: Poorman, 1997.

The community quality-of-life measure was developed by an MPO task force charged with exploring urban issues and their link to transportation system performance. As developed, the measure is a "narrative discussion of a set of numbers rather than a single number . . . the absolute values of the components of the measure are less important than the direction and magnitude of change" (Younger, 1995). In the first iteration, *community* was defined by jurisdictional groupings, although the taskforce desired in future iterations to evolve to a density and service provision definition of urban character. Four major subject areas constituted community quality of life, each including numerous data sources:

- Socioeconomic factors;
  - –Household characteristics,
  - –Income levels of resident households,
  - –Capital district population shifts,
  - –Capital district employment shifts,
  - –City to county ratio of population,
  - –City to county ratio of family income,
  - –Population by race,
  - –Location of the capital district poverty population,
  - –Location of capital district elderly population, and
  - –Number and location of the college-educated residents;

TABLE 5 Measuring Quality, Requirements, and Effects

	Transportation Service Quality
Access	percentage of person trips within defined nonauto to auto difference
	percentage of person trips with travel time advantgage for non–drive-alone modes
	number or percentage of major freight movements with modal alternatives
Accessibility	travel time between representative locations
	peak versus nonpeak by quickest mode
Congestion	hours of excess delay, recurring and nonrecurring by mode
Flexibility	reserve capacity on system
	percentage of person trips that could be accommodated by modes other than auto
	number of corridors with reasonable alternatives during closure
	Resource Requirements
Safety	estimated societal cost of transport and accidents
Energy	equivalent British-thermal-unit/day for transportation capital, maintenance, operation, and use
Economic cost	annualized capital, maintenance, operating, and user costs
	value of commercial time in travel
	External Effects
Air quality	daily emission levels
	attainment status
Land use	amount of open space
	dislocation of existing residences and businesses
	land use–transportation compatibility index
	community character index
Environmental	impacts on sensitive areas
	noise exposure index
Economic	narrative discussion of economic activity supporting or constraining features of a transportation system

- Mobility:
  - –Percentage of jobs within 10 and 30 min,
  - –Person trips accessible by transit,
  - –Journey to work by mode,
  - –Worker destinations by mode,
  - –Number of people who live and work in same municipality,
  - –Vehicle miles traveled,
  - –Vehicle miles of delay,
  - –Number of vehicles per household, and
  - –Location of the mobility-limited population in the district;
- Real estate and road ownership:
  - –Property values,
  - –Median value of single-family home,
  - –Overall property tax rates per $1,000 assessed valuation,
  - –Building permits for new construction,
  - –Permits for additions and alterations,
  - –Capital district office market summary,
  - –Retail activity, and
  - –Centerline road miles by ownership; and
- Cultural factors and nonmeasurables:
  - –Cultural amenities,
  - –Social interactions and privacy,
  - –Service availability, and
  - –Diversity.

The assessment of alternative transportation plans based on the foregoing criteria was subjective. For example, the narrative states, "trends include warning signals. Proactive strategies will be required to impact trends" (Younger, 1995).

Environmental Justice Within System Performance Framework in Atlanta

One of the important social issues likely to confront transportation investment decisions over the next de-

cade is the impact of such investment on different population groups. Part of a much broader concern for distributional equity, environmental justice concerns are likely to be important components of continued monitoring of system and program performance. Included in the analysis of environmental justice issues are the answers to four major questions:

- What are the travel-activity patterns of different income and ethnic groups?
- Do the low-income and minority populations bear a proportionate share of the burdens of transportation facilities?
- Do the low-income and minority populations receive a proportionate share of transportation benefits?
- Where are the transportation investments spent with respect to populations of different races and income levels?

The type and level of analysis that might be needed to answer these questions are still in early development. However, some thought has been given to the types of measures that provide indications of environmental justice impacts. For example, in Atlanta, one of the metropolitan areas developing such measures, the types of measures being considered include the following:

- Concentrations of minority and low-income populations,
- Use of the transportation modes by race and income,
- Population by race and income within accessible distance to transportation facilities,
- Car ownership by race and income,
- Comparison of carbon-monoxide (CO) exposure by race and income,
- Relocation of homes and businesses due to transportation construction by race and income,
- Comparison of location of bus depots by race and income levels of communities,
- Comparison of reduction or elimination of green space by highway or transit construction in communities of different races and income levels,
- Demographics of location of current or planned air-pollution monitors,
- Access to jobs by race and income,
- Access to other quality-of-life destinations by race and income,
- Number of destinations available by transit to communities of different races and incomes,
- Commute times by race and income and mode of transportation,
- Frequency of transit service by race and income,
- Ratio of transit seat miles to total number of passengers by race and income of population served,
- Cost of travel by race and income,
- Number of bike and pedestrian accidents occurring in communities of different races and income levels,
- Comparison of customer satisfaction by race and income levels,
- Comparison of financial investments in transportation by mode to use by race and income, and
- Comparison of financial investment in transportation by location to race or income level of community served.

Note that several of these possible measures are based on typical data collected by transportation agencies, such as travel times, frequency of transit service, crashes, and travel costs. The difference is the finer level of disaggregation of data that allows a determination of incidence of impact.

Economic Development and State Transportation Investment in Maryland

In 1998, the Maryland DOT commissioned a study that examined the transportation investment contribution to economic prosperity in the state (RESI Research & Consulting, 1998). The study does not include all of the social and environmental costs discussed earlier in this paper, but it does represent one of the more substantive efforts to measure the link between transportation system performance and economic activity. The basic approach to this link is shown in Figure 4. The productivity measures reported in the study include the following:

- Annual rate of return on highway spending (reported as 17 percent),
- Cost savings in production expenditures ($1.00 of investment reduced annual production costs by $0.12),
- Total factor productivity (10 percent contribution from highway investment), and
- Transportation's contribution to economic growth (4 percent over 15 years).

The methodology used to obtain these findings was an input-output model that relied on industry cost functions and the transportation element incorporated in each. A statewide economic model was then

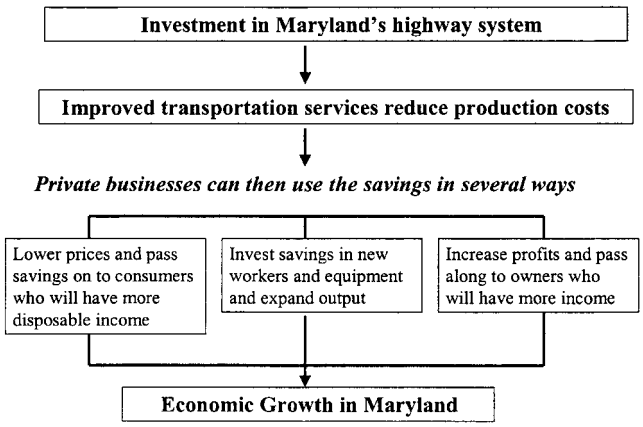


FIGURE 4 Economic impact of Maryland highway investment. SOURCE: RESI Research & Consulting, 1998.

used to simulate regional economic shifts in response to changes in inputs and outputs.

This case illustrates how an economic productivity measure could be used as part of a performance monitoring program. However, it also illustrates the difficulty in developing usable and realistic measures. As noted earlier, this approach incorporates only true economic variables and ignores some of the environmental and societal costs associated with system performance. In addition and perhaps most challenging, the temporal lag in seeing a shift in productivity due to changes in transportation investment is so long that conducting such a study every 5 or perhaps 10 years might seem optimistic.

Twin Cities Audit

In 1997, the Metropolitan Council of the Twin Cities conducted a performance audit of the transportation program in the Minneapolis–St. Paul metropolitan area (Cambridge Systematics et al., 2000). The framework shown in Figure 5 was adopted for defining the desired performance measures for this audit. As shown, the desired performance of the transportation system was linked to economic growth, competitiveness, and quality of life. The necessary feedback loops from each of these societal outcomes to the transportation system are also indicated. Although Figure 5 illustrates the concept of outcome-based performance measurement, it is unclear whether such an approach was ever adopted by the council.

National Performance Measures from U.S. DOT

U.S. DOT (1996) gave considerable thought to the types of performance measures that could reflect the role of transportation in a variety of societal outcomes. Two performance measure categories that especially relate to societal outcomes are the following:

- Economic health and competitiveness:
  –Cost of transportation reflected in final cost of goods and services (transportation consumer price index versus manufactured goods consumer price index),
  –U.S. and international balance of trade,
  –Value of Dow Jones "transportation stocks," and
  –Survey of businesses that cite problems with transportation as major factor in productivity; and
- Social equity, mobility, and quality of life:
  –Percentage of day devoted to traveling,
  –Percentage of income spent on travel, and

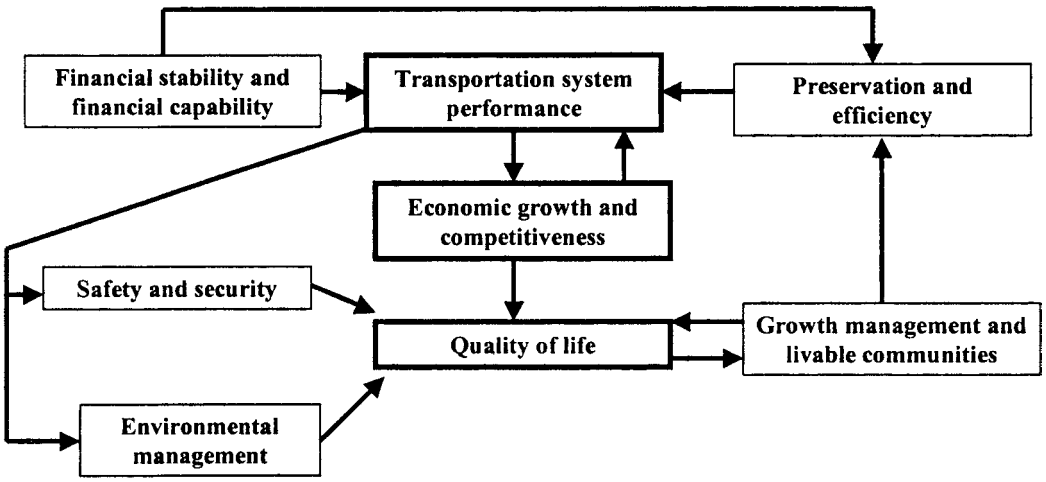


FIGURE 5 Desired performance measures for Twin Cities audit.

–Percentage of disadvantaged travelers with public transportation alternatives for essential business and personal travel.

Given the national focus of this agency, it is not surprising that these measures are defined at a much broader scale than those discussed in the previous cases. The use of a survey for determining the role of transportation in economic productivity is of interest.

Minnesota DOT's Business Planning Performance Targets

The Minnesota DOT has been one of the nation's leaders in developing performance measures targeted at the business of the agency. In the mid-1990s, Minnesota DOT developed the concept of a "family of measures" that reflected the range of impacts and outcomes that are influenced by transportation system performance. These outcomes and example measures include the following from Minnesota DOT in 1998:

- Time directness: A predictable travel time for length of trip is maintained so that customer expectations are met.
  - –Number of freeway miles congested,
  - –Average travel time and distance, and
  - –Percentage of Minnesotans satisfied with trip time.
- Safety: Incidents and crash rates are minimized to Minnesota DOT's current and potential ability to influence infrastructure, partnerships and education, full range of solutions, and driver behavior.
  - –Motor vehicle crash rates and fatal crashes by roadway design,
  - –Percentage of Minnesotans feeling safe while driving in work zones, and
  - –Percentage of Minnesotans satisfied with the safety of roadways.
- Condition of infrastructure: An infrastructure that meets customer expectations is maintained.
  - –Pavement quality index,
  - –Bridge structural rating, and
  - –Bridge functional rating.
- Access and basic levels of service: Services are provided to meet personal travel and shipping needs.
  - –Percentage of Minnesotans with satisfactory transit options,
  - –Posted bridges and bridge load carrying capacity,
  - –Miles of truck highway spring weight restrictions, and
  - –Percentage of Minnesotans satisfied with travel information.
- Environment: Minnesota DOT is a proactive, responsible, environmental steward.
  - –Percentage of residential areas in incorporated areas exposed to noise that exceeds standards, and
  - –Number of wetland acres affected and replaced by Minnesota DOT.
- Socioeconomics: Transportation investments yield the highest possible economic return to the region, tempered by an evaluation of community values and social impacts.
  - –Total vehicle miles traveled and freight ton miles,
  - –Maintenance and construction expenditures per vehicle mile traveled, and
  - –Percentage of highway funds going to construction.

Additional measures have been proposed for inclusion in this family of measures, including the state's transportation investment and spending as a percentage of the state's gross state product and shipment cost per mile by ton or value, mode, and major commodity.

Senior management adopted target values for many of these system performance measures that relate to departmental strategic objectives. For example, a strategic objective that relates to the economic health of the state could be to ensure that corridors of statewide significance link the state's regional trade centers (measured by the miles of major highways between cities attaining a threshold average speed).

Florida DOT's Mobility Measure

Florida DOT (2000) focused on "mobility" as the key system performance measure for "supporting investment decisions and policy analysis." *Mobility*—defined as the ease with which people and goods move throughout the community, state, and world—is measured as the quantity of travel served, quality of travel, accessibility, and use of transportation systems. Some example measures for each include the following:

- Quantity:
  - –Person miles traveled,
  - –Truck miles traveled,
  - –Person trips, and
  - –Ridership;

- Quality:
  - –Average speed weighted by person miles traveled,
  - –Average delay per vehicle,
  - –Average door-to-door travel time,
  - –Reliability (variance of average travel time or speed),
  - –Maneuverability (vehicles per hour per lane in peak hours), and
  - –Auto or transit travel time ratio;
- Accessibility:
  - –Connectivity to intermodal facilities (percentage within 5 mi),
  - –Dwelling unit proximity,
  - –Employment proximity,
  - –Industrial warehouse facility proximity,
  - –Percentage of miles of bicycle accommodation in right-of-way,
  - –Percentage of miles of sidewalk coverage,
  - –Transit coverage (percentage of person minutes served),
  - –Transit frequency (buses per hour), and
  - –Span of service (hours per day); and
- Utilization:
  - –Percentage of system heavily congested (LOS E or F),
  - –Vehicles per lane mile,
  - –Percentage of travel heavily congested,
  - –Duration of congestion (vehicles per hour per mile at LOS E or F), and
  - –Transit load factor (percentage of seats occupied).

Of interest in this set of measures is the effort to measure reliability of travel. Reliability was defined as the percentage of travel on a corridor that takes no longer than the expected travel time, plus some measure of acceptable additional time. Loop sensors used as part of the state's intelligent transportation system (ITS) program were used to collect the data necessary for this performance measure.

Outcome Measures and Transportation System Performance: Conclusions

This paper began by posing several questions concerning the use of societal outcome measures in the context of performance-based planning and decision making. Its conclusions could be unsatisfying because the answer to these questions often depends on the decision-making context and the specific issues facing a community. However, I believe that performance-based planning should exhibit several key characteristics (based on Meyer, 1995).

System Performance Linked to Fundamental Roles of Transportation

The measure of whether the transportation system is performing as expected should relate to a broad perspective on what role transportation plays in a metropolitan area. Congestion on individual links in the network does not inform much about how the system performance is affecting quality of life, economic development, or environmental quality. Performance-based planning should thus consider a broader range of issues than just operational efficiency of the modal networks.

Outcomes and Outputs

Initial experience with performance-based planning suggests that agencies measure success by the level of output produced. For example, the number of lanes per mile maintained or constructed or number of revenue bus-hours provided shows how productive an agency can be. These are indeed important indicators of the amount of service provided in a region. However, in keeping with the characteristic described previously, outcome measures are also important indicators of system performance. Outcome measures relate to the ultimate effect of the transportation system on a community, such as quality of life, environmental health, equitable distribution of benefits and costs, economic development, safety, and security. Outcome measures should be part of the performance-based planning process.

Mobility and Accessibility

Providing individual mobility and accessibility to urban activities is an important goal for transportation planning, and I would argue that it is a critical precursor to the types of societal outcomes desired. Many MPOs have defined measures that indicate the degree to which the transportation system is providing acceptable levels of performance. However, measures of mobility and accessibility prompt the question: mobility and accessibility for whom? The distributional effects of transportation investment on different socioeconomic groups and on different geographic areas of a metropolitan region strongly suggest that performance-based planning should be based on a market segmentation approach that identifies existing and future travel markets as well as

who benefits and who pays for changes to this mobility and accessibility.

Several efforts have been made to develop system-level mobility indices. Table 6 shows proposed mobility measures that could be applied at the metropolitan level (TTI, 2000). Note that travel time plays a leading role in almost all of these measures. Note that one of the measures, the reliability factor, attempts to represent that characteristic of system performance—reliability—which is often of most concern to system users.

Multimodal Performance Measures

Performance-based planning focuses on the ability of people and goods to achieve desired travel objectives and does so without modal bias (in fact, in a society substituting telecommunciations for actual trip making, a mode of transportation in a traditional sense might not be needed to satisfy the objectives). Performance measures should include more than just modally based indicators. One of the ways is to focus on generic characteristics of trip making, such as travel time, and on the total trip experience of the traveler or goods mover. Bottlenecks in the system and thus a delay to the user can often occur at access, egress, or transfer points that most likely will not be under the control of the agency responsible for the line-haul portion of the trip. Defining performance measures from a total trip perspective provides opportunities for identifying these congestion points, especially for those operating the system.

Performance Measures Tied to Project Evaluation Criteria

Given that performance measures reflect what decision makers consider important indications of system success, they should be closely tied to the evaluation criteria used to select among plan alternatives and projects. This relationship becomes an important system performance linkage to the stated purpose of the transportation investment. If job creation has been identified by decision makers as an important performance measure for system impact, then the evaluation of plan and project alternatives should use such a criterion.

Definition of Outcome-Oriented Performance Measures

Critics of outcome-oriented performance measures argue that so many factors influence the ultimate outcome (such as economic productivity, quality of life, and ecological health) that their use is meaningless. However, in many cases, measures can be defined that act as precursors or surrogates for transportation's role in the outcome. In such cases, the direction or trend of the slope of the surrogate is sufficient to inform the decision makers. In addition, some outcomes might have a significant transportation component, but they also have elements that transportation agencies have little control over. For example, safety is an outcome that is often pointed to as one transportation agencies can influence. But they cannot control driver behavior or the weather, two important contributors to crashes. Is it fair to hold the transportation agency accountable for crash measures when external factors can exert such an important influence? In such cases, it might be appropriate to define a measure that is more targeted to the role of transportation, for example, number of accidents caused by geometric design factors.

Strategic Data-Collection and Management Plan

The success of performance measurement relies heavily on the availability of data. For example, many MPOs responding to the federal requirement to establish a congestion management system developed performance measures that could be defined only with existing data. This was especially true for smaller MPOs, which did not have the resources to pursue a new and expensive data-collection effort. A critical element of performance-based planning is thus the development of a strategic data-collection and management plan. The term "strategic" implies that this plan should encompass the entire spectrum of data that needs to be collected, which agencies will be the source of such data, and the frequency of data collection. As for outcome measures, strategic includes surrogate variables and corresponding data that allow for an indication of achievement without measuring the exact final outcome measure.

New Data Management and Analysis Techniques

The technology of data collection and management is evolving, with techniques used today that were unavailable several years ago. Video and machine vision recognition of vehicular movement, aerial and satellite photography, automatic vehicle identification, instrumented vehicles, and advance passenger information systems could be useful in providing the data necessary to conduct performance-based planning. New analysis tools such as geographic information systems (GIS) have made some performance

TABLE 6 Proposed Measures of Mobility

	Individual
Travel rate (minutes per mile)	$= \frac{\text{travel time (minutes)}}{\text{segment length (miles)}} = \frac{60}{\text{average speed (mph)}}$
Delay rate (minutes per mile)	$= \frac{\text{actual travel rate}}{\text{(minutes per mile)}} - \frac{\text{acceptable travel rate}}{\text{(minutes per mile)}}$
Relative delay rate	$= \frac{\text{delay rate}}{\text{acceptable travel rate}}$
Delay ratio	$= \frac{\text{delay rate}}{\text{actual travel rate}}$
Corridor mobility index	$= \frac{\text{passenger volume (people)} \times \text{average travel speed (mph)}}{\text{optimum facility value* (person-mph)}}$
Travel rate index	$= \frac{\left(\frac{\text{travel rate}}{\text{freeflow rate}}_{\textit{Freeway}} \times \text{peak period VMT}\right) \times \left(\frac{\text{travel rate}}{\text{freeflow rate}}_{\textit{Principal arterial street}} \times \text{peak period VMT}\right)}{\text{(freeway peak period VMT + principal arterial street peak period VMT)}}$
Reliability factor (RF_{10})	= percentage of time that person's travel time is no more than 10 percent higher than average
	Total
Accessibility (to opportunities)	= sum of number of jobs, shops, or other travel objectives that are within acceptable travel time for each origin
Total delay (vehicle minutes)	= [actual travel time (minutes) − acceptable travel time (minutes)] × vehicle volume (vehicles)
Congested travel (person miles)	= sum of all [congested segment length (miles) × person volume]
Congested roadway (miles)	= sum of all congested segment lengths (miles)

*125,000 for freeways; 25,000 for streets.
SOURCE: Texas Transportation Institute, 2000.

measures easier to estimate and thus feasible in the context of providing information to decision makers. The best example is the use of GIS to estimate accessibility measures (e.g., How many people can access x square feet of retail space within a certain travel time?). As the evolution in analysis tools allows transportation planners to become more sophisticated in their analysis efforts, this increased analysis ability can also be used to improve performance measurement.

My concept of how to link societal outcome measures to transportation system performance is to use mobility and accessibility measures in a broader framework of performance monitoring, perhaps by including an expanded economic cost accounting regime or a series of sustainability measures that encompass quality-of-life issues. One of the most vital concerns in developing such a concept is that the number of measures needs to be reasonable (for example, anything more than 10 measures is sure to lose impact) and that there is a clear understanding of the theoretical link between transportation performance and the outcome measured.

Figure 6 illustrates that concept using the conceptual framework developed at the beginning of this paper. As shown, performance measures based on

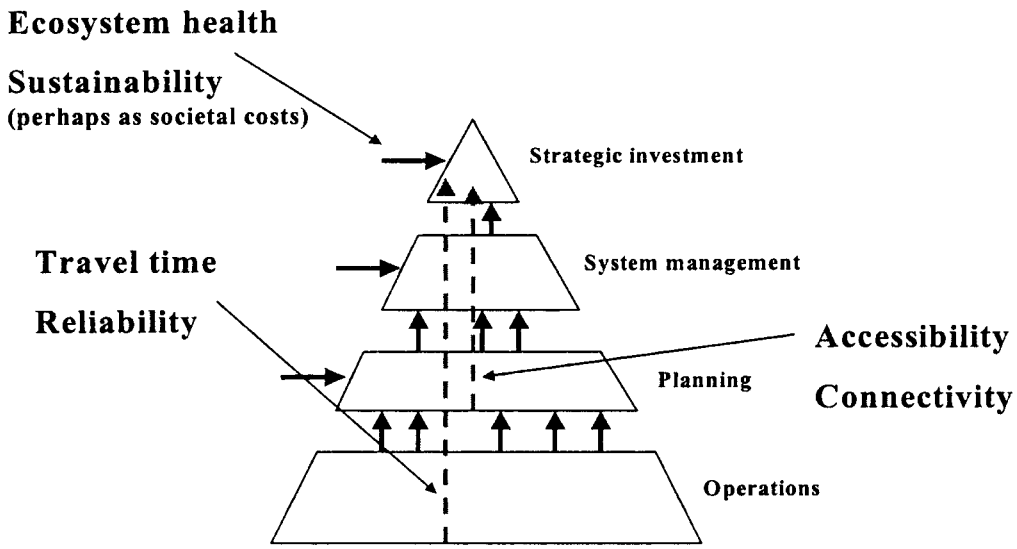


FIGURE 6 System performance measurement based on outcomes.

data collected at the operations level can be considered important surrogates for some societal outcomes (perhaps for economic development). Similarly, performance measures founded on planning data can be used in the strategic decision-making process (perhaps for quality of life). Even with these types of measures, there might be other performance measures, such as ecosystem health and sustainability, that decision makers desire for consideration.

As transportation policy and planning continues to be viewed as an enabler of important functions and outcomes in society, we in the profession must give more thought to how we can show the level of accomplishment associated with transportation investment decisions. Not only does that make sense from an investment perspective, but I believe that it will be increasingly important for establishing accountability and credibility in our planning processes.

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Panel Discussion

Tarek Hatata, *Booz Allen & Hamilton, Inc.*
Neil Pedersen, *Maryland State Highway Administration*
James Corless, *Surface Transportation Policy Project*
Sheldon Edner, *Federal Highway Administration, Moderator*

From Outputs to Incomes—No Perfect Indicators

Tarek Hatata

I have to admit to you that when I heard about the subject matter that I was asked to contribute to, I was a little concerned. I said here comes another Ph.D. who is going to tell us all about soft, touchy-feely issues, leave us confused, ask a lot of questions, and never answer them. So I read Mike Meyer's paper, and to some degree, I was correct. I'm always concerned when we try to make transportation more than what it is. I fully understand the last slide where we say we are not the center of the universe. It reminds me of actually a very nice presentation that Teresa McMillan from MTS once gave about what are some of the challenges for transit. Transit in California has not always had the best reputation. She was saying that you have to run transit like a business. You have to really look at business principles and run it.

Then you add to it—oh, yeah, but you have to also help the transit-dependent folks and go out of your way to help them. By the way, you need to be environmentally friendly, etc. At the end, you have a huge proposition that nobody, no matter how smart, how much money, how much anything they have, can possibly perform and be all these things to these different people. As a result, you have transit agencies, not just in California but everywhere, that have bus service that costs $15.00 per trip because they want to fulfill every single goal or societal outcome that they are charged to do. So I'm a little hesitant to completely accept that transportation has this larger-than-life role and that this should be the focus of transportation planners, operations, and decision makers.

Having said that, I did find a few gems in the paper that I'm not going to talk about directly, but I will give you a little bit of an update about what California is doing. I've been working with CalTrans for a while now on performance measurement and how we addressed some of the challenging issues that have been presented in the paper.

There is something that I think is worth repeating. There are many, many kinds of performance measures. If you add all kinds of performance measures, you get a book not just of 700, such as in the NCHRP report, but one of 5,000 measures. For instance, there are modal performance measures. We heard from transit agencies talking about unlinked passengers, fare box recovery ratio, and other things. We said, we understand those are important, but we are not going to look at those. This is a purview of a transit agency. The transit agency knows how to do them and knows how to use them. This is not necessarily a function of the state DOT or state perspective. We look at that. We take them into account. But that wasn't the focus of this study or this initiative.

There are also some agency performance measures such as How much money are you spending in "admin"? What percentage of your people is retained long enough to be productive? How are you organizationally tracking the performance of the individuals and of the different groups? Those are critical.

There isn't a single agency that can perform well without having some type of agency performance measures. But again, those were agency specific. You cannot come up with an umbrella set of performance measures, and say that all agencies have to conform to this. So we knew that this is not something that can be tackled within the initiative that CalTrans had started. The focus here with the CalTrans initiative is on system performance measures, and I'll talk to you a little bit more about that.

- Outcome based. Mike's paper has a lot of discussion about outcome based versus output based. That was a lengthy discussion in California. We had a huge steering committee. The steering committee had representatives from the state, from the MPOs, from private firms, and so on. They set a framework for developing these performance measures. First, they had to be outcome based. *Outcome* here is defined a little bit differently from what is in Mike's paper or in other discussions. By outcome, we meant something that affects the customer and that the customer can see and react to. So it is really market focused and outcome based.
- Multimodal. Multimodal is another thing that is discussed in Mike's paper. For example, a transit project is sold or marketed to a decision-making group. The proponents say, "We have great fare box recovery ratio, unlinked passengers, etc." After the transit advocate goes out, the highway advocate comes in and says, "My VC ratio is going to go from .95 to .85, and my average speed is going to go from 35 to 37." That person leaves the room, and the decision makers sit together and say, "We don't understand what these guys are talking about. It is very difficult to compare these two. So we are going to go with whomever we feel lobbied harder and seemed more sincere." The multimodal aspect really is to come up with measures and indicators that are modally blind. That is a challenge for any of you who have tried it.
- Easy to understand. If you have a measure that you cannot communicate to your customer, chances are it is not the right measure. That is a challenge on its own.
- Rely on existing data to the extent possible. One of the guidelines, and one of my issues with performance measurement in general, is that even though relying on existing data makes it faster to implement, we are going through a revolution of information technology and information data sources. We really should sit down and think about it. Maybe we need to change and put additional funds into it, as opposed to relying on the same data, just trying to manipulate it, and making it into something else. It may be why things haven't changed in 50 years—because there is a reluctance at every level, the regional, state, and federal levels, to think outside of the box and say, "Let's collect new data, brand new data that may give us brand new answers."
- Useable to both monitor and forecast. We didn't talk a lot about that today. The monitoring part is understanding how the system is performing today. You can never really develop a plan for where you want to be (broad goals, societal goals, or other goals related to more easy to understand things such as travel time) unless you know what the travel time is today. Or else how do you know whether you are successful or not? So monitoring is critical, but given the lag between the actual decision and the actual implementation, which can often be 5 to 10 years or longer, you also need to be able to forecast.

Forecasting is not a precise science. A lot of people get disappointed when they look at travel demand models that regions use and say, boy, they are predicting things I don't see as possible. Well, as I said today in the breakout session, Alan Greenspan doesn't know how to predict beyond 3 months. If you ask Alan Greenspan what the GDP will be next year, he will not have an answer. He can tell you based on current trends and if nothing else changes and if the Asian economy continues to grow, we will probably be somewhere between 3 and 5 percent. So don't expect the forecasting part to be as detailed or as precise as the monitoring part. But you have no excuse, really, to have your monitoring not be pretty precise. So without monitoring, trend analysis, and investment evaluation, you can never go back and say, "Did we make the right decision, and did we implement it correctly?"

- Outputs, outcomes, and other things (see Figure 7). Mike is right, this is what we used to look at historically. We used to look at transportation outputs, on the right of the figure, number of lanes, vehicle miles, average speeds, speed variation, incidents, accidents, and so forth. When you go, for instance, and talk to customers about volume-to-capacity ratio or number of lane miles, they cannot really figure out what you're talking about. So what if California has increased its number of lane miles by 5,000? What does that mean to you? It doesn't mean a whole lot. However, that is important because it is your inventory.

We want to be on the left-hand side of the figure. Those are the system performance outcomes, as agreed to by the steering committee, that are important. When you go through them, between mobility, reliability, cost-effectiveness, and so forth, you find out that they pretty much cover everything. This is done by design. It always baffles me when I look at

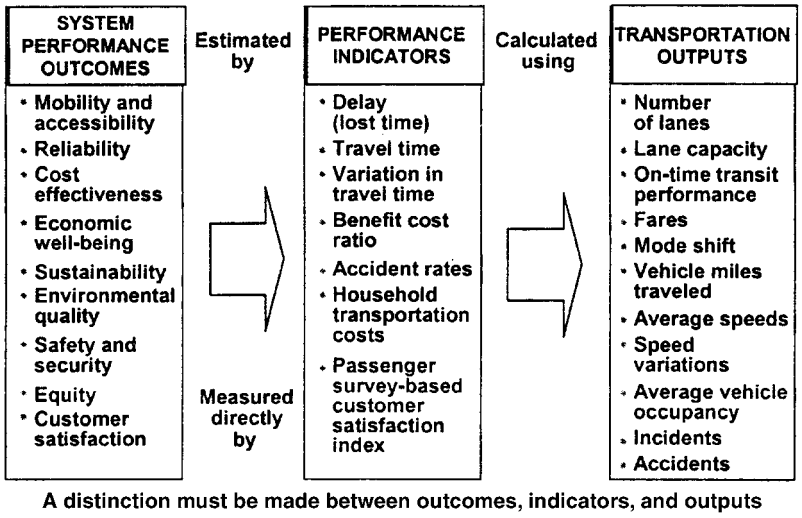


FIGURE 7 Outcomes, indicators, and outputs.

this list, then I look at your list, and I see how close they are, but somehow California is never mentioned in any one of these studies. I have a chip on my shoulder about that.

The reason these studies were conducted is that in California, we have Senate Bill 45 that permits, or actually provides, the regions their own decision making on transportation improvements. So as the committee thought about which outcomes are critical for the state, they said we cannot decide for every region what is important. Let's try to define a fairly well-rounded number of outcomes, and let each region decide which outcome is critical to its own area. For instance, in Eureka, environmental quality—as defined by pollution—may not be as critical as in Los Angeles, but it is one of the outcomes that we're looking at.

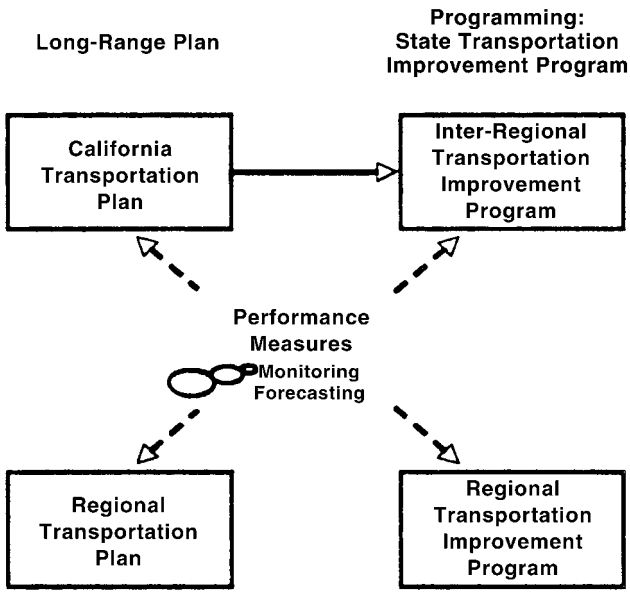
Now the trick here is to go from outputs to outcomes. There is no way to come up precisely with a measure that reflects mobility for everybody. We can come up with indicators that estimate, in general; this idea seems to be less obvious to some than others. There is no way that delay and travel time are enough to talk about mobility for everybody. We have the curse of the average person. There is no such thing as the average person. What we do is add up all the travel time divided by the number of people and say the average delay is *X* or the average travel time is *Y*. That is not really what happens. But it is the best we can do. If we wait until we have a perfect indicator that truly measures mobility, we may never implement performance measures.

The same thing with reliability: We heard about on-time performance for transit. Well, there is variation in travel time for highways. Now we figured a way to say what percent variation do you see in your commute on a day-to-day basis, and we came up with an indicator. It is not a measure that truly measures reliability but an indicator that estimates reliability. Customers have told us that they understand that in Los Angeles, they are not going to drive flow free during the peak hours, but they want to have the trip take 30 min today and maybe 32 min tomorrow, 35 maximum—not 30 min today, 45 min, and then 20 min. That is what we tried to capture.

So we tackled outcomes, outputs, and indicators. We fully recognize that indicators are estimation methods, possibly with the exception of customer satisfaction, because if you can do a good sampling, you may be able to get the true measure of customer satisfaction. That hasn't been done yet. But all the others are estimation. If a better one comes up than this indicator, there is no problem replacing the existing one or supplementing it.

Finally, how do we hope to integrate performance measurement into decision making? (see Figure 8). If you monitor and forecast, you provide that information for the long-range planning process at both the state level and the regional level. We find them in both regional and statewide transportation improvement plans. The bottom line is decided by MPOs, more or less, with the blessing of the California Transportation Commission. The top right one is more the statewide interregional plan and is done with the blessing of the governor (and so forth).

One last comment: I've heard a lot during this session about operations versus planning versus system management and so forth. We are really working hard in California to make sure that there are oper-



To become fully effective, performance measurement must be integrated into existing planning and programming processes.

FIGURE 8 Integrating performance measurement into existing planning and programming processes.

ational and planning strategies that deal with congestion. If these two don't work hand in hand, you don't get the most for your money. So we are really trying to marry the two disciplines, make them use the same measure, the same indicators. They can have additional ones that they don't share, but to the greatest extent possible, the two should overlap.

Society's Values Change—And What Is Expected of Us

Neil Pedersen

Good afternoon, everyone. My name is Neil Pedersen, and I give you greetings from the state of Maryland. It is sometimes known as the "smart growth state." I'm going to be talking a little bit about the upper-left-hand arrows in Mike Meyer's diagram: what we're hearing about in the state of Maryland in terms of input and expectations in the transportation system and transportation decision makers that address broader societal goals.

I first met Mike Meyer 26 years ago when we were fellow graduate students at Northwestern University. I do commend you: the paper that you wrote does give a good broad background, you might say an academic, intellectual background, in terms of the subject area that we're talking about. Working in an implementing agency, I would like to focus my remarks on the kinds of things that we're really facing where the rubber meets the road, so to speak, in the implementing agency.

Context for Transportation in Maryland

I want to give you the context in Maryland so you can understand some of the questions we are being asked. Maryland is dominated by two major metropolitan areas, Baltimore and Washington. Eighty percent of the population of the state is in those two areas. We've been experiencing decay of the urban core in both of those areas as well as in our other cities, with rapid sprawl development occurring in the outer suburbs.

The Chesapeake Bay is the environmental jewel of the state of Maryland. Perhaps more so than in a lot of other states, there is a fundamental environmental ethic in our population associated with the Chesapeake Bay. Governor Parris Glendening is very proud, rightfully, of the Smart Growth program. It has really been the centerpiece of his legislative initiative during his first term as president of the National Governors Association (NGA). He is going around touting that, and I'll be getting into what some of the implications are, particularly from his perspective with smart growth issues. He also has something called Managing for Results. This really is bringing the type of business planning into state agencies that includes vision, goals, and objectives. However, it is really performance measure oriented.

Now, how does our governor view transportation? He doesn't really view transportation primarily as an end in itself but as a tool for achieving other goals, primarily economic development, urban revitalization, and environmental protection and enhancement. This affects, to a great extent, the kinds of questions that we're being asked to answer and ultimately have to develop performance measures for.

The context of what I'm talking about is driven by some recent legislative initiatives that we have faced in the state of Maryland. Last year, legislation was introduced that proposed that the Maryland DOT be held accountable to prevent any increase in vehicle miles of travel in the state. If we were not successful in meeting that goal, then funding would be withheld from any future expansion of highways. Through the legislative negotiation process, we were able to change that into legislation that required us, by law,

to develop performance measures that in a number of instances would be tied to these broader societal goals, not the traditional performance measures that we have developed.

We had bicycle-pedestrian legislation introduced that would have mandated three percent of our entire budget go to bicycle-pedestrian improvements. Again, we were able to take that portion out. We had bicycle-pedestrian legislation passed that had a "bit of teeth" associated with it, and we're going to have a major emphasis on performance measures associated with bicycle-pedestrian mobility.

We had a change in transit fare box recovery ratios as well this year. We are to develop additional performance measures associated with the transit system that substitute for former requirements that we had for meeting a 50 percent fare box recovery ratio.

Issues Associated with Societal Goals

I'm going to go through a potpourri of issues associated with these broader societal goals, now that I've given you the context.

Environmental Streamlining

The first is the environmental streamlining initiative that we have under way in Maryland. Environmental resource agencies have been asking for us, not just at the national level but also within Maryland itself, to become much more involved in planning. This has introduced significant challenges for us. Instead of the traditional environmental performance measures that were used in the Environmental Impact Study (EIS) process, there are new environmental performance measures that we can use at the planning level to address a number of environmental issues. There is also the challenge of the analysis methods associated with those new broader environmental performance measures. There has also been an expectation that we, as the Maryland DOT, are going to become much more involved in other types of planning.

- Watershed planning. We have a major initiative under way, being led by our Maryland Department of Environment and Corps of Engineers in terms of doing comprehensive watershed planning, with transportation an active player.
- Land use planning. I'll talk about some of the smart growth issues, but Maryland DOT is expected to be involved in the discussions at the local level in terms of land use decisions and be talking about what the implications are of those land use decisions on our transportation system.
- Air quality planning. We've been involved in this obviously for some time, but there are performance measures associated with that.
- Revitalization planning as a central part of the smart growth program. Again, we are expected to be at the table developing performance measures associated with revitalization planning.
- Economic development. I'll talk some more about that in a minute.

Smart Growth

There are a number of smart growth questions we are being asked. In each of these questions, there are performance measures that we need to be thinking about.

- How much do our transportation plans contribute to development outside planned growth areas? The centerpiece of our smart growth legislation is that capital investments by the state of Maryland will only be made in what are called priority-funding areas. In general, they are areas either where development already exists or where development meets certain standards. On the residential side, for example, at least four housing units per acre. Outside of those areas, with only some exceptions primarily associated with safety and linkage of priority funding areas, we cannot make capital investments in our system anymore.
- How much do the investments made lead to the development outside the growth areas? I'll talk some more about that in a minute in terms of some specific context.
- How much can you lessen the need for transportation improvements through changes in land use patterns? We're being asked, as part of our planning studies and project level studies, to address the issue. Instead of making the major capital investments in either a new highway or transit program, what if, instead, you changed the land use patterns? Could you reduce the need for making that capital expenditure and making that investment? We have to have performance measures associated with that.
- What mitigation measures can be incorporated in our transportation plans and projects to offset sprawl-inducing effects? How effective are these mitigation measures?

I have talked about one of the exceptions being linking priority-funding areas. We're expected when we make these improvements between priority-funding areas to develop our projects in such a way that you're not going to be getting any development

along that particular project. When we're converting an arterial to a freeway and building service roads to local access, we're looking at things such as having access controls on those service roads and preventing additional development along that roadway.

- How effective are transportation investments in urban revitalization areas in helping to bring about the revitalization? Our legislation is particularly asking questions about this because more and more of our transportation program is going into trying to support urban revitalization.
- What are the synergistic effects of transportation and other investments and programs in creating sprawl and spurring urban revitalization? I've often said that if we don't build water and sewer systems, just making the transportation investments is probably not going to have as much of an effect in terms of inducing sprawl in areas where we don't want it. We need to be able to answer questions about these synergistic effects.
- What would be the effect on congestion and safety of not making transportation investments in areas outside smart growth areas? Sprawl continues to take place. We may not be making improvements in those areas where the sprawl is taking place. Ultimately, what's going to happen and what are our predictions in terms of safety and congestion issues in particular?

Secondary and Cumulative Impact Analysis

I think we're probably about as far out front as any state in terms of addressing sector and cumulative impact issues in the environmental impact statements that we're developing. We're accused of being the cause of a lot of the development that's taking place. In the I-270 corridor, which is a freeway that leads northwest from Washington, D.C., we widened it from 6 to 12 lanes to support planned economic development within an area that really couldn't have taken place without that roadway widening.

Thirty miles to the north, in Frederick County, we're being accused of all the development that has taken place there, as a result of that 12-lane widening further south that was done to support economic development.

In Seattle, Charlie Howard told me about a letter they just received from the National Marine Fisheries with regard to the I-405 project, where they're expecting 200,000 additional people to move into the county that's being served by I-405. They're expected to conduct an analysis of what the effect that development and the 200,000 increase in population will have on the salmon in that county.

Transportation agencies have to account for impacts of all development in the travel shed area, regardless of whether the development is caused by the proposed development. We're expected by the environmental agencies to do that in our secondary and cumulative impact analyses. Think about the performance measure implications of that.

New methods are required to bring a dose of reality to measuring what the actual causal effects are in proposed transportation improvements. I will submit to you that our attempts at using land use models have been a disaster in that regard. We are finding that the use of expert panels really is the approach to use for developing the performance measures associated with that. NCHRP 8-36 is developing methods as well, and we have a transportation community system preservation (TCSP) grant to apply the approach in the I-270 corridor as well.

Economic Development Analysis

Michael made reference to the study that was done in Maryland by an arm of Towson State University, the Economic Return of Highway Investments (ERHI) Study in Maryland. He asked how that was used. We originally did that study when we expected that we would be going for a revenue increase, which we still haven't done. So it's not being used for what its original intended purpose was. But we want to start applying some of the underlying methods and theory that were developed in some of our individual projects in terms of relating what the economic development effects and benefits of those projects are, particularly in terms of how much they support economic development and whether development is or is not taking place with the improvements.

Quality-of-Life Issues

Michael talked about, and his paper gets into further, how we in the past have tended to try to use mobility-related measures as an indicator of changes in quality of life. Here are the kinds of questions we're being asked:

- How good a neighbor are our facilities?
- How are facilities fitting into their environment?
- What is the appearance of our facilities?

How do we measure those things? I submit to you that we really need to be focusing on customer service.

Equity Issues

Michael covered this, so I'm not going to spend too much time on this because I think he covered what the fundamental questions are. But these are the kinds of questions that we're being asked to address under environmental justice. Think back 20 years in terms of what the distribution was of minority and low-income communities, and think about what they are today and how good a job could we have done 20 years ago in terms of predicting what we have today. Yet the proposed regulations are expecting that we do that in the future. I submit to you that I want procedures that U.S. DOT has blessed and said are acceptable or we're going to find ourselves in a liability situation.

Environmental Enhancements

Just very quickly, more and more we're being expected to fund environmental enhancements, and I think you're going to find that we have to have performance measures that indicate what kind of return we're getting for investing in that.

Other Issues

What concerns me the most in terms of some of the types of performance measures that we're being asked to develop is the expectation that we're going to be measuring things that transportation agencies have little influence over, such as the type of thing I talked about before when we're expected to keep the vehicle miles traveled (VMT) from growing at all. It is easy to measure VMT, but in terms of setting those standards, we have to be concerned about this expectation and about measuring and setting standards on things that we don't have influence over.

We need to be thinking about leading indicators and trends that affect travel, particularly underlying economic trends that are occurring. There are societal trends, and Michael got into sustainability measures. But we're being asked more and more to develop measures associated with broader sustainability issues, including what the effect is of our plans and projects on global warming. Think about that in terms of performance measures.

My final conclusion is that the questions we are increasingly being asked to answer are not only how we relate the performance of the transportation system to societal values but also how societal values change what is expected of the transportation system and transportation agencies.

Ways We Grow, Ways We Measure

James Corless

I'm James Corless, California Director for the Surface Transportation Policy Project or STPP. We're a nonprofit advocacy organization, a nongovernmental agency—that is important to understand about our perspective. We're actually a national coalition. We have offices in Washington, D.C., and three here in California, and we're made up of environmental groups, civic groups, the National Trust for Historical Preservation, actually over 250 groups around the country who really care about smart growth and public transit, walkable communities, livable communities, all the buzzwords that you hear.

The reason I'm here today is that we are immensely interested in and concerned about the connections between transportation and the larger societal social issues and environmental issues—land use, environment, quality of life—and we want to try to establish those connections among these types of issues.

We also want to move beyond rhetoric. We talk and hear a lot about smart growth, and certainly we're advocates of smart growth. But what exactly does that mean? In many ways, the battle over the rhetoric of smart growth has been won. You cannot be against smart growth now. But what exactly are you for? We're big proponents of establishing a broader range of measures that start to incorporate some of these societal values, such broader values as quality of life, safety, livablility, and accessibility.

A couple of observations I just want to make. First and foremost, I think the two things that really hamper this are the lack of data and outdated indicators. For example, we are very interested in bicycle and pedestrian safety, walking and bicycling—what we call the "green modes of transportation." But we have very little information about how much walking or bicycling actually occurs on any government, state, federal, or local level. That makes it incredibly difficult to assess performance when you're talking about walking and bicycling and these kinds of modes. For instance, pedestrian fatalities have declined in the last 20 to 30 years nationally, and the statewide trends are very similar. But we also believe, anecdotally, that the level of walking has declined. Actually, people are walking less. There is less pedestrian activity. That is absolutely critical when we get to accident rates.

The U.S. Census, as many of you know, is a great source of information for many things. It is a lousy

source of information for transportation. Friends of mine on the East Coast tell me that for counting bicycling—and let's not even forget this is journey-to-work trips, obviously a very small share of all trips —the census in 1990 happened to pick a week in March on the East Coast where we had a freak snowstorm. Few people were out bicycling or walking. Yet those were the data collected that then went into the next 10 years of planning. You look at those mode shares, and they seem to be very small.

I want to talk about three things in terms of performance measures, three areas that we think are important, especially here in California: capacity, mode share, and safety. This, I think, relates to what Mike was talking about in terms of outputs versus outcomes. We couldn't be more concerned about the use of outputs and the inherent implications that somehow these outputs are really what we're after.

Capacity

In terms of capacity, in California we have been engaged in a debate for many years, but especially in the last year, about additional transportation investment. We have heard over and over again that in the last 10 years in California, our state highway system has only grown by 1 percent in terms of lane miles. Population has grown by 13 percent; VMT has grown by 26 percent. So things haven't kept up with one another. Unfortunately, the state highway system is the state-owned road system. It actually has very little to do with the actual functional capacity of the entire system. Our state highways also double as little local main streets that run through small towns. Highway 1 is a state highway. That actually is a very lousy performance measure for how much lane mileage you have out there. What's much more reliable, of course, is freeways, expressways, and principal arterial streets. If we counted those, didn't look at the state level, and focused on the metropolitan area, we would actually see that road capacity has increased. It has actually increased on par with population. But what we haven't been able to keep up with is VMT. VMT is off the charts, as it is in most places. We think that's a really critical distinction to make. At the state level in California, we get into all kinds of problems, trying to look at such a macro level on these numbers.

Mode Share

Mode share, which is statewide in California, is about 3 to 4 percent. This sounds pretty lousy. Yet we have tremendous transit ridership, largely in Los Angeles and the San Francisco Bay area. We have seven times as many transit riders in California as commercial airline passengers out of all of our major airports. Yet that never really gets discussed. If you focus in on the regional level, even at the corridor level, the transit ridership going into downtown San Francisco through the I-80 corridor is 38 percent of all trips. In Los Angeles including downtown, it's 30 percent; in San Diego, it's 18 percent. So if we focus on the corridor level, we see that these are much more reliable indicators.

Safety

In terms of accident rates, especially for bicyclists and pedestrians, be very cautious of using just pure fatality and injury rates per population. If we do that in San Francisco, we have the highest fatality and injury rate of any county or city in California. That is because we also have the highest level of walking —the highest amount of pedestrian activity—which we think is a very good thing and in urban areas, something we want to encourage. However, just the accident rates alone would make you think that San Francisco is a very unsafe place to walk. The fact of the matter is, there are a lot of places that are far less safe, but we don't have numbers for levels of exposure or levels of activity or mileage walked, something that is critical in terms of looking at accident rates for pedestrians and bicyclists.

Sheldon mentioned that we passed Assembly Bill 2140 in California last year. This is a first step to establish some common performance measures. I couldn't agree more with the notion that all the regions in California are very different. We do, however, think there is some core measures that need to start to be counted that actually do apply to region to region. These are basically VMT per capita, congestion, road condition, mode share, safety and accident rates, access to transit, and access to jobs. Those are the measures embedded in State Law AB 2140. That law is permissive right now. You don't have to do anything. But it's a first step. It's not in state code in terms of establishing performance measures at the MPO, the regional level, in California.

So in conclusion, it's critical what we measure. The environmental community is behind quantifying a lot of the things that we care about. Yet we also worry about the details, and we need to measure many more things than we're currently measuring. That point was made earlier, and I couldn't agree more. We've got to think outside the box, and we have to get beyond some of these traditional quantification methods. We also need to apply the measurements

out forward, at both the corridor level and the regional level. In the 20-year plans, we actually do think there are land use models and growth scenarios out there that can actually illustrate that if we grow in different ways, different land use and growth patterns can have tremendous impacts on congestion, on the cost of infrastructure, air quality, and accessibility. If we apply those measurements to different growth patterns in transportation scenarios into the future, we think it could help the public and stakeholders better understand the choices that we have before us.

General Discussion

Issue: How well is the Maryland smart growth initiative working? Will it be sustained under new state leadership? Does the initiative include nontransportation agencies?

Discussion: It is too early to tell, since it has only been in effect for about 2 years now. The urban revitalization portion seems to be effective, but we won't know the impact on sprawl for some time. The smart growth initiative is in the state legislation, but it will take the support of a new governor to pass. The coordination with local government is essential. The initiative includes all state agencies. For example, spending in the education area for state-supported school construction and rehabilitation changed from spending 85 percent on new schools, mostly in newly developed areas, to 85 percent for rehabilitation in areas to be revitalized.

Issue: How does performance measurement that includes these societal impacts improve public accountability?

Discussion: Over time, this type of performance measurement will have an impact on investments and lend credibility to the process. The key is making sure that the underlying theory is correct. There is an important phrase with regard to making sure that the performance measures link to the societal outcomes that you're measuring.

Issue: Are the smart growth land use and environmental impacts measured at the project, corridor, or systems planning level?

Discussion: It is currently done at the project and corridor levels, but the pressure is to do it at the systems planning level. The state of the art is not there at the systems planning level yet.

Issue: Transportation providers are often asked to measure impacts that they are unable to influence. Is there a way of finding out to what extent transportation does have an influence?

Discussion: The experience in Maryland is to use expert panels rather than models to get an indication of the impacts.

Issue: What are some of the dimensions of the measure of quality of life, especially the quality-of-life costs of congestion?

Discussion: In a recent customer satisfaction survey, the availability of pedestrian and biking facilities and the quality of pavement markings ranked higher from a public viewpoint than did congestion.

Issue: Is there a way for transportation agencies to use the measurement of societal impacts to show that the larger impacts come from nontransportation programs?

Discussion: The synergistic effects of all government programs have a bigger effect on land use patterns than transportation alone. The availability of water is the biggest factor driving growth in the Atlanta area. Developing programs to address the jobs-housing imbalance in an area may be more effective than attempting to add transportation capacity.

Workshop Summary

Scott Bassett, *Oregon Department of Transportation*
Bradley Beck, *Contra Costa Transportation Authority*
Conan Cheung, *San Diego Association of Governments*
Jim Dorre, *Arizona Department of Transportation*
Tremain Downey, *California Department of Transportation*
Lisa Klein, *Metropolitan Transportation Commission*
Marian Lee-Skowronek, *San Francisco County Transportation Authority*
Jon Williams, *Transportation Research Board*

State of the Practice

The issues raised during the presentation at the final session can be summarized as follows:

- Just baby steps to date;
- Increasing demands that agencies deal with broader goals;
- Limited research connecting transportation and broader goals; and
- Transportation being behind the curve but agencies getting involved in more interagency efforts, more interdisciplinary efforts, and more public and private efforts.

In discussion, the group defined broader goals as those that affect everyone and are not directed toward one individual. Although some transportation agencies may be slightly ahead of others in what they are trying or have accomplished, we all need to recognize that the steps taken are only baby steps. There is an ever-increasing demand that agencies deal with goals and issues that were or are considered outside the influence of the transportation agency. There is limited research to guide the agencies in connecting transportation to the broader goals demanded by society. To overcome the limited knowledge, transportation agencies must become more involved with other agencies outside of the transportation community, support interdisciplinary efforts, and develop an outreach to other public and private efforts.

Issues

- No public accountability in long-range plans;
- Lack of understanding about the cause and effect on broader goals;
- Difficulty in balancing multiple broad objectives;
- Arrogant stewardship perhaps;
- Definition of common measures for different groups and areas; and
- Subjective definitions of broader issues, such as equity, mobility, and others.

In discussion, participants commented that currently the long-range plans of transportation agencies have no public accountability. This situation stems from the failure to implement plans or from a change of goals before implementation, resulting in the constant updating of long-range plans. The transportation agency's desire to respond to changes may, in fact, have a long-term negative impact and may display a lack of understanding of the long-term cause and effect of transportation on broader goals. The result is a difficulty to balance multiple broad objectives in the community. Sometimes the public considers the transportation agency as practicing arrogant stewardship because of the apparent short-sighted goals and protection of the transportation process from the public. Some ways to overcome this viewpoint would be the understanding and definition of common measures for the different customer groups and areas, such as defining equity and mobility.

Opportunities and Constraints

- Possibility of piggybacking on other disciplines to address broader goals,
- Possibility of partnering with other agencies and stakeholders to achieve broader goals,
- Possibility of leveraging nontraditional funds by linking transportation to broader goals,
- Limited authority to deal with broader goals, and
- Conflicting public- and private-sector objectives.

There was discussion on ways that transportation agencies can enhance their acceptance in responding to conflicting public- and private-sector issues in the community. One approach would be to work with other agencies and stakeholders to understand the broader goals. This cooperative effort could help the transportation agency, with limited authority, to develop partnerships involving nontraditional funding that could link transportation needs to the solution of the broader goals.

Actions Required and Next Steps, Including Research Needs

- Improve new market research and public involvement tools.
- Survey customers.
- Include historical and trend information to create performance measures.
- Make better use of
  - –Market research,
  - –Expert panels,
  - –Multidisciplinary approaches,
  - –Other professions and agencies, and
  - –High-tech methods.
- Use modal-neutral and systemwide measures.
- Set best practices in transportation and land use connections.
- Conduct research on the relationship of transportation and broader goals.
- Define and measure the relationship of transportation and quality of life, social equity, and environmental justice.
- Determine the cost trade-off between improving the housing-jobs balance and the transportation investment.
- Determine the decision structure needed to make best use of broader measures.

One goal that all agencies need to consider is refinement in market research and public involvement tools, with an emphasis on connecting performance measures to broader goals. Some states are having success with their surveys of customers. Participants posed the question, Are we asking the right questions to define transportation in the whole community? We need to learn from our past by reviewing historical and trend data to help create performance measures for the future. All areas can improve by making better use of market research, expert panels, multidisciplinary approaches, other professions and agencies, and high-tech methods. Modal-neutral and systemwide measures will help agencies look outside the box. There were other questions and points to consider. What are the best practices in transportation and land use connections? Are there examples that can be modified? Additional research may be needed to develop or understand the relationship of transportation and quality of life, social equality, environmental justice, and other matters and to measure that relationship for success. What kind of transportation is needed to balance housing and jobs? Is a balance necessary? What kind of tools do the transportation agencies need to make these assessments and measure the success of the decisions? How is the success measured?

Much of the data collection described in Mike Meyer's paper is being done now, but there are poor linkages to performance measures for design and practice. Transportation is blamed for many situations, some valid and some not. There is a link between transportation investments and societal impacts, but we do not know how to measure the link. When an agency changes performance measures, it needs to inform the public and private sectors to ensure credibility. Any outcome-based performance should reflect what the customer sees. Surveys can ask customers about transportation quality of life. Sometimes the transportation issues that the customer sees as pertaining to quality of life differ from those that the transportation agency sees. How do you measure quality of life? Transportation issues should not overlook state- and local-mandated goals for development and protection. How much of a difference can transportation make in societal issues?

Freight Performance Measures

Current Issues in Freight Movement

Public-Sector Freight Performance Measures

PANEL DISCUSSION, PART 1

Current Issues in Freight Movement

Harry Caldwell, *Federal Highway Administration*
Gary Nichols, *Contract Freighters, Inc.*
LaDonna DiCamillo, *Burlington Northern and Santa Fe Railway Company*

This panel discussion was intended to inform participants about progress in dealing with the establishment of freight performance measures. Because the movement of freight is primarily a private-sector responsibility, the discussion included representatives from both the private sector and the public sector.

The discussion took place in two parts. Part 1 consisted of three background presentations that discussed the general practice and current issues of freight movement. Part 2 consisted of presentations from public-sector representatives who discussed how public agencies can deal with private-sector issues cooperatively and develop meaningful performance measures for freight movements.

FEDERAL HIGHWAY ADMINISTRATION'S FREIGHT ANALYSIS FRAMEWORK*

Harry Caldwell

- The Federal Highway Administration (FHWA) Freight Office developed a business plan to be completed by 2002. The primary reason for federal involvement is the concern for the impact of freight movement on the economy of the country. With the globalization and growth of the economy, some serious freight issues must be addressed. Freight movements are forecasted to double over the next 20 years.
- Trends in freight transportation include shifts from push to pull logistics, from price-based costing to cost-based pricing, and from just-in-time deliveries to time-definite deliveries.
- A consultant is developing 5- to 10-page white papers on nine driving themes that FHWA identified. The papers will be posted on the website when they are completed.
- FHWA developed a freight analysis framework. The enormous capabilities of this system are illustrated in the full presentation.
- The three major focus areas of FHWA are institutional development, information technology, and infrastructure.

*Copies of this presentation and other information from the freight office are available on a CD-ROM that can be obtained from the speaker. Additional information is available from the FHWA website (www.ops.fhwa.dot.gov/freight).

• FHWA hopes to have a federal legislative proposal for the next reauthorization of federal transportation legislation in 2004.

Issues and Trends in the Trucking Industry

Gary Nichols

• Regulatory compliance is a major issue because of international, national (United States, Mexico, Canada), state or province, and local regulations.

• Customer supply-and-demand relationships are changing.

• Safety is the number one concern of Contract Freighters, Inc.

• Carriers are concerned with asset optimization (including technology, capital investment infrastructure, and planning) and interact with the public sector on all of these issues.

• Carriers would like input on such critical public issues as hours of service, pollution control, highway design and construction, highway access, rest area design and location, and practical experience input to key committees and government boards.

Issues and Trends in the Railroad Industry

LaDonna DiCamillo

• Key railroad performance measures are dwell time per car, filled time per car, intermodal lifts per day, and transit time.

• Railroad transportation is at least two modes. Intermodal traffic increased 52 percent over the past 5 years.

• Air quality requirements are driving the need to replace locomotives. Locomotive use is another key performance measure for the railroads.

• Capital investment in railroads increased significantly from 1994 to 1999 but will slow down in the coming years.

• Current issues include community views on locomotive whistles, vibration, and grade separations.

• Railroads have difficulty dealing with the long project-planning schedules of public agencies.

• New trends include the Internet to increase car use and time-sensitive services.

PANEL DISCUSSION, PART 2

Public-Sector Freight Performance Measures

Gerald Rawlings, *Chicago Area Transportation Study*
Dilara Rodriguez, *California Department of Transportation*
Mark Larson, *Minnesota Department of Transportation*

PROJECTIONS IN FREIGHT PLANNING*

Gerald Rawlings

Since my time is short here, I am going to condense my point to a short parable. Let me tell you about the one legendary case of performance analysis that was applied to the freight transportation industry; it was in the folk song, "The Rock Island Line." It's a mighty fine line. The second stanza concludes, "It's right on time, but it's yesterday's train." The moral of that story is that performance analysis, as performed by Wall Street, is cruel because—as one of your former presidents would have said—we do not have the Rock Island to kick around anymore.

This is how planning for freight comes across to me in a metropolitan area. There are five gradations of the freight planning process:

- Nominal—data;
- Ordinal—data comprehension (What does it all mean?);
- Interval—to get through the thought process;
- Ratio; and
- Serial.

Nominal is your basic inventory. Anybody can do that. It does not require much more than a willingness to drive around and see what you see. Facility *A*, Location *XY*—bingo. For *ordinal*, then you have to say, there are several of them and one of them is twice as big as the other one. *Interval* is the same thing; it's two times. We could do that, but it does not always have as much utility as to get through to the time series.

We analyzed the volumes of the largest intermodal yards in Chicago with the data that we got from the American Association of Ports. We saw—not altogether to our surprise—that we have several intermodal rail properties in the metropolitan Chicago area (northeast Illinois, really) that are larger than all but a small handful of national ports. From this came a sound bite: "Chicago is the third largest port in the world if you use intermodal volume handling as your metric, third only to Hong Kong and Singapore, and double Rotterdam, which is the largest European port."

So this is what started the thought process partly because I have always believed there is lots of data around that is simply not understood for its full value. Somebody collects it. It serves an immediate short-term purpose, and then it goes into the round file. If you pull it out quickly enough, hold it for a short time, and compare it with something else, then maybe it has more value than you thought it had. Two products are regularly produced in northeast Illinois: gross annual average daily traffic counts and periodic truck counts. By using the first count as the denominator and the second count as the numerator, and simply doing some simple division, you get the percentage of truck occupancy for all the Interstate highways and numbered routes in the six-county area of northeast Illinois. We did that, and we came up

*A published version of this paper is available from the speaker.

with some astounding numbers. Overall it runs in the range of 26 to 30 percent.

We then developed a list of the intermodal yards that are processing in northeast Illinois. We took the acreage and the throughput to get an average for the number of containers or trailers per year by acreage. We made some projections and calculations and then announced that if the region continued to perform this service at this level, with the projections that some people were making—and we made very conservative ones—then another 4,200 acres would be needed by 2020 for intermodal handling to get to a volume that is something like 2½ times what it is now. This news shook everybody up. It was a breakthrough in the use of numbers. We were among the first people to say that we needed to have a projection of some kind. You do not have to say it is absolutely right. However, as it turns out, for the past 3 years at least, our projections have been fairly close. You have to make certain assumptions about holding the technology constant.

The private sector said that if these government guys can figure it out, we should perhaps take another look ourselves. As a result, as least partially attributed to this analysis, a mammoth intermodal development on part of the acreage that used to be the Joliet Arsenal will be developed by the private sector. Centerpointe Properties will develop it, and the Burlington North and Santa Fe Railway Company will be the principal rail tenant—the sole tenant at this point. They will develop about 12 million square feet of peripheral warehousing and assorted service space.

We always should be pushing the envelope. It requires a willingness to confront our own contribution. We are a metropolitan planning organization. It is our responsibility to do this. I do not believe that freight planning is ever going to come easily because, as somebody else said earlier on, we are largely in the people-planning business, and we have been doing that for 25 years.

Goods Movement in California

Dilara Rodriguez

I will be talking about a strategy that we have adopted for goods movement. Goods movement is extremely important for California. It provides $40 billion/year to national economic output, more than 1 million jobs, and more than $8 billion/year to federal taxes and customs duties. A total of $640 billion in California commodities was moved in 1993, and more than 60 percent was moved within the state.

California is a major port and a major source for the economy of this nation. Therefore, for the state to be able to perform and continue growing as it is projected to grow, the system has to be improved. We are dealing with issues of accessibility, reliability, and safe performance. In our designs and planning, we are constantly working with the trucking industry, the rail industry, and the shipping industry. We cannot talk about one mode and not the other. Although we are a California Highway Department, we do not talk about only the highway. We look at all the modes, so that we can build a strong partnership.

I would like to speak about an exciting project that California is participating in with seven other states: the I-10 corridor. We are looking to turn the entire I-10 highway from California to Florida into a nationwide automated truck facility. What do we mean by a nationwide automated truck facility? The whole concept is this: if we are looking at improving the economy and looking at being able to grow and keep traffic growing without compromising safety, then maybe we need to look at a way of moving goods efficiently, while keeping the system safe and efficient for the daily users.

We are really in the beginning phase. Next week will be the first time that representatives from all eight states will sit and talk together. Texas is leading the effort. Goods movement is extremely important to us, and I-10 is the major east-west system. Most of the previous talk has been about north-south corridors because of the North American Free Trade Act (NAFTA) with Mexico and Canada. The logical flow is north-south. But we also have the east-west system. We have the major ports in Los Angeles with goods that go through the other states. Other sources of traffic come from the Florida side, and Texas is a major player.

How can we work together as a team and look at choosing technology? The speaker from the trucking industry shared many exciting things that the truck-

ing industry has already taken upon itself, and I am sure the rail people also are using the available technology to be able to move goods safely and to track them. We have a new technology department in the California Department of Transportation (Caltrans) that deals specifically with the technology aspect, but I would like to relate it to the performance measures. Why is it important for us to look at new ways of being able to do our old business of moving goods and moving people, and using the technology that is growing faster than we can catch up to it? Because we are concerned with accessibility, mobility, and reliability.

I am sure during this week my colleagues from California have been talking about the efforts that have been taking place in southern California and northern California. How can we successfully move together the goods and the people? We cannot build this partnership unless we have the private sector with us. One of the key things for us to be able to measure is data. I am glad to hear that the trucking industry has numbers. We can tell you which routes are better. We find some difficulty in being able to have the trucking and rail companies opening up to the government.

There is a sincere effort in California from both the private and public sectors to work together. I would like to extend an invitation to everyone to provide data and information so we can work together on this project.

Direction for Freight Performance Measures

Mark Larson

It has been a long road this week, and I am going to try to bring it back to performance measures. At the Minnesota Department of Transportation (MnDOT), we have a freight office and a performance measurement section that I am involved with. I am going to talk a little bit about how we cooperated with our private sector, the Minnesota Freight Advisory Committee, to come up with some concepts and direction for freight performance measures.

How do we get the freight measures? Our goal is to improve our freight planning. Perhaps looking at our outcomes and measures and establishing some measures in that area will bring some fruitful results in our planning efforts.

MnDOT established seven customer segments:

- Commuters,
- Personal travelers,
- Farmers,
- Emergency vehicle operators,
- Carriers,
- Shippers, and
- Intermodal transporters.

Four of the seven customer segments involve freight if you include farmers. We have a freight advisory committee. It used to be part of our chamber of commerce. It moved over and affiliated with our department of transportation through some behind-the-scenes work. So in May 1999, we got together for a 2½-h session with shippers and carriers. We involved some major shippers of various commodities and products in our state. They expressed a willingness and an interest in helping us set some direction for some performance measures. This committee helps the department look at investment, policy, and planning issues; therefore, performance measurement fits into their activity. Nevertheless, to get a significant number of private-sector people to sit down and talk about measures is not an easy task. The previous relationship building that we had had gotten us to this point. We brought together about 21 people that day, working in about five different groups.

The objective of the group was to create a yardstick for looking at our department and our state; how are we doing at serving freight needs? The group also created some options for us in the department to begin looking at and incorporating in our measures framework. We worked in small groups. They

TABLE 1 Proposed Performance Measures with Available Data for Minnesota's Freight Transportation System

Proposed Measure	*Data Available*
Predictable, Competitive Metro-Area Travel Time	Metro freeway travel time by route and time of day Average speed on metro freeways by route and time of day Congestion ranking of metro freeways by route Congestion level compared with other major metropolitan areas
Economic Cost-Benefit Ratio	Cost-benefit ratio of major state transportation projects[a]
Transportation Investment	Minnesota's transportation investment and spending as percentage of gross state product[b]

[a]Data are available for most projects showing a benefit for heavy trucks. A project financial analysis model has been created by MnDOT Metro.
[b]Public-sector data are available.

devised the concepts, not specific measures. The Freight Advisory Committee emphasized

- Time—predictable and competitive;
- Economic impact—across all areas (time, safety, access, and infrastructure);
- Economic competitiveness—in time and cost of shipping; and
- Investment planning—cost-benefit ratio and location of facilities.

After that session, we brought people in from different parts of the department and analyzed and translated the concepts into potential measures. Then, we looked at whether the data were really available. (Tables 1 and 2 summarize the current status of these measures.) After the staff work was done, we brought it back to the group; members made a few modifications and gave it their blessing. A few of the measures have been implemented, but we have a long way to go to bring it all into our program.

I should step back and say, How do you develop freight measures? Well, you could get your staff to-

TABLE 2 Proposed Performance Measures Requiring Development for Minnesota's Freight Transportation System

Proposed Measure	*Data needed*
Intercity Travel Time	Peak-hour average travel speeds on major highway routes between 27 regional centers[a] Shipper point-to-point travel time[b]
Freight Travel Time to Global Markets	Travel time to major regional, national, and global markets by rail, air, water, and truck[c]
Competitiveness of Shipping Rates	Shipment cost per mile by ton or value by mode for major commodities[d]
Crash Rate and Cost Comparison	Dollar value of crashes and crash cost comparison by mode[e] Crash rate per mile traveled (or other basis) by freight mode[c]
Bottlenecks and Impediments	Number of design impediments to freight traffic by mode and type (at-grade rail crossings, restricted roads, deficient bridges, etc.)[f]
Timely Access to Intermodal Terminals	Number of design impediments slowing access to truck, rail, air, and waterways terminals[g]

[a]Calculated speeds; preliminary development has been done for the MnDOT Interregional Corridors Study.
[b]Developed from private data.
[c]Requires development.
[d]Requires research and development.
[e]Some data are available; requires development.
[f]Data for some types are available; others need development.
[g]Some data are under development.

gether, use an analytical approach and use the staff knowledge. If you work with shippers and carriers, some of it will be the same, but some of it will be different. That is the advantage, and you will see some different perspectives.

We asked them several questions:

- What are your critical issues?
- What changes would you like to see in our freight transportation system?
- By what measure would you know that we had made some progress?
- How would you know that we achieved changes that met some of your needs?

Just to summarize, some of the areas of emphasis are obvious: time predictability was a key area, particularly the competitiveness of our metropolitan area of Minneapolis–St. Paul. Is our congestion as bad as Los Angeles, Atlanta, and other cities? How competitive are we? We may have to live with congestion, but how does it compare with other areas? The Texas Transportation Institute (TTI) index is helpful there.

The group has an economics perspective on safety in all areas and is very concerned about investment planning. Where are freight terminals being located? Why are transportation planning and land use planning not integrated? There is a concern that our terminals and access points are being pushed farther and farther away from centers of economic activity.

Two general categories of measures came out of these sessions. The first had to do with overall policy measures. Again, it came back to competitive travel time: How competitive is our metropolitan area in transportation? What is our time of travel to global markets? That is something that we do not have data on right now, and I do not know if it is on the horizon for the Federal Highway Administration (FHWA), but that was a big concern.

By the way, FHWA has put together a nice report, *Measuring Improvements in the Movement on Highways and Intermodal Freight*. Through a staff effort, FHWA came up with some recommended performance measures that it is going to be developing. That is a nice resource that you can use. However, some are useful at the local level, perhaps, but many focus at the national level.

I cannot go through all the recommendations in detail; I will mention a couple of items here. Transportation investment as a percentage of our gross state product was discussed. The shippers and carriers looked at that percentage as to whether we are investing enough to meet the needs of our system. It provided some interesting data showing that our investment in transportation by public and private sectors combined is actually going down because of tremendous improvements in productivity and efficiency. It is a curious measure in the sense that we are not sure whether it should go up or down. It is more of an indicator that is interesting and important for people to follow.

Several measures that came out of our sessions were in line with what FHWA is recommending. We are working with the University of Minnesota's Logistics Task Force now to develop a shipper panel. It is going to start with focus groups and eventually involve a survey, which we hope will become annual, of 1,600 shippers around Minnesota to evaluate and track the quality of service in the private sector and potentially from the public infrastructure. That panel is just under development.

Measures that we can use for investment in project design decisions include

- Interregional travel time,
- Predictable metro travel time,
- Bottlenecks and impediments,
- Cost-benefit ratio, and
- Safety economics.

Nancy Melvin from our Metro Division developed what she calls a "freight scorecard" that our Metro Division is using to evaluate a particular corridor project, which has several factors.

What came out of the Freight Advisory Committee included measures for interregional travel time. With our Interregional Corridors Program, we have to set targets for a project, and this was not simply because of freight considerations, but it coincides with their interests. We have set targets for high priority, medium priority, and regional corridors around our state and average speed targets for those corridors.

Another area that repeatedly came up was bottlenecks and impediments. Again, FHWA is looking at this area. We established some categories, and we are developing a system for tracking impediments to freight movements such as lane drops, lane weaves, substandard bridges, and low overpasses. It is a practical kind of measure that you could use in doing project analysis to identify the number and types of impediments to freight.

We do cost-benefit analyses on our major construction projects. The committee wanted to know what the cost-benefit ratio for freight is. We have a crude measure that is one of the components of our cost-benefit analysis, already as a freight component, but it could use a lot more development.

The committee also saw safety as a big factor; Gary Nichols talked about how important safety is for the freight companies. Finally, shipper point-to-point travel time was discussed. Contract Freighters, Inc., already volunteered to provide data to FHWA to measure travel time directly from the shipper, and some of the carriers and brokers in our state were interested in possibly providing data. They said they are already keeping this kind of data. Let's see if we can work it into our measurement systems.

What are our conclusions? The shipper view is essential and distinct from carriers and the state department of transportation. Shippers are, to a degree, ultimately mode neutral. They are trying to get the goods there in the most timely, safe fashion they can. They are going to provide a less skewed view in some sense of the overall bigger picture of which freight measures and goals we are looking for. For example,

- Regional competitiveness is a key focus for shippers.
- Customers will give direction but are less interested in details of measurement. When you involve people from the freight community shippers and carriers, it is probably going to be difficult to find anyone who is going to work at a real detailed level. However, if you combine your staff effort and help them provide some of the direction and concepts, then you should be able to make some progress.
- Intensive staff work is required to evaluate options. A lot of staff focus is needed to report it.
- Customers are action oriented. Ultimately, your relationships with shippers and carriers and their organizations are going to depend on being action oriented. They are action oriented. If you want to have credibility, you are going to have to be able to make it clear that your department and your organization are going to move forward on some of their concerns.

Those are some of the lessons we learned. We have a long way to go to implement what we learned, but my message is to try to develop those relationships. It will enrich and improve the quality of your measures work.

Summary and Conclusions

The conference on Performance Measures was considered a success by sponsors and participants. There was strong participation in the general sessions and in the workshops as well as in the preparation of the workshop summaries.

Summary

Little controversy was raised during the conference on the use of performance measurement; rather, it was a starting point of the discussion that performance measurement can and should be used in several functions within an organization. As a result, discussion focused on how, when, and where to use performance measurement. As an example of the positive, upbeat nature of this conference, the participants listed many more opportunities associated with performance measurement than constraints. A great deal of experimentation is still under way in many agencies on the types of measures that are appropriate for different settings, and the literature that documents the experience of these implementation efforts is growing.

Most agencies develop performance measures that focus on the portion of the transportation system that they own or are directly responsible for operating. The participants were interested in advancing the state of the practice on multijurisdictional and multimodal performance measures. They were concerned about the inability to measure the nontransportation (societal) impacts of transportation decisions, and several promising approaches were presented.

Even though many technical issues that need additional work remain, the primary need identified by the participants as the next step was the further sharing of information and experiences on the processes used in the various agencies relating to performance measurement. The methods identified for sharing information were National Cooperative Highway Research Program (NCHRP) studies, synthesis projects, peer group reviews, and additional workshops and conferences.

The main points of the conference can be summarized in several statements:

- On lessons learned, there is no one best solution.
- The state of the practice is evolving.
- Accountability, customer focus, and societal impacts will continue to drive the need for performance measurement.
- Participants want to continue to share information and experiences.
- Concerns were raised on tying performance measures to decision making.
- Concerns were raised on resource requirements and the sustainability of the effort.
- Transitioning from the single-mode or the system measures to the multijurisdictional measures is difficult.
- More research and experimentation are needed for multimodal and societal measures.
- Important data and analytical issues remain.
- Freight performance measurement is advancing with new data availability.

Conclusions

The conclusions of the conference probably can best be presented by answers to several key questions raised during the conference.

Issue: What is really new here with the discussion of performance measures? Haven't we always done this in the planning process? Is this another management process *du jour*?

Discussion: There is a long history of measuring the performance of the workforce and the transportation system. What is new is the context and the formalization of performance measurement into decision-making processes. Public accountability (legislated or implied), customer focus, information technology, management systems, and societal impacts are current emphasis areas in public policy that require performance measurement. Performance measurement is a long-term process, and the emphasis on measurement will only grow in the future.

Issue: What is the motivation for an agency undertaking a performance measurement program?

Discussion: For some agencies, performance measurements grow out of the "quality management" initiatives of the past; they are consistent with and support current initiatives such as management systems and asset management. In some cases, legislative requirements such as the Government Performance and Results Act at the federal level and similar requirements at the state and local levels are the impetus. However, in many agencies, the motivation is simply good government and good management practice.

Issue: What is the context for performance measurement in the various states?

Discussion: The context varies widely across states and across transportation agencies. In some states, transportation performance measurement takes place under the umbrella of larger state policy initiatives, such as economic development or smart growth. In other states, transportation performance measurement is within the policy goal framework of a state transportation or strategic plan. Agencies operate in the context of customer satisfaction and accountability. Performance-based planning and performance-based budgeting also provide contexts for performance measurement.

Issue: What functional areas of an organization use performance measurement?

Discussion: Participants reported on performance measurement used in the variety of functions present in an organization, including strategic planning, system planning, programming, project development, design, construction, maintenance, and operation. They generally felt that there should be only a few, well-understood, broad measures at the upper level (planning) and that the measures could become more numerous and more detailed at the lower level (operations). The alignment of measures across functions is important, and operational measures should be connected to and support broad agency strategic goals.

Issue: What institutional issues arise when developing performance measure programs?

Discussion: Much of the experience with performance measurement to date has been single-agency measurement; many such examples exist. The issues are fairly well defined, there are examples (models) for performance measurement at different points in the process, and there is literature on different types of measures. Interagency measurement within the same jurisdiction and multijurisdictional measurement examples are not as numerous, and the issues and needs are not as well defined. Interagency measures raise additional issues related to data integration, institutional relationships, and use in joint decision making.

Issue: What types of performance measures are used in the transportation field?

Discussion: Performance measurement within a single mode (e.g., highway or transit) has a fairly long history, and some agencies are satisfied with their measures. Multimodal measurement is still under development. There has been some experimentation and some use of multimodal measures within a planning context but little documentation of multimodal measurement used for decision making on the allocation of resources. Examples of the measurement of societal impacts of transportation were offered in Mike Meyer's resource paper. Atlanta, for example, is exploring techniques to characterize how travel activity patterns vary among different income and ethnic groups and how these groups are affected by new transportation facilities. Although many agencies are still developing performance measures to track social impacts, such as environmental justice, approaches are available while the state-of-the-practice improves.

Also, under subject matter, there is a distinction between the measurement of passenger travel and facilities and measurement in the freight area. Most of

the measures discussed at the conference related to passenger movements. However, the presentations during the freight sessions offered examples of evolving methods, data systems, and analytical capabilities in the freight sector.

Issue: What common lessons have been learned from previous and current activities in implementing performance measurement systems?

Discussion: The resource papers, panel presentations, and subsequent discussions are remarkably consistent. The first resource paper, "Use of Performance Measures in Transportation Decision Making," summarizes the lessons learned:

- Performance measurement involves more than measures; an integrated framework is necessary.
- We need to build on existing processes.
- We need to link to overall agency goals and connect strategic and operational levels.
- Progress and implementation are incremental.
- Top management support is critical.
- Performance measurement should inform the decision process, not replace it.
- We need to understand the causality between actions and performance results.
- Data, analytical tools, and information are at the core of success.
- There will be resistance and institutional barriers.
- Feedback and assessment are critical.

The conference report and the workshop summaries add background and specifics to the lessons learned but do not materially alter them. The conference discussion brought out that the establishment of a performance measurement system usually is not a clean step-by-step process but, in fact, a "messy, grinding, ugly" struggle that involves much dialogue, experimentation, and analysis. Many said that, from an agency standpoint, going through this process—discussing what you are really measuring, what the results really mean, what modifications are needed, and recycling until there is agreement—is as important as the measures themselves.

Issue: What is the state of the practice?

Discussion: The most complete summary of the state of the practice can be found in the Workshop Summary on Agency Implementation of Tranportation System Measures; the other Workshop Summaries generally agree with this one. It is clear that the state of the practice is evolving. The experience in the different agencies varies. Some are very advanced, having gone through several iterations before settling on measures, whereas others are waiting or are now considering establishing a program of performance measurement. The state of the practice depends on the dimension (jurisdiction and subject matter) of the measurement. The Summary of Poster Sessions (Appendix A) provides another description of the state of the practice.

Issue: What are the issues related to improving the state of the practice?

Discussion: The following major issues were raised:

- Linkage of performance to decision making: understanding the information needs of decision makers, customers, and stakeholders;
- Communications: making measures understandable by tailoring them to the audience;
- Customer input: identifying the customers and stakeholders, determining the most effective methods for obtaining their input, and balancing short-term customer preferences with long-term stewardship responsibilities;
- Quality of information: gather reliable and sustainable information, surrogate measures, projections versus actual data, and validity and error estimations;

- Top management support: aligning strategic (business) measures with organizational measures throughout the agency;
- Institutional and organizational issues;
- Data collection, analysis, and integration;
- Sustainability of performance measurement through leadership change and over the long term;
- Resource requirements: added burden, and benefits exceeding the costs;
- Unintended consequences and feedback processes;
- Selection of measures: resulting in outcomes vs. outputs, surrogates;
- Analytical issues: identifying tools, trade-off analysis, and causal relationships.

Issue: What are the opportunities associated with performance measurement?

Discussion: The participants listed many opportunities associated with implementing performance measurement systems:

- Support internal decision making (relate decisions to consequences, establish a nested hierarchy of

measures linked to decisions, and secure top management and internal buy-in).

- Support efforts to secure funding by demonstrating measured value.
- Leverage nontraditional funds by linking transportation measures to broader goals.
- Foster proactive rather than reactive approaches.
- Generate external understanding and support through the use of customer surveys, enhanced credibility of performance measures, understanding of factors beyond agency control, increased involvement, and understanding public concerns.
- Improve interorganizational coordination (link access to performance results across modes and jurisdictions, and build on federal performance monitoring systems such as the Highway Performance Monitoring System and the National Transit Database).
- Assist institutionalization with pay-for-performance programs.
- Increase data sharing, partnerships, and integration through intergovernmental cooperation and use of information technology, including the Internet (collect data that serves multiple purposes).
- Create public-private partnerships in data collection and analysis.
- Partner with other disciplines to address broader goals.

Issue: What are some of the constraints?

Discussion: Stated constraints include the following:

- Limiting resources (data collection, analysis, and planning programs are usually the first to be cut),
- Accepting change (consistency of leadership, measures change over time, reluctance to share information, control),
- Having the right set and number of understandable measures,
- Penalizing risk taking, resistance to change, or use of "gotcha" measures used by inhibitory organizational cultures,
- Relying on data ("gaming" vs. measuring),
- Limiting the authority to deal with broader goals, and
- Conflicting public- and private-sector objectives.

Next Steps

At the Conference on Refocusing Transportation Planning for the 21st Century (Feb. 1999), Meyer suggested a research framework that includes four categories of actions: enabling or basic research; tools, techniques, and methods; process; and implementation.

The premise of this approach is that there is a hierarchy involved in research. We need to understand the basic relationships (enabling research) before we can develop tools, techniques, and methods; processes; and implementation. The workshop recommendations are organized and summarized below under these four categories.

Enabling or Basic Research

Two areas that include actions within the category of enabling or basic research were identified.

Transportation Performance Measures: Connection to Broader Goals

- Incorporate community or society goals into the performance measurement process.
- Add quality-of-life and sustainability performance indicators.
- Use performance information to make cross-discipline decisions.
- Link transportation outputs to broader societal outcomes with proxies.
- Develop a guide to quantify intangible measures or indicators.
- Research the outcomes that influence the causality of broader societal outcomes.
- Connect the performance measures for land use and transportation.
- Research the relationships of transportation and broader goals.
- Define and measure the relationships of transportation and quality of life, social equity, and environmental justice.
- Trade-off cost between improving housing-jobs balance and transportation investment.

Multimodal or Mode-Neutral Performance Measures

- Develop performance measures for cross-modal investment decisions.
- Create a state-of-the-practice report on analysis, data, and tools to compare modes.

Tools, Techniques, and Methods

Tools in General

- Provide tools for managers and policy makers for applying and using performance measures.
- Determine the limitations of performance measurement tools and how they fit into a total decision-making process.
- Identify other desirable or essential tools that must complement performance measurement.
- Establish a guide to measure and understand errors.
- Improve planning techniques regarding surveys, use of intelligent transportation systems (ITSs), data behavior, and behavioral models.

Market Research and Customers

- Improve the understanding of the current use of market research in decision making and how it can be improved to provide decision makers with important outcome information.
- Create new market research and public involvement tools.
- Survey customers.
- Maximize use of market research, expert panels, multidisciplinary approaches, other professions and agencies, and high-technology methods.

Communications

- Communicate performance to customers, stakeholders, and the public.
- Gather examples, case studies, and tools to effectively communicate performance measures to policy makers, legislatures, and the public, providing quality information to decision makers in a usable format.
- Determine how performance measures are communicated to decision makers.
- Develop a web library of samples of communicating, summarizing, and presenting performance results to decision makers and the public, particularly ones using graphics and visual aids instead of tabular, text-oriented reports.

Data

- Create a directory of private-sector data (goods movement) and privacy issues.
- Collect data on demographic stratification.
- Identify which data we have stopped collecting (state and federal) and why.
- Integrate data.
- Amass historic and trend information to create performance measures.
- Synthesize data availability at the national, state, and regional level, and develop strategies for using existing data sources.
- Recharacterize data collection as performance monitoring.
- Revisit data quality issues.

Terminology

- Clarify and standardize terminology and differences between organizational and managerial and systems measures.
- Align the definition of goals across the industry to extent possible and standardize the measures.
- Create consistent standards so that performance measures can be reliably compared across agencies.

Process

All workshop groups recommended additional documentation and sharing of information and experiences on creating performance measurement systems. *NCHRP Report No. 446: A Guidebook for Performance-Based Transportation Planning* includes a comprehensive review of the state of the practice, including case studies and a library of performance measures based on information collected in 1997 and 1998. The sense of the participants was that the field is changing so rapidly that the effort to update these materials should start as soon as possible. They also recommended several additional mechanisms for sharing information, including *NCHRP Synthesis* reports, peer exchanges on selected topics, and additional conferences and workshops on selected topics.

The topics recommended for additional group sharing were as follows:

- Linking performance measures to decision making: case studies on how measures are successfully used in decision making, including different processes and methods of decision making; evidence of benefits and long-range payoffs of using performance measures for transportation decision making; tools to quantify the impacts of performance measures on decision making; ways to gauge the consequences of using a wrong performance measure; and decision structures to consider societal measures in decision making.

- Implementing performance measurement systems: case studies that show successful implementation of performance measurement systems, including types of measures used; the purposes in using these measures and their pros and cons; lessons learned from what works and what doesn't; closing the loop from strategic goals to input to output to outcomes, with feedback loops from each.
- Synthesizing actual internal processes or mechanisms used by transportation agencies to link agency mission and goals to project investment decisions, including a literature survey of "how to" sources; an integration of strategic planning and performance measurement, including ways to make the total process faster and more responsive; a link of measures from an operational-decision level (internal productivity) up through a policy-decision level (external stakeholder satisfaction); and organizational frameworks that promote the implementation of performance measures.
- Compiling resources that include
  - –Measures library: performance and evaluation measures segmented by market groups, geographic corridors, and areas or regions;
  - –Private-sector examples: case studies from the private sector, including successes and failures in using performance measures in decision making;
  - –Safety measurement: synthesis on different organizational approaches to safety performance measurement;
  - –Pay-for-performance: case studies on applying pay-for-performance or other accountability processes within a public-sector transportation agency.

Implementation

- Implement the findings of *NCHRP Report No. 446: A Guidebook for Performance-Based Transportation Planning*.
- Offer a National Highway Institute course on transportation statistics and measurement.
- Determine how to communicate performance to customers, stakeholders, and the public.
- Identify staff capacity, skill sets, and required training.
- Develop training for managers and policy makers to apply and use performance measurement systems.
- Educate performance measurement implementers and users on why and how.

Appendixes

APPENDIX A

Summaries of 20 Poster Sessions

A number of agencies participating in the conference agreed to prepare a poster session and to provide personnel to discuss and explain the contents of the posters. Participants at the conference were free to walk among the posters, pick up literature, and ask questions at several intervals during the conference. This portion of the conference proved to be quite popular with the participants. Each agency presenting a poster session was asked to summarize the contents of the poster for inclusion in the conference proceedings, thus making the information available to a larger audience. Also included are the name and address of contact people in each agency to encourage additional questions and discussions.

Summaries are provided for the following:

1. Arizona Department of Transportation
2. Washington Department of Transportation
3. Contra Costa Transportation Authority
4. Wisconsin Department of Transportation
5. California Department of Transportation
6. Sacramento Regional Transit District
7. Chittenden County Metropolitan Planning Organization, Vermont
8. Center for Urban Transportation Research, University of South Florida
9. Florida Department of Transportation
10. New York State Department of Transportation
11. Metropolitan Atlanta Rapid Transit Authority
12. Minnesota Department of Transportation
13. Orange County Transportation Authority, California
14. Metropolitan Transportation Commission, Oakland, California
15. Montana Department of Transportation
16. Oregon Department of Transportation
17. Pennsylvania Department of Transportation
18. Metropolitan Washington Council of Governments
19. Regional Transit District, Denver, Colorado
20. Texas Department of Transportation

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Poster Session Summary

Under Construction is an effort to develop a 20-year plan using performance-based measurements.

Background

Arizona is initiating an ambitious effort to develop a long-range state transportation plan. The Arizona

long-range transportation plan (AzLRTP) will chart Arizona's transportation future and guide strategic investments over a 20-year planning horizon. The state is leading this effort in cooperation with regional planning agencies to produce a multimodal plan for state-owned and state-interest transportation facilities and services.

This will be a multimodal plan, developed using state-of-the-art performance planning methods. The plan will recommend a 20-year program of transportation projects that moves Arizona toward achieving its vision defined through an extensive public and stakeholder involvement program. AzLRTP policy, program, and project recommendations will be coordinated with regional and local planning processes. Cooperation and coordination among the planning agencies and the solid endorsement of stakeholders and the public are key to this project's success.

The plan will identify Arizona's existing and future (again, 20 years) multimodal transportation needs for facilities and services identified as being of statewide significance. Two examples of facilities and services of statewide significance—yet not under the jurisdiction of the state—are local or regional roads linking state highways with major intermodal facilities or important traffic generators and light rail systems or other transit services operating within transportation corridors served by state highways. Planning for facilities and services that are predominantly regionally or locally significant will be addressed through separate regional and local efforts. Three financial scenarios will be considered in developing the recommended program of transportation projects.

The plan will be financially constrained, meaning that funding for projects listed in the plan is expected according to current transportation funding. The plan will also contain potential revenue increases (e.g., an increase in the fuel tax), wherein projected increases in revenue can be used and projects added to the plan based on the likelihood of increased funding.

Illustrative projects will be permitted. Illustrative projects have been discussed and would ideally be implemented if funding becomes available. Such capability opens the door to projects that may be funded if there is an increase in funding beyond the reasonably expected revenue increases. Listed below is what we expect to occur:

Under Construction: AzLRTP

1. Overview of process used to develop measures —a cooperatively developed state transportation plan:
   - State;
   - Transportation management areas and metropolitan planning organizations;
   - Councils of governments;
   - Consultation with
     –Local governments, and
     –Tribal governments;
   - Proactive public involvement programs;
   - Focus groups;
   - National experts;
   - Issue papers;
   - Open houses;
   - Videos; and
   - Buy-in from
     –General public,
     –Transportation industry,
     –Advocacy groups, and
     –Developers.
2. Description of measures:
   - Air quality,
   - System preservation,
   - Safety,
   - Congestion,
   - Promotion of alteration modes,
   - Mobility,
   - Accessibility,
   - Economic development, and
   - Integrated land use.
3. How measures will be used:
   - Assess needs and identify projects,
   - Assist in program trade-offs,
   - Measure performance of system, and
   - Serve as basis for allocation of funds.

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Poster Session Summary

The Washington State Department of Transportation (WSDOT) is currently examining practices, procedures, and processes associated with the development, tracking, and reporting of performance mea-

sures. Agency efforts to provide customer feedback, enhance accountability, and track system and organizational performance have resulted in the development of many levels and areas of performance measures and data-tracking activities. This has led to the proliferation of performance measures as well as fragmentation and lack of alignment of existing measures that the various organizations and programs apply. The executive board appointed a subcommittee tasked with examining possible process improvements and making recommendations to implement a more systematic approach to performance measurement within the agency.

The executive performance measurement system process improvement team is working to develop a framework for an agency performance measurement system. This framework will strive to facilitate a measurement system that links all existing measurement elements and can be used as a decision tool for organizational and system investments and operations (see Figure 1). Such effort will provide a system of performance measures for WSDOT. The subcommittee's work plan includes the consideration of development, alignment, timing, structure, communication, feedback, deployment, implementation, integration, and institutionalization of performance measures. The team is identifying components of an optimum performance measurement system by conducting an inventory and gap analysis, which will result in the design of a framework and system approach.

Concurrent with this activity, the secretary's office reviewed organizational business plans and related performance measures and found opportunities for improvement. In addition, the first round of performance measurement data that aims to track the performance of the agency's strategic plan is currently being compiled and analyzed.

WSDOT also uses other nonsystem (non-Washington transportation plan–related) benchmarks and measures of the Blue Ribbon Commission on Transportation. They include the following (see Table 1 for details):

- Efficiency and organizational benchmarks and performance measures:
  - –Administrative costs as a percentage of transportation spending at the state, county, and city levels should improve to the median in the short term and to the most efficient quartile nationally in the longer term;
  - –Washington's public transit agencies will achieve the median cost per vehicle revenue hour of peer group transit agencies;
  - –TBD4 project cost benchmark: improve operations, maintenance, and project delivery costs;
  - –TBD5 transportation revenue benchmark: ensure that transportation spending keeps pace with growth;
- Other:
  - –Local preservation element (related to Vision Outcome 2) outside of Washington transportation plan scope, and
  - –Zero percentage of local arterials in poor condition.

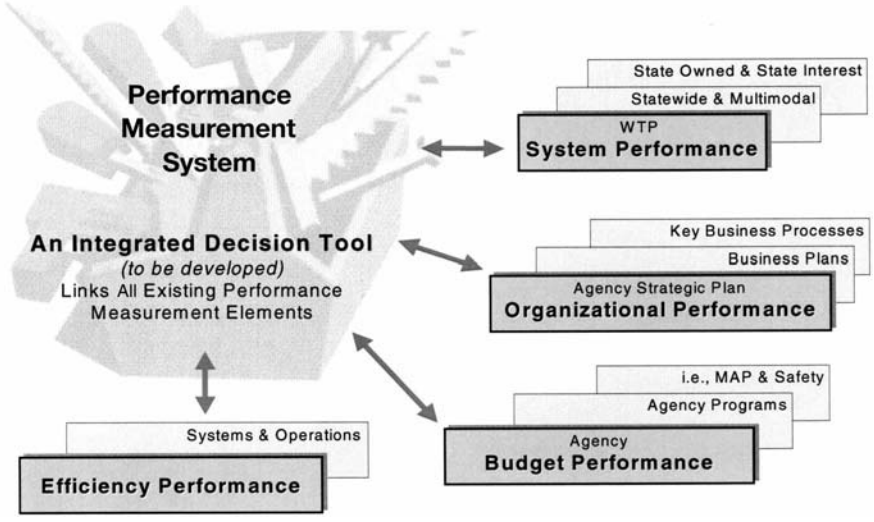

FIGURE 1 Washington State DOT performance measurement system. (WTP = Washington transportation plan.)

TABLE 1 WSDOT Outcomes, Performance Measures, and Benchmarks

Outcome No.	*Outcome*	*Performance Measure*	*Blue Ribbon Benchmarks*	*Service Objective*
1*	**Essential Mobility: System Operation and Maintenance** The transportation system operates effectively, efficiently, and predictably	Cross-modal survey of user opinions regarding the respective transportation system's level of effectiveness and reliability		**1.** Maintain the effective and predictable operations of the transportation system to meet customers' expectations **2.** Increase the efficiency of operating the existing systems and facilities **3.** Maintain vital transportation services in the event of a natural disaster
2*	**Essential Mobility: System Preservation** Transportation facilities are in sound operating condition	Owners of major transportation facilities report average condition rating of facilities	1. Zero percent of Interstate highways in poor condition 2. Zero percent of major state routes in poor condition 3. Zero percent of local arterials in poor condition (outside of WTP scope) 4. Zero percent of bridges structurally deficient 5. Complete seismic safety retrofits of all Level 1 and Level 2 bridges	**4.** Preserve transportation infrastructure to achieve the lowest life cycle cost and prevent failure
3	**Essential Mobility: Special Needs Transportation** Transportation system provides all citizens access to basic services	Transit providers and brokers report the number and nature of unmet special needs transit requests both inside and outside their area		**5.** Meet all basic transportation needs for special needs population
4*	**Enhanced Mobility: Congestion Relief** WTP corridors operate with minimal delay for people and freight and with continual reduction in the societal, environmental, and economic cost of congestion	Extent and duration of travel delay that exceeds the performance thresholds for all modes within WTP corridors (both in and outside metropolitan planning organizations)	6. Traffic congestion on urban Interstate highways will be no worse than the national mean 7. Delay per driver will be no worse than the national mean TBD6. Person delay benchmark: reduce overall hours of travel delay per person in congested corridors	**6.** Reduce person and freight delay on WTP corridors **7.** "Travel time" service objective to be developed in future updates **8.** "Reliability" service objective to be developed in future updates

NOTE: CTED = Department of Community, Trade, and Economic Developments; H&LP = highway and local programs; TBD = to be determined; WSDOT = Washington State Department of Transportation.
*Measures that are emphasis areas for data gathering.

(*continued on next page*)

TABLE 1 (*continued*) **WSDOT Outcomes, Performance Measures, and Benchmarks**

Outcome No.	*Outcome*	*Performance Measure*	*Blue Ribbon Benchmarks*	*Service Objective*
5	**Enhanced Mobility: Increased Travel Options** Throughout the state, travelers have viable alternatives to the privately owned automobile for their trips	Biennial cross-modal survey of user opinions of viable transportation options	8. Maintain vehicle miles traveled (VMT) per capita at 2000 levels 9. Increase nonauto share of work trips in urban centers or reverse the downward trend of nonauto share of work trips in urban centers	**9.** Improve existing travel options; "travel options" is defined as new options and a better quality of existing options based on market demand
6*	**Enhanced Mobility: Seamless Connections** The transportation system offers easy connections between different services throughout the state	Cross-modal survey of user opinions on ease of connections between services		**10.** Create links and remove barriers between transportation facilities and services
7*	**Improve Safety: Continuously Reduce Injury, Fatalities, and Risk** Attain a safe transportation system without deaths or disabling injuries and with continuous reductions in societal cost of accidents	TBD	TBD1. Traffic safety benchmark: traffic accidents will continue to decline	**11.** Reduce and prevent deaths and the frequency and severity of disabling injuries and societal costs of accidents (focus on the rate of frequency and severity)
8	**Improve Safety: Increased Security** Customers are safe and secure while using the transportation system	Cross-modal survey of user opinions of safety and security		**12.** Improve transportation facilities with state-of-the-art safety and security features **13.** Improve security of all transportation facilities
9	**Livable Communities: Effective Community-Based Design** Integrated community design, land use, and transportation investments improve quality of life	Report on the level of integration among land use, design, and transportation investments		**14.** (a) Reduce impact on communities and their resources with the development and implementation of transportation projects (b) Increase integration of state and local interests in the development and implementation of transportation services and facilities (c) Balance state and local needs in the development and implementation of multimodal transportation projects

(*continued on next page*)

TABLE 1 (*continued*) **WSDOT Outcomes, Performance Measures, and Benchmarks**

Outcome No.	*Outcome*	*Performance Measure*	*Blue Ribbon Benchmarks*	*Service Objective*
10	**Livable Communities: Collaborative Decision Making** Collaboration occurs between federal, tribal, state, regional, local, and private-sector partners	Survey of federal, tribal, state, regional, local, and private-sector decision makers relative to their process of decision-making efforts		**15.** Increase early and continuing involvement of community stakeholders, partners, and WSDOT in actions that affect transportation systems
11*	**Effective Competitive Freight Movement** Freight movement is reliable,* and transportation investments support Washington's strategic trade advantage* (see congestion relief)	Number and duration of pass closures (T1); number and duration of flooding closures (T1 & T2); number and duration of freeze and thaw closures (T1–T4); rail closures exceeding 4 h on strategic freight lines; number and duration of unscheduled grain barge	TBD2. Freight mobility benchmark: freight movement and growth in trade-related freight movement should be accommodated on the transportation system	**16.** Reduce barriers that delay effective and reliable movement of freight **17.** Maintain ability to move freight and goods in event of alterations to the Columbia–Snake River system as transportation right-of-way
12*	**Support General Economic Prosperity** Transportation supports general economic prosperity	Personal income growth		**18.** Support statewide economic development through targeted transportation investments **19.** Support economic development in distressed areas through targeted transportation investments
13	**Support for Tourism** Recreational travelers have convenient and inviting access to tourist destinations	CTED Tourism Division will include in annual survey questions by H&LP to assess customer satisfaction with travel-related experiences in Washington		**20.** Increase traveler information on tourist destinations **21.** Improve the quality of tourists' related travel experiences in Washington State
14	**Maintain Air Quality** Transportation services and facilities help maintain air quality by meeting air quality health standards	Biennially, WSDOT's Environmental Affairs Office reports the number of days Washington State was in violation of national ambient air quality standards in air quality regions of the state	TBD3. Air quality benchmark: maintain air quality (carbon monoxide and ozone) at federally required levels	**22.** Reduce impact of transportation facilities and services on air quality in conformance with statewide implementation plan for air quality

NOTE: CTED = Department of Community, Trade, and Economic Developments; TBD = to be determined; WSDOT = Washington State Department of Transportation.
*Measures that are emphasis areas for data gathering.

(*continued on next page*)

TABLE 1 (*continued*) **WSDOT Outcomes, Performance Measures, and Benchmarks**

Outcome No.	*Outcome*	*Performance Measure*	*Blue Ribbon Benchmarks*	*Service Objective*
15	**Meet Water Quality Standards** Transportation services and facilities help maintain water quality by meeting water quality standards	Biennially, WSDOT's Environmental Affairs Office reports the percentage of engineered stormwater treatment facilities or best management practices operating at current intended standards		**23.** Reduce water quality impacts caused by transportation facilities and services to comply with federal and state water quality requirements
16	**Maintain Habitat and Watershed Quality and Connectivity** Transportation services and facilities help to maintain the quality of and contribute to the recovery of ecological functions of watersheds and habitats	WSDOT's Environmental Affairs Office documents and reports on environmental impacts and benefits of transportation projects to habitat and watershed quality and connectivity		**24.** Reduce impacts of past projects and avoid or minimize impacts to watershed and habitat from current and future transportation activities
17	**Reuse and Recycle Resource Materials** Transportation services and facilities prudently use, reuse, and recycle resource materials	Biennially, WSDOT's Field Operations and Support Service Center reports to the Washington State Transportation Commission on ratio of total highway surfacing materials (in tons) used in WSDOT projects to total (in tons) of this recycled material		**25.** Minimize use of resources and increase use of recycled materials

Contra Costa Transportation Authority

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Poster Session Summary

Use of Performance Measures in Contra Costa's Measure C Growth Management Program

Contra Costa Transportation Authority's Measure C Growth Management Program, called for in the measure approved by voters in 1988, requires three performance measures:

- Traffic service objectives (TSOs) for routes of regional significance;
- Level-of-service (LOS) standards for all other nonregional roadways; and

• Performance standards for police, fire, and park services; sanitary facilities; and water and flood control.

Table 2 outlines how these standards are applied.

Flexible Versus Fixed Standards

Measure C sets fixed standards only for local, nonregional routes. These standards, which are tied to adjoining land uses, are listed below

• Rural LOS low C [V/C (volume-to-capacity) ratio of 70–74];
• Semirural LOS high C (V/C ratio of 75–79);
• Suburban LOS low D (V/C ratio of 80–84);
• Urban LOS high D (V/C ratio of 85–89); and
• Central business district LOS low E (V/C ratio of 90–94).

Through their general plans, local jurisdictions decide which of these standards to apply to which roads. The performance standards for public facilities are set by each local jurisdiction as part of their general plan. The only criterion is that they be measurable.

The TSOs for regional routes reflect the intent of the regional committees that set them. Although each

TABLE 2 Contra Costa Performance Measures in the Measure C Growth Management Program

Measures	*Routes of Regional Significance*	*Nonregional Routes*	*Other Public Facilities*
Definition	Routes connect regions of the county or the county to other regions	Any local roadway is not designated as route of regional significance	Fire, police, parks, sanitary facilities, water and flood control
Standard	TSOs, established by regional committees, are quantitative measures of effectiveness, such as vehicle occupancy or hours of congestion	Traditional level-of-service standard is tied to adjoining land uses	Set by local jurisdictions
Included in	Action plans for routes of regional significance are prepared jointly by jurisdictions within the subareas of Contra Costa	Growth management element of local general plan	Growth management element of local general plan
Used in	Review general plan amendments (ensure that amendments would not hinder achievement of TSOs)	Local jurisdiction review of developments	Local jurisdiction review of developments
Monitoring	Authority monitors as part of periodic update of countywide comprehensive transportation plan	Local jurisdiction monitors as part of biennial compliance reporting	None
Compliance Review	Regional committee review of general plan amendments	Authority reviews through annual compliance checklist	None
Consequences of Noncompliance	Loss of jurisdiction's share of local streets and roadways funds generated by Measure C	Loss of jurisdiction's share of local streets and roadways funds generated by Measure C	Loss of jurisdiction's share of local streets and roadways funds generated by Measure C

TSO = traffic service objective.

TSO must be measurable, it is not tied to any specific measure of effectiveness. Regional committees have used LOS, delay index, transit ridership, and average vehicle occupancy as TSOs to answer the following questions: should performance measures be consistent throughout the county? Or is it more important that the standards fit the unique circumstances of each area?

Setting Standards

Local jurisdictions define and are responsible for standards for public facilities; they choose which LOS to apply to local, nonregional routes. Regional committees, made up of local jurisdictions within each part of Contra Costa, define the TSOs; the theory is that regional routes should not be the responsibility of a single jurisdiction. Should regional committees set local facility standards? Should the authority set TSOs?

Standards as Only Lowest Common Denominator

Failure by local jurisdictions to meet adopted standards—whether TSO, LOS, or facility standards—could result in their loss of some Measure C funds. This potential loss may encourage local jurisdictions to choose only standards that are easily achieved but that do not reflect their local goals. Should the authority set minimum standards for public facilities?

Upstream Projects and Downstream Impacts

The growth management program assumes that local jurisdictions should be responsible for local streets but not regional routes. Traffic from other jurisdictions, however, does not use only regional routes. Should a local jurisdiction be responsible for traffic impacts on their streets that result from development in another jurisdiction?

Wisconsin Department of Transportation

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Poster Session Summary

Planning and Programming Goal for Highway Performance

In the mid-1990s, Wisconsin Department of Transportation (DOT) set out to create a unified, data-driven process for the management of the state trunk highway system (roads the state maintains including Interstates, U.S. highways, and state routes). Initially concentrating on traditional planning and programming issues, the process was designed to support the following functions:

- Development of policies and financially constrained, performance-oriented, long-range system plans;
- Development of performance goals and priorities for the highway improvement program, which is consistent with those of the long-range system plan;
- Development of projects for inclusion in the 6-year highway improvement program;
- Development and justification of biennial budget requests; and
- Monitoring of the performance achieved by the improvement program.

Work is currently under way relating to highway maintenance operations and may be incorporated into the process in the future.

Process

The fundamental concept of the process is to integrate data and information from the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) management systems into what is referred to as the "meta-management system." Data integration is accomplished with the geographic information system (GIS). In the early stages of the effort, a great deal of time was spent to ensure consistent linear referencing among many departmental databases, including the following:

- Highway inventory,
- Traffic counts and forecasts,
- Pavement management,

- Bridge management,
- Congestion management,
- Safety management, and
- 6-year highway improvement program.

Using current condition assessments, geometric characteristics, and traffic counts, future conditions on the state trunk highway system are forecast and compared with thresholds of acceptable performance. When physical or functional conditions become unacceptable, a range of improvements addressing the range of needs is identified using information from the individual management systems.

With the development of the long-range state highway plan, the costs of the alternative improvements are identified, priorities are set, financial constraints are applied, and resulting system performance is estimated. Differing priorities and financial constraints are tested, leading to a long-range plan having both reasonable financial requirements and reasonable highway system performance. Priorities are also set to guide decision making in the event of funding shortfalls.

Information on the needs addressed in the long-range highway plan is used to help guide the allocation of highway resources to the various programs managed by the department. Data on highway system needs, alternative improvements, and priorities are made available for highway district use as those in the district identify, scope, and prioritize actual projects to include in the 6-year highway improvement program. Data are also used by central office staff assigned to develop the program and who focus on the significant capacity improvements needed in the state.

When the 6-year improvement program is identified, the projects in the program are used to update predicted system conditions in the year in which each project is scheduled. In this way the department can compare current highway system performance with forecast performance both with and without the 6-year program. The performance achieved is compared with the long-range system plan to identify gaps. Significant short-run gaps and knowledge of the projects needed to close them provide information and justification for use in the development of biennial budget proposals.

Results

To date, the use of this process has brought the following results:

- A long-range state highway plan calling for $20.4 billion in expenditures over 20 years; a 33 percent increase over current funding levels. If implemented, the plan would result in significant improvements in statewide pavement and bridge conditions as well as a large reduction in miles of congested highway. Some congestion needs were not addressed due to the significant costs involved.
- A $30 million per year biennial budget increase to address statewide pavement needs.
- A $31 million reallocation of highway improvement funding among districts. The funding allocation is reassessed every 2 years.
- Preparation of environmental studies on 11 of the top 20 highway-congestion needs on the state trunk highway system, before seeking budget authority for their construction.
- A GIS database used by the districts to identify improvement needs and support project scoping.
- Data for prioritizing projects recommended for the Interstate highway system. Project requests exceed available funding by more than 20 percent.
- A 6-year improvement program that updates statewide pavement and bridge conditions while allowing for a small increase in miles of congestion. Funding for the program has not increased to the levels called for by the long-range plan, and the program's relatively higher emphasis on pavement and bridge conditions is consistent with the priorities in the long-range plan.

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Poster Session Summary

The following are the Caltrans performance measure initiatives:

- Project goals:
  –To develop indicators and measures to assess the performance of California's multimodal transportation system for supporting informed transportation decisions by transportation offi-

cials, operators, service providers, and system users; and
–To establish a coordinated and cooperative process for consistent performance measurement in California.
- Project phases in design:
–Initial testing and refinement of candidate indicators; and
–Incremental implementation.
- Key conclusions:
–Performance measurement is an effective tool and must be integrated into the planning and programming processes; and
–Performance measurement requires data integration to provide the "right data" for analysis and benchmark setting.

Sacramento Regional Transit District

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Poster Session Summary

Purpose

The purpose of this paper is to provide a narrative description of a poster session display (see Table 3) showing the performance indicators used by the Sacramento Regional Transit District (RT).

Background on Sacramento RT

Sacramento RT provides public transportation services to a population of about 1.2 million people in a 418-mi^2 service district including most of urbanized Sacramento County. The service includes 69 bus routes and 20.6 mi of light rail for a total of 214 buses, 36 light rail vehicles, and 100 paratransit vehicles. This fleet serves a total of 26 million passenger trips each year.

RT has one operating facility for each of the three modes (bus, rail, and paratransit). The paratransit mode is operated by a nonprofit agency under contract with RT. Although RT is (unofficially) classified as a medium-sized transit agency, it has almost all of the functional responsibilities of a large transit agency. This means that the data-collection and performance-monitoring requirements are also similar to those of a large transit agency.

Development of Performance Indicators

As with most public transit agencies, the development of performance indicators is an ongoing, evolving process. The indicators used by management change as the need for new indicators emerges and the need for some existing indicators wanes. There are several factors that determine what performance indicators are used in the reports to management:

1. Need to measure the performance of various functions that the district is responsible for. These functions may be external (e.g., providing safe, reliable, and efficient transit service) or internal (e.g., maintaining vehicles, managing labor resources). As new functions are added, performance indicators may be added as well. Likewise, as functions are deleted, performance indicators may be deleted. However, the latter occurs much less frequently than does the addition of functions.
2. Cost and availability of data. These two are a major determinant in deciding what performance indicators to use.
3. Continuity of reporting information. Most performance indicators are used on a trend basis. That is, the performance in the current reporting period is compared with performance in past periods to determine whether the agency is doing better or worse over time. Adopting a new performance indicator means starting over with the establishment of a new base of relevancy for that indicator. This charting of unfamiliar waters is an activity not to be taken lightly by senior management.
4. Need to report mandated performance indicators. Such indicators would include those required by FTA (National Transit Database) and the State of California (Transportation Development Act).

Except for the few standards that are mandated by the Transportation Development Act, RT management does not set standards (i.e., explicit numeric thresholds that delineate good or bad) for performance indicators. Rather, most performance indicators are evaluated as trends that depict improving or deteriorating performance. Some performance indicators relating to ridership and ridership productivity are evaluated on a route-by-route basis. Those routes

TABLE 3 Performance Measures to Improve Transportation Systems and Agency Operations: Sacramento Regional Transit District

Functional Area	*Transit Services*	*Ridership and Customer Services*	*Fare Collection*	*Vehicle Maintenance*
Performance Indicators	Cost per Vehicle Mile/Hour, Miles Between Road Calls	Passengers per Vehicle per Hour, Cost per Passenger Complaints and Commendations per 1,000 Passengers	Fare Receipts Versus Budget, Fare Recovery Ratio, Operating Subsidy per Passenger Trip, Average Fare per Passenger Trip	Miles Between Road Calls/Incidents, Miles per Unit of Fuel and Power, Maintenance Cost per Mile, Vehicles out of Service
Data Collected	Vehicle Miles, Vehicle Hours, Pullouts, Platform Hours, Accidents, Road Calls, Cost Allocation, GIS Data	Boarding Passengers, Vehicle mph, Customer Complaints and Commendations	Fare Revenues (Prepaid and "at the Farebox"), Number (%) of Riders by Fare Category (Special Fare Survey)	Road Calls or Incidents, Vehicle Miles, Labor and Material Costs, Fuel and Power Consumption Inspection/Service
Reports	Monthly Operating Statistics (Bus, Rail, and Paratransit)	Monthly Ridership Report, Call Center Report, Complaints, Commendations, Service Request Report	Revenue Summary, Cash Receipts (Bus and Rail), Prepaid Fare Sales, Fare Survey Results	Maintenance Status Report
Frequency and Level of Detail	Monthly by Mode, Geographic Area, and Political Jurisdiction	Monthly by Route (Passengers), Monthly (Customer Requests)	Monthly (Revenue Reports), Annually (Fare Survey)	Monthly by Mode
Applications	Allocation of Service Resources Schedule Adjustments	Allocation of Service Resources, Training for Operators on Courtesy, Assisting Riders	Fare Pricing and Discounts, Group Fare Programs, Special Fares	Fleet Procurement, Maintenance Procedures, Training Requirements, Manpower Needs
Future Developments	On-Time Performance System Using AVL Technology and Schedule and Runcut Analysis	Web-Based Trip Planning, Customer Satisfaction Survey, Load/Capacity Profiles	SMART Card Fare System, Credit/Debit Sales, Zone Fare System, Group Pass Fare Programs	Labor and Materials, Use by Vehicle

AVL = automatic vehicle locator; GIS = geographic information system; ERP = enterprise resources planning; DBE = disadvantaged business enterprise.

that fall in the lower percentile are identified for corrective action or possible elimination.

RT management adopted about 100 performance indicators to report on a regular basis. At first glance, this number seems large, but note that it includes some of the same performance indicators by mode (bus, rail, and paratransit) and by labor category. Consequently, the number of unique performance indicators is only about 25.

RT Performance Indicators

Table 3 is a replica of the poster displayed at the conference in Irvine. Across the top, it lists eight functional areas. This list is not comprehensive, but it does cover the main functional areas for which the district is responsible. Within each functional area, the following information is presented:

Human Resources and Labor Utilization	*Finance*	*Capital Programs and Major Projects*	*Retirement Plan*	*Comprehensive*
Employee Assistance, Program (EAP) Use, Employees Trained, Percentage of Absences, Operator Time by Category	Operating Expenses: Actual Versus Budget by Line Item, Capital Expenses by Project, by Grant, by General Ledger No.; Revenues: Actual Versus Budget	% Complete Versus % Schedule, % Spent Versus % Budgeted, DBE Participation, Major Variances and Exceptions, Grant Revenue Status	Investment Returns (%) Relative to Indexes, Investment Risk Relative to Indexes	Over 100 Indicators
Number of Employees Assisted, Absences by Employee Category, Training by Employee Category, Operator Time by Category	Actual Expenses by Line Item, Actual Revenues by Line Item, Cost Allocations by Mode	Cost by Task, Work Performed by Task, DBE Contract Costs, Grant Approval Process	Investment Returns ($), Net of Fees by Asset Class	Various Cost, Revenue, Activity, and Service Data Across Agency
EAP Use Report, Absenteeism Report, Training Report, Operator Timekeeping Report	Budget Expense Report, Budget Revenue Report, Audited Financial Statement, State Comptroller's Report	Project Schedule Updates, Progress Reports, Cost Reports	Investment Returns and Risk by Asset Class, Actuary Report on Required Contributions	Performance Report (to Board of Directors)
Quarterly (EAP), Monthly (Absenteeism, Recruitment), Quarterly (Training)	Monthly (Budget Reports); Annually (Cost Allocation, Financial Statement, State Comptroller)	Monthly (Major Projects), Quarterly (All Projects)	Quarterly	Quarterly
Budget for EAP, Absence Control Program, Training Program/Resources, Work Assignment Process	Budget Adjustments, Budget Preparation, Cost Control Measures	Decisions on Work, Programming and Scheduling, Allocation of Resources	Decisions on Selection and Retention of Investment Managers	Service Planning, Strategic Planning, Budgeting
Extra Board Cost-Effectiveness Analysis, Track Costs of Special Services	Relationship Database (ERP) Applications with Better Cost Reports	Better Cross-References Among Projects, Grants, and General Ledger Accounts; Monitor Cost of Change Orders	Report on Retirement Benefits by Individual (Available On-Line)	Database "Roll-Up" of Performance Report Information Through Local Area Networks

Performance Indicators This row lists the main performance indicators that pertain to each respective functional area.

Data Collected This row presents the data collected to support that set of performance indicators.

Reports This row lists the reports that present the indicators to management. These indicators are usually presented on a trend basis (i.e., comparing the value of the indicator in the current reporting period with those of previous periods). However, ridership and productivity performance indicators are also presented in a cross-sectional format, whereas bus routes are ranked by their efficiency and effectiveness.

Frequency and Level of Detail The next row lists the frequency and level of detail, whereby the per-

formance indicators are reported. Most indicators are reported quarterly, but some (ridership) are reported monthly.

Applications This row lists the applications for the performance indicators under each functional area. The most extensive of these is the allocation of service resources. Figure 2 shows the processes for allocating new service and reallocating existing service resources. Performance indicators play a major role in deciding to increase, decrease, or modify transit service. In the other functional areas, performance indicators provide information for decisions on training, manpower, fare policy, budgets, capital procurements of equipment and facilities, and investment strategy.

Future Developments This last row lists RT projects and programs that will develop performance-monitoring systems in the future. For example, RT currently has no means of comprehensively measuring and evaluating the reliability of transit service. The installation of automatic vehicle locator technology on the transit vehicles will provide data on the vehicle locations at major time points. These data can then be compared with the scheduled times and locations to determine the amount by which the vehicles are early or late. Another future innovation is that of Smart Cards for fare payment. This device will provide convenience to the passengers and allow the district to better record passenger movements and fare payments through the system.

Summary and Conclusions

Probably the best overall summary of the extent of performance indicators used at RT can be found in the quarterly performance report. This report provides a summary comparison of most of the key performance indicators. Information is presented graphically and in tables. The report begins with a discussion of those indicators that are showing significant variations or trends. To the extent possible, this narrative provides the reasons why the variations occurred. The next section of the report provides a summary of ridership trends by (fixed-route) mode. The third section provides comparison of differences (absolute and percentage) in financial performance indicators for the fixed-route systems. The next section compares operational performance indicators. The final section presents key statistics and indicators for the paratransit system. A glossary is included to define the various terms and acronyms used in the report. This report is presented by RT staff to the board of directors on a quarterly basis. Board members receive the report several days before the meeting to have ample time to read it and prepare questions. The discussion that ensues at the board meeting can precipitate decisions on policy, programs, or priorities that the board deems necessary to improve performance of one indicator or more.

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Poster Session Summary

Using Performance Measures to Assess Progress Relative to Long-Range Goals

In Chittenden County, Vermont, as in many small metropolitan areas, measuring the outcomes of long-range planning had been a missing link in the transportation planning and implementation process. To close the feedback loop between the current plan, implementation, and the next plan update, the Chittenden County Metropolitan Planning Organization (CCMPO) prepared a report entitled Regional Indicators: Measuring Our Progress Toward Chittenden County's 20-Year Transportation Goals. The report uses quantifiable and qualitative performance measures and documented planning, engineering, and project implementation actions to assess progress relative to the goals of the current long-range plan. Systemwide performance measures were developed from a variety of sources, including the CCMPO regional transportation model, regional and statewide vehicle

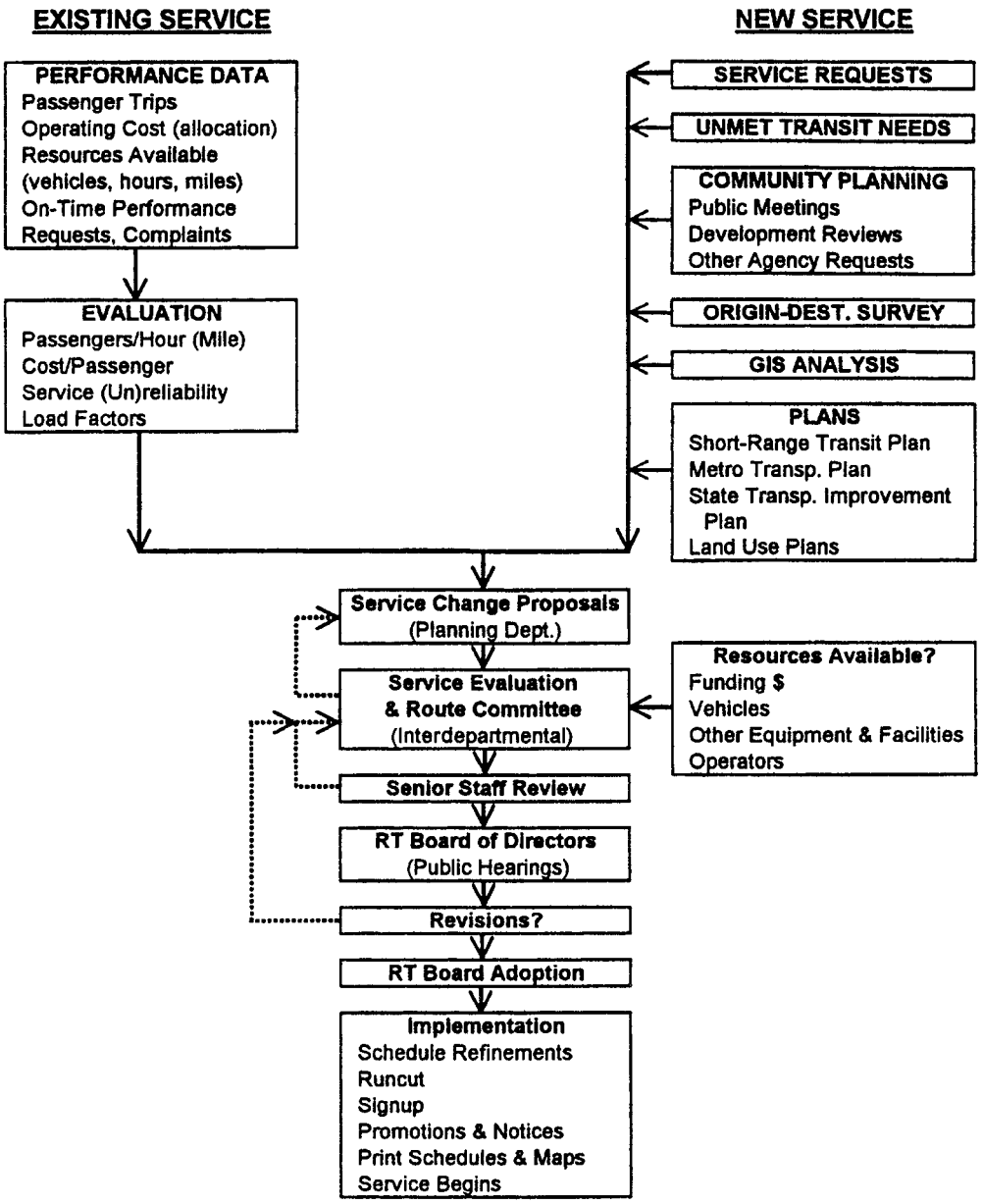

FIGURE 2 Sacramento Regional Transit (RT) District service planning and allocation process. (Dest. = destination; GIS = geographic information system; Transp. = transportation.)

counting programs, Vermont Agency of Transportation management systems, municipal grand lists, commercial and public employment databases, and transportation improvement programs.

The current long-range plan contains four general goals supported by 19 subgoals. For each subgoal, the outputs of the performance measures and actions were synthesized into an overall outcome indicator of positive, negative, or mixed. The outcome indicators for the subgoals were then used to assess the performance of the four general goals. To offset the subjectivity of the methodology, broad-based committees were invited to comment on drafts before releasing their document to the public

This analysis provided the first objective assessment of performance in the county. Critical trends in infrastructure management, land use development, mobility, and development of alternative travel choices were effectively documented using performance measures. The deficiencies and successes identified in the regional indicator report will feed directly into the issues and opportunities to be addressed in the 2025 Metropolitan Transportation Plan.

Regional Indicators Report: First-Time Evaluation As an initial step in developing a new long-range transportation plan, CCMPO produced its Regional Indicators Report. The report evaluates progress toward the goals contained in the current long-range transportation plan (LRTP) by assessing performance measures; it marks the first time that CCMPO performed an evaluation of any of its long-range plans. The LRTP, titled A Twenty-Year Vision for Transportation in Chittenden County, sets forth a regional vision founded on the following activities: preserving the existing transportation system; using the existing system more efficiently; increasing use of walking, biking, and transit; closely linking transportation with land use; and completing key highway system facilities. The LRTP has a base year of 1993 and presents a blueprint for future transportation facilities and related community development under the umbrella of four regional goals.

Long-Range Transportation Plan Regional Goals

- Project selection and participation,
- Smarter mobility,
- Making the land use–transportation connection, and
- Being an agent of change.

These broad regional goals are further supported by 19 subgoals. Each subgoal was evaluated using the format exemplified in Figure 3. Under the "Progress" heading are a combination of quantifiable performance measures, based on data available sometime before the LRTP's 1993 base year and 2000; and examples of relevant decisions, planning work, engineering work, and projects or services delivered. The "Assessment" column justifies a progress indicator with a discussion of whether the measurements and actions listed, when considered together, generally support the intent of the subgoal. The progress "Indicator" is a qualitative assessment if the trend has been positive (+), negative (−), or mixed (+/−). "Recommendations" for improving or maintaining progress toward the subgoal are also presented.

The progress indicators for all 19 subgoals were presented in the summary report card, shown in the section that follows. The indicators were aggregated further to provide an overall progress indicator for each of the four broad planning goals. This final synthesis allowed CCMPO to identify which goals were being satisfied and which goals required more emphasis. It also provided critical feedback to the opportunities and issues that will be addressed in CCMPO's 2025 metropolitan transportation plan.

Summary Report Card

Goal 1: Project Selection and Participation Ensure our limited financial resources are used in the most cost-effective manner. (key: +, positive trend/progress; −, negative trend/progress; +/−, mixed trend/progress).

- Ensure a high level of local, state, and citizen cooperation (+);
- Ensure balanced financing among modes (+);
- Promote public involvement (+);
- Minimize cost of transporting people and goods (+); and
- Use financial resources for the maintenance and modernization of the existing system and include alternative modes (+).

Goal 2: Smarter Mobility Ensure the mobility of people and goods by implementing systematic maintenance programs, and transit capacity improvements. Congestion management programs designed exclusively to increase highway capacity for single-occupancy vehicles should be undertaken only when no better alternative can be found.

- Relieve congestion, manage access, and preserve functional integrity (−);

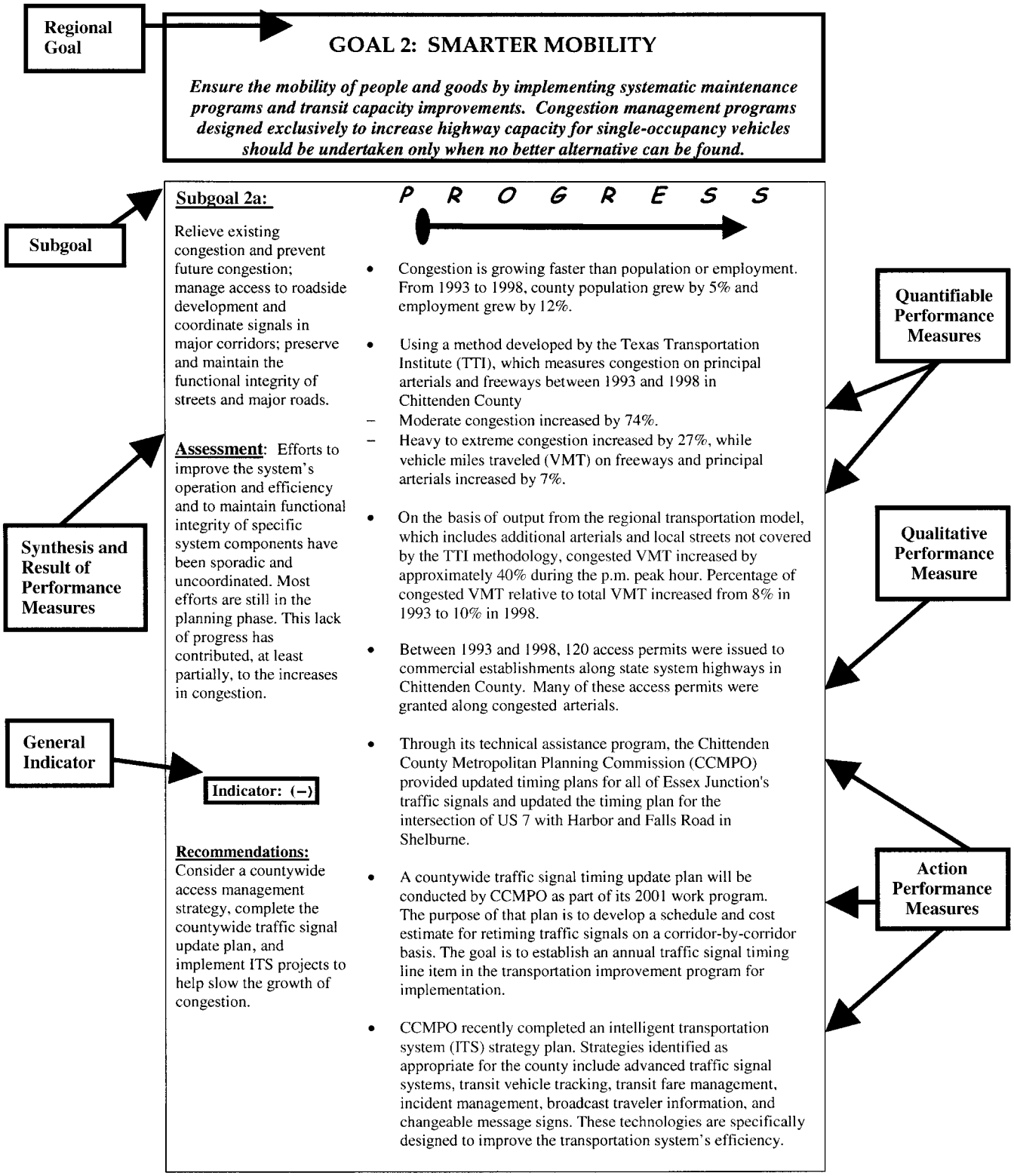

FIGURE 3 Goal evaluation table: Chittenden County MPO, Vermont.

- Maintain existing facilities and meet demand by using the existing system more efficiently (+/−);
- Ensure safety and security of transportation system users (−);
- Use management systems to improve mobility (+/−); and
- Analyze multimodal needs on corridor and subarea basis (+).

Goal 3: Make the Land Use–Transportation Connection Use an investment in the transportation infrastructure to improve the economic and environmental sustainability of the region by supporting existing and planned growth centers.

- Create a balanced, integrated, safe, accessible, and energy-efficient system (+/−);
- Support growth centers and recreational sites and provide intermodal connections (+/−);
- Support economic vitality and foster private-sector participation in funding (+/−); and
- Integrate public transportation and land use (−).

Goal 4: Be a Change Agent Decrease automobile and truck dependency by offering sustainable transportation alternatives.

- Establish regional, multipurpose, nonmotorized path system (+/−),
- Integrate transportation facilities with community fabric (+),
- Promote higher use of rail corridors (+),
- Make transportation accessible to elderly and disabled people (+), and
- Use an enhancement program to improve the natural and built environments (+/−).

Major Points

- Goals should be designed with performance measures in mind. Progress was often difficult to measure because the goals contained in Chittenden County's 1997 LRTP were too broad and contained too many elements.
- Numbers alone do not tell the whole story. Quantifiable performance measures need to be considered along with planning, engineering, and implementation actions before a complete assessment of progress can be made.
- Assessing outcomes and results requires synthesizing and interpreting the outputs from many performance measures and actions. The assessment portion of each goal evaluation was a critical element in making sense of all the information.
- Performance results must be easy to understand. Systemwide performance measures are not understandable to everyone. Using positive, negative, or mixed assessment summaries was a valuable way to summarize the analysis and make it user friendly for the public and decision makers.
- Findings should be reviewed by broad-based committees before public release. The interpretation and synthesis required to reach conclusions are often subjective. Inviting and incorporating comments from people with different perspectives improves the quality of the analysis and creates credible results.
- Planning for performance measures is necessary to fill in data gaps. Developing performance measures from scratch requires mixing and matching data from different time periods, geographic areas, and sources. This cold start approach has helped CCMPO identify deficiencies in data collection that can be addressed in future work programs.
- Measuring performance is critical to developing a credible long-range plan. The outcome of the regional indicators report closes the plan-implement-measure feedback loop between the current long-range plan and the next update. The results will flow directly into the next LRTP update. Furthermore, through measurement of performance, the relevance and significance of an LRTP is acknowledged.

Conclusion

Developing performance measures for the first time presented many challenges. The goals of the current LRTP were not defined in a manner that facilitated measuring. The data available covered different time periods, and the methodology used to develop some data changed during the period analyzed, making comparisons questionable. It was difficult to resist the temptation to use inputs and outputs rather than outcomes.

Such challenges were mostly overcome. Combining quantifiable performance measures with the planning, engineering, and implementation actions provided a robust and objective approach to assessing progress. Moreover, inviting review by a committee with representatives from all perspectives added quality control and credibility.

Most important is the outcome of the analysis itself. With the identification of critical trends in infrastructure management, land use development, mobility, and development of nonauto travel choices, the county has a sense of whether it is on a course toward realizing the vision statement and goals articulated in the current LRTP. When such feedback is provided, adjustments can be made in the next LRTP

update, effectively closing the loop between planning and implementation.

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Poster Session Summary

Performance Evaluation of Florida's Public Transit Systems

The performance evaluation of Florida's fixed-route and demand-response transit systems is tracked on an annual basis using data from federally required National Transit Database (NTD) reports. The primary objective is to assist the Florida Department of Transportation (FDOT) in applying a performance evaluation system, which was developed by the Center for Urban Transportation Research (CUTR) and FDOT, to meet Florida's statutory requirements: S. 341.041: "Develop, publish, and administer state measures concerning system management, performance, productivity, cost distribution, and safety of governmentally owned public transit systems." In addition to several other products, four documents were prepared as part of the performance evaluation project. The reports from the most recently completed study are as follows: Part I, Fixed-Route Trend Analysis, 1984–1998; Part II, Fixed-Route Peer Review Analysis, 1998; Part III, Demand-Response Trend Analysis, 1984–1998; and Part IV, Demand-Response Peer Review Analysis, 1998. The study was first completed in 1989. Currently, CUTR is conducting its 12th annual performance evaluation study.

Background

Rapid growth in Florida has resulted in greater attention to public transit as a potential solution to ever-increasing transportation problems in the state. Along with more emphasis on public transit comes the necessity to assess the effectiveness and efficiency of transit systems. Florida legislation requires FDOT and Florida's transit systems to develop and report performance measures.

Consistent with the legislation, a series of four separately bound reports has been developed, providing an overview of the individual and collective performance of Florida's transit systems. The series examines both fixed-route and demand-response services throughout the state. Fixed-route service is a type of transportation that involves passenger revenue vehicles repeatedly following a consistent time schedule over the same route. In Florida, fixed-route modes include motorbus, heavy rail, automated guideway, and commuter rail. In comparison, demand-response transportation is characterized by the flexible routing and scheduling of vehicles for the provision of point-to-point service at the user's request with less than a 24-h prior notice. Public transit systems are required to provide this service to comply with the Americans with Disabilities Act. This service is provided for people unable because of a disability to use an existing fixed-route system.

Both types of service are investigated in the series of documents by using trend (individual performance over time) analysis and peer review (comparative performance versus similar systems) analysis techniques. The statewide fixed-route trend analysis provides a summary of the combined performance of Florida's transit systems. A variety of tabular and graphical data are included in the trend analyses, which portray the changes in several performance, effectiveness, and efficiency measures from Fiscal Year 1984 to the most recent fiscal year (currently 1999). The peer review analysis presents tabular and graphical data contrasting the performance of Florida's transit systems with one another and with similar systems from around the country for the most recent fiscal year.

Purpose of Performance Review Since performance analysis is only one means of evaluating performance and is limited to those aspects included in the analysis, considerable caution is always recommended when interpreting the results. The analysis is particularly strong in reviewing cost-effectiveness and efficiency; however, it does not report on the extent to which other objectives of the transit authority are being attained. For example, the performance evaluation will not directly measure several relevant considerations, such as passenger satisfaction with regard to levels of service, taxpayer and public attitudes toward the agency, employee morale, success in attaining minority hiring or contracting goals, quality of

planning, contributions to economic development, air quality improvements, or other goals that may be important to the agency. Moreover, several aspects of quality of service are not measured in performance reviews. These aspects include vehicle cleanliness and comfort; operator courtesy; on-time performance; quality of marketing and passenger information support; and level of satisfaction with hours of operations, frequency of service, and geographic coverage of the service.

In addition to the understanding of the limits of this analysis, use caution when interpreting the meaning of the various measures. The performance review does not necessarily provide information regarding which aspects of performance are within control of the agency and which measures are not. Factors that affect transit performance are included in Figure 4.

Performance reviews are useful and important tools in monitoring and improving transit system performance. However, it should be recognized that the results of trend and peer analyses are only a starting point for fully understanding the performance of transit systems. The issues identified as a result of the analyses provide the basis for a series of questions, which can lead to an enhanced understanding of the hows and whys of system performance.

Performance Indicators and Measures The evaluation measures used throughout the performance review are composed of three major categories: general performance indicators, effectiveness measures, and efficiency measures. General performance indicators report the data in the selected categories that are required by NTD reporting. They tend to be key indicators of overall transit system performance. Effectiveness measures typically refine the data further and indicate the extent to which various service-related goals are achieved. For example, passenger trips per capita is an indicator of the effectiveness of the agency in meeting transportation needs. Efficiency measures involve reviewing the level of resources (labor or cost) required to achieve a given level of output. It is possible to have very efficient service that is not effective or to have highly effective service that is not efficient. Similarly, the service can be both efficient and effective or inefficient and ineffective in attaining a given objective.

The substantial amount of data available through NTD reporting provides an opportunity to develop a large number of measures. Sets of general performance indicators, effectiveness measures, and efficiency measures have been selected on the belief that they provide a good representation of overall transit system performance. Other measures and categorizations may be developed with the same data. Table 4 lists the indicators and measures used for directly operated transit services and provides subcategories when appropriate. The extensive list of indicators and measures provides a voluminous amount of data, all of which are required to fully understand the performance of a transit system.

Peer Selection Process

The methodology for the selection of peer systems for the statewide peer review is relatively straightforward. Selection of peer systems is based foremost on geographic location. Specifically, peer groups are chosen from the 12 southeastern states, as shown in Figure 5.

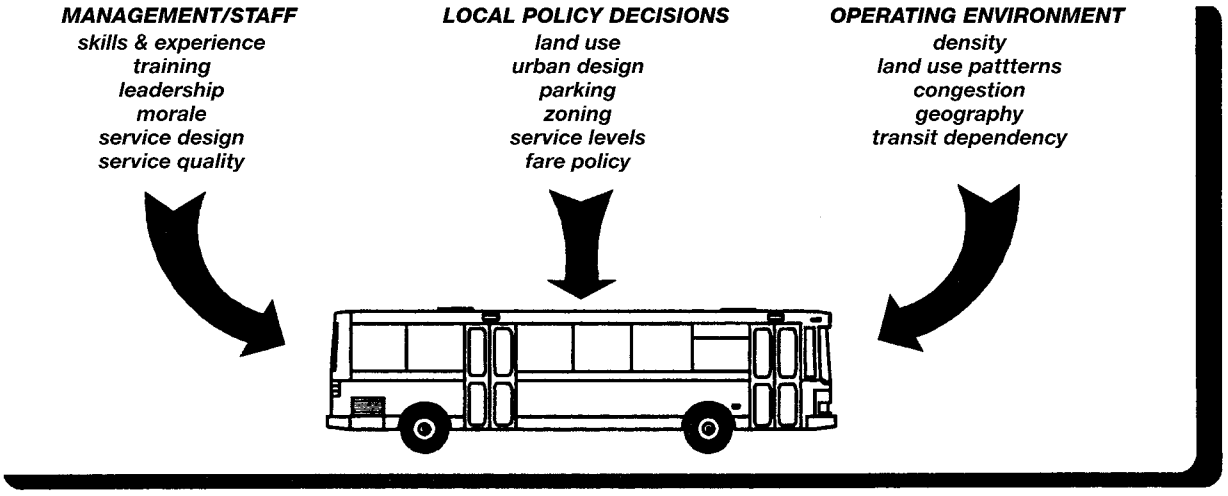

FIGURE 4 Factors affecting transit performance.

TABLE 4 Performance Review Indicators and Measures: Directly Operated Transit Services

General Performance Indicators	*Effectiveness Measures*	*Efficiency Measures*
Service Area Population	**Service Supply**	**Cost Efficiency**
Service Area Size	Vehicle Miles per Capita	Operating Expenses per Capita
		Operating Expenses per Peak Vehicle
Passenger Trips	**Service Consumption**	
Passenger Miles	Passenger Trips per Capita	Operating Expenses per Passenger Trip
	Passenger Trips per Revenue Mile	Operating Expenses per Passenger Mile
Vehicle Miles	Passenger Trips per Revenue Hour	Operating Expenses per Revenue Mile
Revenue Miles		Operating Expenses per Revenue Hour
Vehicle Hours	**Quality of Service**	Maintenance Expenses per Revenue Mile
Revenue Hours	Average Speed	Maintenance Expenses per Operating Expenses
Route Miles	Average Headway (Minutes)	
	Average Age of Fleet (Years)	**Operating Ratios**
Total Operating Expenses	Number of Incidents	Farebox Recovery
Total Operating Expenses (1984 $)	Revenue Service Interruptions	Local Revenue per Operating Expenses
Total Maintenance Expenses	Revenue Miles Between Incidents	Operating Revenue per Operating Expenses
Total Maintenance Expenses (1984 $)	Revenue Miles Between Interruptions	
Total Capital Expenses		**Vehicle Utilization**
	Availability	Vehicle Miles per Peak Vehicle
Federal Contribution	Revenue Miles per Route Mile	Vehicle Hours per Peak Vehicle
State Contribution	Weekday Span of Service (Hours)	Revenue Miles per Vehicle Mile
Total Local Revenue	Route Miles per Square Mile of Service Area	Revenue Miles per Total Vehicles
Local Contribution		Revenue Hours per Total Vehicles
Directly Generated Nonfare Revenue		
Passenger Fare Revenue		**Labor Productivity**
		Revenue Hours per Employee
Total Employees		Passenger Trips per Employee
Transportation Operating Employees		
Maintenance Employees		**Energy Use**
Administrative Employees		Vehicle Miles per Gallon
		Vehicle Miles per kW-h
Vehicles Available for Maximum Service		
Vehicles Operated in Maximum Service		**Fare**
Spare Ratio		Average Fare
Total Gallons Consumed		
Total Energy Consumed (kW-h)		

Fixed-route systems operating in these states and falling into the specified peer groups for the number of vehicles operated in maximum service (1 to 9, 10 to 49, and 50 to 200) were analyzed based on eight indicators. They consist of six operating characteristics (vehicles operated in maximum service, passenger trips, revenue miles, revenue hours, average speed, and total operating expense) and two exogenous variables (service area population and service area population density).

The performance of each of the potential non-Florida peers was compared with the average of the

FIGURE 5 Geographic area for selection of peers.

Florida systems for each of the three peer groups. A peer received one point for each measure for which it was within 1 standard deviation (SD) of the Florida systems' mean. One-half point was given for each measure that fell between 1 and 2 SDs from the Florida systems' mean.

Three of the measures (service area population density, revenue miles, and average speed) are considered primary measures of comparison. To give weight to systems that are close to Florida's averages for these three variables, ½ point was awarded to peers falling within 1 or 2 SDs of the Florida systems' means (for density, revenue miles, and speed) in each of the motorbus vehicle categories.

After the total scores were determined, the potential peers were ranked in descending order. For the 1 to 9 and 50 to 200 groups, the top six scorers were recommended as peers for Florida systems. In the 10 to 49 group, the top eight peers were selected. Note that some of the recommended peers elected not to participate in the peer review analysis or were unable to provide their NTD reports in a timely manner. In these cases, several of the next-highest scoring systems chosen in each category to serve as backup peers were used instead.

Comparison of peers using standard deviations is different from the past methodology, which selected systems based on whether they were 10 or 15 percent within the Florida averages. Note that the results of this analysis were not radically different from the results derived from the previous approach. However, the use of SDs is a widely used, statistically valid technique that proved to produce expected, commonsense results.

Unfortunately, since only one Florida system is included in the greater-than-200 motorbus group (i.e., Miami–Dade Transit Agency in Miami), it was not possible to use the SD methodology used for the other peer groups. Potential peers for Miami were scored according to whether they were within 10 or 15 percent of Miami's values for the eight indicators. In addition, due to the size of the system and number of modes (directly operated and purchased motorbus, heavy rail, and automated guideway) operated in Miami, the search for peers was not restricted to the 12 states displayed in Figure 5. For the most recent review, seven peers were chosen to comprise the greater-than-200 group.

Statewide Findings

Passenger Trips Ridership on Florida's public transit systems has increased by 45 percent since 1984. Between 1998 and 1999, ridership increased by 4.6 percent from 176 million trips to approximately 184 million trips. In addition, total ridership has increased by 22.5 percent since 1992.

Service Miles Since 1984, the amount of service provided (i.e., service miles) by Florida's fixed-route bus and rail systems has increased by 67 percent. Between 1998 and 1999, service miles increased by approximately 2 percent from 92.7 million mi to 94.8 million mi. In addition, the number of service miles has increased by 28 percent since 1992.

Operating Cost per Service Mile Operating cost per service mile has increased by 60 percent for all modes since 1984; the cost per service mile for bus service increased by nearly 55 percent. Overall, increases in operating costs per service mile were lower than the

rate of inflation (64 percent) during the period of 1984–1999.

Other Study Components

The original performance evaluation project has been enhanced over the past 12 years. Initially, CUTR only examined fixed-route data. The demand-response category was added in FY 1995. These four performance evaluation documents are currently available on CD-ROM and the Internet. In addition, the performance evaluation project includes a performance reporting investigation, NTD data-collection and -reporting training workshops, and an executive summary report. Finally, the most recent addition is a Florida transit handbook.

Florida Department of Transportation

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Poster Session Summary

Florida's Mobility Performance Measures Program

Florida's Need for Performance Measures Citizens, elected officials, policy makers, and transportation professionals in Florida are seeking new ways of measuring the performance of the transportation system to answer the following questions:

- How do we improve transportation to serve people and commerce in Florida?
- What are we getting from our investment in transportation?
- Are we investing in transportation as efficiently as possible?

Mobility performance measures are needed to answer these questions and to track performance over time. They also provide accountability and link strategic planning to resource allocation. By defining specific measures, the Florida Department of Transportation (FDOT) is able to measure the effectiveness of programs in meeting department objectives.

Principles of Florida's Mobility Performance Measures Program Florida's mobility performance measures are tied to the goals and objectives established in the Florida transportation plan. The plan emphasizes four key areas: safety, mobility, economic prosperity, and preservation.

Following a review of national research, Florida's Mobility Performance Measures Program is based on the following principles:

- Program builds on national research,
- Process is policy driven and supported by data,
- Measures reflect users' experience on system,
- Measures address multimodal considerations,
- Results are understandable to the general public, and
- Results can be forecast into the future.

Florida's Mobility Performance Measures Mobility, as FDOT defines it, is "the ease with which people and goods move throughout their community, state, and world." This definition emphasizes mobility from the user perspective. Florida's mobility performance measures describe the following dimensions of mobility:

- Quantity of travel—reflects the magnitude of the use of a facility or service;
- Quality of travel—describes travel conditions and the effects of congestion;
- Accessibility—describes the ease with which people can connect to the multimodal transportation system; and
- Utilization—indicates whether a transportation system is properly sized and has the ability to accommodate growth.

Table 5 provides a summary of FDOT's mobility performance measures for highways, and Table 6 provides a summary of mobility performance measures for transit.

Results of Mobility Performance Measures Figures 6 through 9 provide examples of the mobility performance measure results for quantity of travel, quality of travel, accessibility, and utilization, respectively.

TABLE 5 Mobility Performance Measures for Highways: Florida DOT

		Highway Systems				
Dimension of Mobility	*Mobility Performance Measures*	*State*	*Florida Intrastate*	*Florida Intrastate Corridors*	*Metro-politan*	*Definitions*[1]
Quantity of Travel	Person miles traveled	•	•	•	•	AADT * length * vehicle occupancy
	Truck miles traveled	•	•	•	•	AADT * length * % of trucks
	Vehicle miles traveled	•	•	•	•	AADT * length
	Person trips				•	Total person trips
Quality of Travel	Average speed	•	•	•		Average speed[2] weighted by PMT
	Delay	•	•	•	•	Average delay
	Average travel time			•		Distance/speed[2]
	Average trip time				•	Door-to-door trip travel time
	Reliability			•	•	% of acceptable travel times
	Maneuverability			•		Vehicles per hour per lane
Accessibility	Connectivity to inter-modal facilities	•	•	•	•	% within 5 miles (1 mile for metropolitan)
	Dwelling unit proximity		•	•	•	% within 5 miles (1 mile for metropolitan)
	Employment proximity		•	•	•	% within 5 miles (1 mile for metropolitan)
	Industrial and warehouse facility proximity		•			% within 5 miles
	% of miles bicycle accommodations	•			•	% of miles with bike lane/shoulder coverage
	% of miles pedestrian accommodations	•			•	% of miles with side-walk coverage
Utilization	% of system heavily congested	•	•	•	•	% of miles at LOS E or F
	% of travel heavily congested	•	•	•	•	% of daily VMT at LOS E or F
	Vehicles per lane mile	•	•	•	•	AADT*length/lane-miles
	Duration of congestion	•	•	•	•	Lane-mile-hours at LOS E or F

NOTE: AADT = annual average daily traffic; PMT = person miles traveled; VMT = vehicle miles traveled; LOS = level of service; HCM = *Highway Capacity Manual*.
[1]Definitions shown are generally for daily analysis. Calculations for peak are based on prevailing conditions during the typical weekday 5:00 to 6:00 p.m. peak.
[2]Speed is based on models using the HCM or field data.

Future Directions

Florida is continuing to refine its Mobility Performance Measures Program. Future directions include the following:

- Incorporation of person-trip–based measures,
- Development of dynamic display systems for measures,
- Refinement and reporting of the reliability measure,
- Reporting of measures at the corridor level, and
- Incorporation of intelligent transportation system data and analyses.

TABLE 6 Mobility Performance Measures for Transit: Florida DOT

Dimension of Mobility	*Mobility Performance Measure*	*Definition*
Quantity of Travel	Ridership	Total passenger trips
Quality of Travel	Auto to Transit Travel Time Ratio	Door-to-door trip time
	Reliability	On-time performance
Accessibility	Coverage	Percentage of person minutes served
	Frequency	Buses per hour
	Span	Hours of service per day
Utilization	Load Factor	Percentage of seats occupied

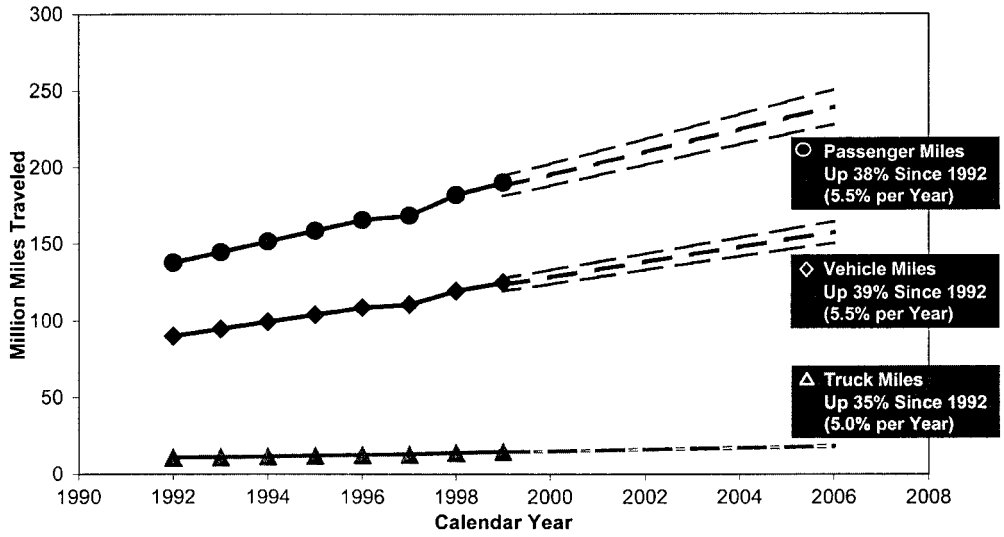

FIGURE 6 Quantity of travel: Florida DOT example. (1 mi = 1.61 km.)

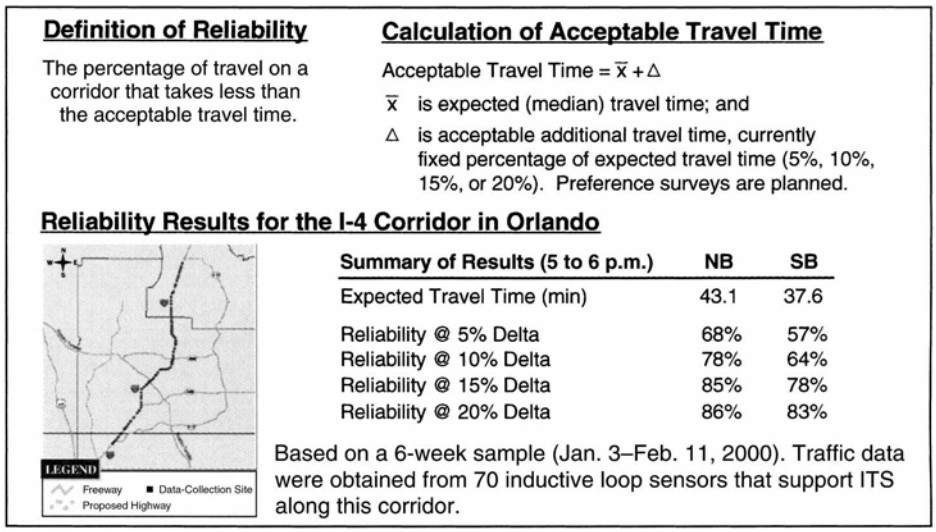

FIGURE 7 Quality of travel (reliability): Florida DOT example. (NB = northbound; SB = southbound; ITS = intelligent transportation system.)

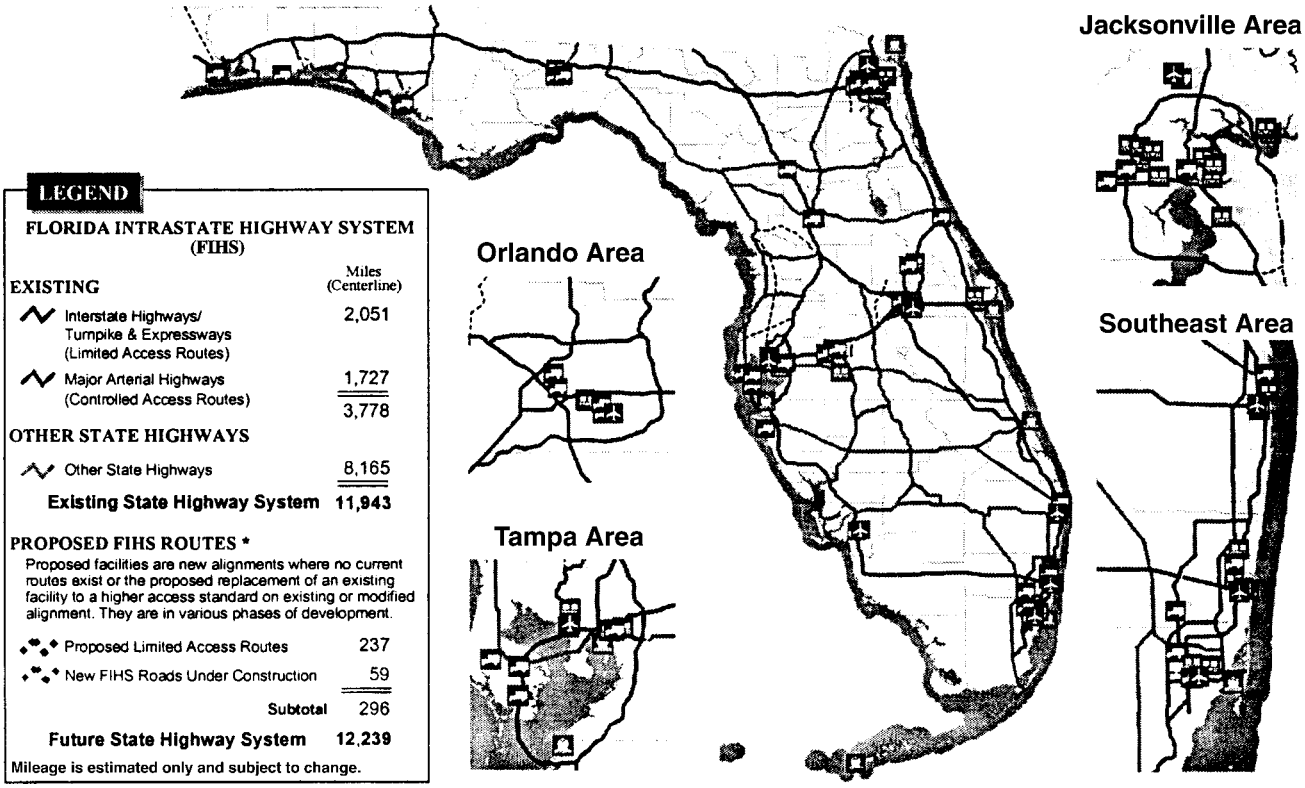

FIGURE 8 Accessibility (connectivity to intermodal facilities): Florida DOT example.

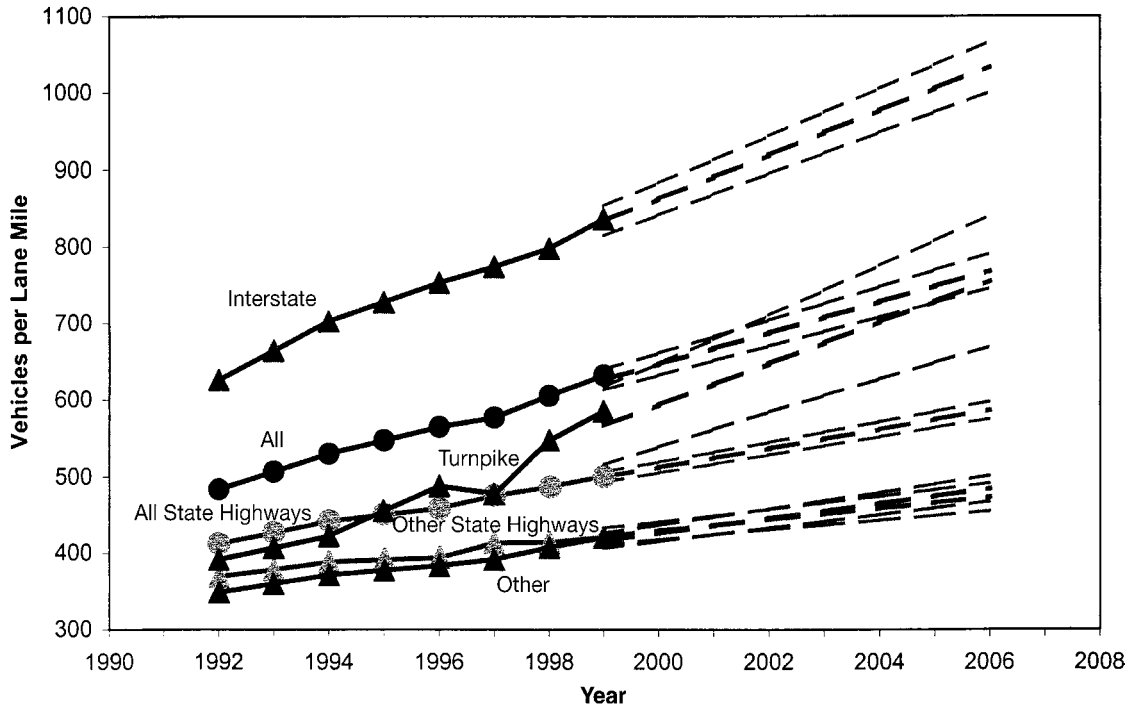

FIGURE 9 Utilization: Florida DOT example.

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Poster Session Summary

The New York State Department of Transportation's (NYSDOT's) poster presentation reflects the department's use of performance measurement as a critical decision support tool for helping it to manage a large, multiyear capital and maintenance program. The presentation highlights NYSDOT's attempt to integrate the use of this tool within a comprehensive management framework for both program development and management. This framework consists of the following key elements:

- Establishment of major program area goals (e.g., pavements, bridges, safety, and mobility), which establish the department's strategic direction;
- Formal program update process; and
- Use of performance measurements to assess effectiveness in each program area and as a basis for reassessment of strategic goals.

The poster presentation used NYSDOT's current pavement goal as one example of how the department integrates performance measurement into this programmatic framework. The pavement goal is as follows:

> Maintain a balanced program of preventive maintenance and capital projects which result in 60 percent of lane mileage in good or excellent condition. Give priority to NHS [National Highway System] and other corridors with high commercial traffic or potential for economic growth.

The department then relies on three primary performance measures to assess how individual regions and the state as a whole are accomplishing the goal. The measures are as follows:

- Percentage of lane miles with surface ratings greater than 7 (good or excellent);
- NHS average surface rating = 7.00; and
- 14-year average treatment life.

These measurements, along with computerized models, enable NYSDOT to both assess past performance and to project future performance based on specific funding levels and varying program strategies. The poster presentation provided specific graphical examples of what the department uses to achieve these objectives through performance measurements.

The presentation concluded with a statement of the keys to success in the use of performance measurements. They include the following

- Identification of clear and measurable transportation goals (strategic direction); and
- Disciplined business process for establishing goals, program development, measurement and evaluation of goal accomplishment, and reassessment of goals for the future.

The use of agreed-on performance measurement within this overall management framework provides important technical and management tools for the department's regional transportation planners and engineers with project selection responsibilities and for central office management charged with statewide programmatic responsibility and quality assurance vis-à-vis the individual regional programs. Above all, NYSDOT's approach recognizes that performance measurement is a decision support tool rather than a stand-alone mechanism for simply displaying data.

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Poster Session Summary

The Metropolitan Atlanta Rapid Transit Authority's (MARTA's) organizational performance review process is driven with a focus on our mission "to provide quality public transportation in a safe and effective manner." Performance indicators relating to our stra-

tegic and operational goals and objectives are reviewed on a regular basis.

MARTA's performance review process identifies factors that influence the attainment of our mission-quality public transportation (demonstrated by increasing trends in ridership) as safe (trends in internal and external safety-related issues), and effective (financial efficiency and relative costs for service delivery). The premise that measurable trends in such indicators will influence the results of mission accomplishment is what drives the organizational improvement process at the action plan level.

Selection of Measures

MARTA considers many factors in determining its information requirements. Some information is requested or required by external agencies, whereas other information is internal and essential for MARTA to determine its performance.

Laws and regulations mandate some of this information. MARTA was created and is governed by the Metropolitan Atlanta Rapid Transit Authority Act, a Georgia statute that imposes certain financial reporting requirements. MARTA receives funding from the federal government, which imposes other reporting requirements to ensure that MARTA meets FTA, Department of Transportation, and Environmental Protection Agency guidelines. This information must be provided to ensure continued funding and authorization to operate. Other mandated information is required to meet equal opportunity and safety reporting requirements.

Information selection for internal measures is based on how performance contributes to the success of MARTA's five strategic goals:

- Customer focus,
- Transit advocacy,
- Employee development,
- Continued quality improvement, and
- Business management.

Customer Focus Focusing on the customer, MARTA uses a quality-of-service survey as a guide for tracking performance. The survey is conducted annually by MARTA to determine satisfaction of its customers with the system. The results of this survey are analyzed and disseminated throughout MARTA. Leadership then identifies performance measures at all levels aligned with the factors found in the survey and monitors them regularly to ensure that the organization is improving performance in areas important to customers.

MARTA also responds daily to and tracks customer complaints, recommendations, and suggestions. The customer service center uses the helpdesk expert automated tool to process and maintain a central depository for this information, and it prepares a monthly report for management. This information provides an ongoing measure of satisfaction of riders and is used to modify operations when warranted.

Transit Advocacy Transit advocacy is the initiative that brings the other four strategic goals into focus. Successful attention to our customers and employees, development of sound business practices, and continuous improvement of our processes will help to ensure that MARTA, as the centerpiece of transit in Atlanta, benefits as more and more people choose transit as their preferred method of transportation.

Employee Development Employee satisfaction and well-being are important to MARTA's leadership. MARTA conducted an organizationwide employee survey in 1995 and 1999 to determine satisfaction and, on the basis of the results, reorganized to make itself more effective. MARTA also developed action plans at all levels to focus on areas of employee concern and has just initiated a new survey to determine the current state of employee satisfaction.

Continuous Quality Improvement As MARTA continues its expansion and conducts significant renovations on equipment and infrastructure, it monitors the progress of the various projects. Managers track the progress of contractors and employee project groups daily. A bimonthly report and briefing to executive management covers the schedule and budget status of major construction projects.

Business Management Fiscal stability is important to MARTA because although MARTA is a quasigovernment entity, it must by law receive 35 percent of its operating budget from the fare box. In addition, 50 percent of the sales tax revenues must be applied to capital projects and cannot be used to subsidize the operating costs. MARTA constantly monitors its revenue from our sales tax, passenger fares, federal grants, advertising, and other sources, comparing it with targets and estimates. Information is collected and reported each month to senior management and the board of directors.

Integration of Measures

MARTA's performance measures do not exist in isolation. Strong relationships exist between the mea-

sures at all levels. Increasing or decreasing the performance of one measure, such as improving customer satisfaction, has a relative impact on improving the fiscal stability aspects of business management. The impacts of such relationships are discussed and then understood during the business planning process.

The operation and maintenance of bus and rail systems generates volumes of information. Some information is used immediately, such as that produced in the control of our automated rail system and in location information for our bus system. Other information is generated for review and analysis at a later time by managers and MARTA leadership. The primary criteria used for the majority of this information are (*a*) the impact the information has on determining the safety and effectiveness of the bus and rail systems and (*b*) the satisfaction of our customers.

Front-line supervisors and managers focus on information that guides daily operations. They monitor vehicle on-time performance, accidents, complaints, crime reports, and vehicle availability. Additionally, they review personnel-related information dealing with attendance, staffing levels, and overtime. They use this information to make real-time decisions that affect daily operations.

Directors, executive management, and their staffs rely on the compilation of these daily data, along with additional information, to manage the organization and to plan for its future. They select information that allows them to compare performance against goals, objectives, and performance measures and to identify trends.

Information flows through the organization both manually and electronically; automated systems are becoming more prevalent. MARTA has developed several systems to support decision making. The financial information system was implemented to support accounting and budgeting requirements, the human resource information system supports personnel information, and the maintenance management information system connects the maintenance sites and headquarters to manage maintenance and supply functions. Interfaces among these systems provide for the transference of data. The automated scheduling and run cutter system is used to manage information necessary to develop bus routes for operator assignment, and the police information management system manages police records and dispatching of officers. New systems include an applicant tracking system, automated dispatch, and intelligent transportation system components.

MARTA has just installed Oracle database software as the first step in developing an enterprisewide data warehouse. Current and future systems will be migrated to this platform, and users will soon be able to access and relate information from the various sources to support decision making. Manually prepared reports are equally important to management.

Analysis of Performance

Raw data have little value to decision makers. The data produced by the various systems within MARTA must be analyzed to gain value as a management tool.

Analysis in Support of Performance Reviews Analysis of organizational performance is conducted at all levels of the organization. Front-line supervisors evaluate operational data as they develop and make required decisions to meet our daily commitments to keep buses and trains on time, maintain our facilities, and ensure the safety of our customers and employees.

The department of operations publishes a daily report of key operational indicators that are used to monitor and control bus and rail systems. As daily operational information is compiled and reported, each level of management conducts its own analysis of the information and the responses of subordinates to the data. Staff at each level take additional corrective action if required and forward the information. As the information rises through the organization, each leader analyzes the information and responds to it appropriately. At senior levels, the response may be to redirect resources to meet challenges or opportunities.

MARTA conducts a monthly executive performance review during which vice presidents report on the performance of their organization, using more than 50 performance measures. Each vice president explains any deviation from monthly and annual targets and the steps that are under way to correct any shortcomings.

MARTA's quarterly achievement report provides the board of directors, executive leadership, and all managers with an opportunity to review performance from throughout the organization. This report contains quantitative operational and financial information and subjective qualitative evaluation of performance goals and objectives.

Analysis in Support of Decision Making MARTA's goals, objectives, and performance measures identified annually by senior staff in the business planning process are incorporated into action plans at the office and branch level. Each action plan identifies a link to a MARTA goal and objective and establishes performance measures and milestones to be met at

that level to ensure overall accomplishment of authority objectives, appropriateness, and achievability.

Linkage is further established through MARTA's compensation program. Nonunion employees' compensation is tied to performance through the performance partnership process. The employee evaluation process requires that each nonrepresented employee have a performance plan that includes standards of performance. These standards of performance must be linked to unit goals and ultimately to MARTA goals. Employees and supervisors ensure the linkage during initial counseling sessions and formally document performance during the semiannual and annual reviews.

Achievement of such performance measures is directly linked to employee merit raises. Sixty percent of an employee's annual evaluation score is based on standards of performance, and the score determines the amount of the employee's annual merit raise.

Analysis in Support of Daily Operations MARTA includes several internal areas that analyze the data produced by MARTA and provide leadership with analysis and information for decision making that affect daily operations. The office of quality assurance conducts a series of monthly performance audits that evaluate areas directly affecting our customers and the transit system. Front-line management uses these reports to reinforce positive trends and take corrective action when warranted.

The department of planning and analysis monitors and analyzes the productivity of bus routes and proposes recommendations to make the system more effective and efficient. It analyzes the annual quality-of-service survey to give management customers' perceptions of the importance of various service factors and their evaluation of our performance. The department then conducts quadrant, factor, multivariate, and cluster analyses to identify trends and patterns. It produces customer satisfaction and loyalty indexes, which can be used for establishing future goals. The results of this information are used in developing and executing action plans at the office and branch levels.

MARTA has developed several models to use information to predict future outcomes. For example, the office of planning and analysis uses models to predict future ridership and response to proposed fare increases. The office of business management and financial analysis uses a financial capacity model and a sources-and-uses model to predict future funding requirements and to plan expansion options.

Minnesota Department of Transportation

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Poster Session Summary

Since the early 1990s the Minnesota Department of Transportation (MnDOT) has undergone several stages in building a performance planning approach. In 2000, for the first time, strategic objectives have been set forth and performance measures aligned at three planning levels: strategic, system, and business. Going beyond monitoring historical results, MnDOT has set performance targets at all three levels. Time and adjustments will be necessary for managers to learn to use these targets and measures effectively in planning and operational decisions.

Development of a department-level family of measures began in 1993. Subsequently, the creation of a market research capability made it possible to define customer needs and measures. One result is that maintenance engineers have reallocated resources to achieve service levels that better match what customers care about.

In 1997, MnDOT executive staff mandated creation of measures by all districts and offices. As a part of system planning, 20-year performance targets for pavement and bridge condition were set to guide capital investment decisions.

Since 1998, MnDOT has been building activity-based cost models across the department. MnDOT's objective is to enable managers to improve competitiveness by balancing measures of cost, timeliness, and quality in making decisions.

With the advent of departmentwide business planning in 2000, performance measures have been revised to fit strategic priorities: interregional corridors, multimodal, program delivery, and information as well as outcomes for infrastructure and safety. Emphasis is expanding to operational measures to manage the business effectively. A general customer orientation is beginning to shift to one of market segmentation.

The ultimate challenge is not measurement but management; that is, reporting measurement data

does not guarantee improved transportation system performance. For results, transportation organizations need to analyze performance, set direction, and manage based on data and targets. External customer needs must be translated into operational measures, over which operational managers believe they have control or influence.

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Poster Session Summary

Overview of Master Plan of Arterial Highways

The master plan of arterial highways (MPAH) was initiated to establish a set of consistent standards and to provide a basis for coordinated countywide planning for arterial streets and highways in Orange County. MPAH consists of a network of major roadways including freeways, transportation corridors, and arterial highways. The Orange County Transportation Authority maintains the integrity of MPAH through coordinated planning efforts with the various city and county agencies. The goal is to work together to build an effective arterial roadway system providing the highest possible level of service to commuters in Orange County. The conversion of the MPAH database to a geographic information system (GIS) format in 1996 has significantly improved the authority's ability to analyze the county's arterial system, particularly in determining future construction and funding requirements and in identifying critical capacity issues. This project demonstrates how GIS has been used as an analytic tool in determining the adequacy of the existing and planned arterial system in Orange County.

System Description

The arterial component of MPAH consists of 1,491 mi of centerline, which includes 6,989 lane-mi of arterial roadways divided among the five arterial classifications listed in Table 7. Currently, approximately 96 percent of MPAH centerline-miles have been constructed. However, of those, only 71 percent have been constructed according to the plan designation. As of June 1996, 1,425 centerline-mi of arterial roadway had been constructed in Orange County, resulting in 6,026 lane-mi. Nevertheless, 963 lane-mi still need to be completed to fully implement MPAH. It is anticipated that approximately $1.34 billion will be required to fully implement MPAH. Figure 10, showing the lanes needed for full MPAH compliance, compares the existing arterial network with MPAH and provides an overview of this situation for a portion of the county. Figures 11 to 15 illustrate the build-out requirements expressed in the map view of Figure 10.

Level of Service

The level of service (LOS) is expressed in the map view as a percentage. The map view compares existing traffic volumes with existing arterials and MPAH roadway classifications. It is based on the LOS criteria in the MPAH guidelines and provides a general overview of congestion. The map view also shows the most critical areas where traffic volume exceeds current arterial capacities. As exhibited in our poster session, the areas marked with thicker lines represent areas of congestion and serve to highlight areas re-

TABLE 7 Master Plan of Arterial Highways: Orange County

Classification Name	*Number of Lanes*	*Design Daily Capacity (vehicles)*	*Typical ROW/ Road Width (ft)*
Principal	8 divided	60,000	126–144
Major	6 divided	45,000	102–126
Primary	4 divided	30,000	84–100
Secondary	4 undivided	20,000	64–80
Collector	2 undivided	10,000	40–56

NOTE: Average daily trips at Level of Service C. (1 ft = 0.30 m; ROW = right of way.)

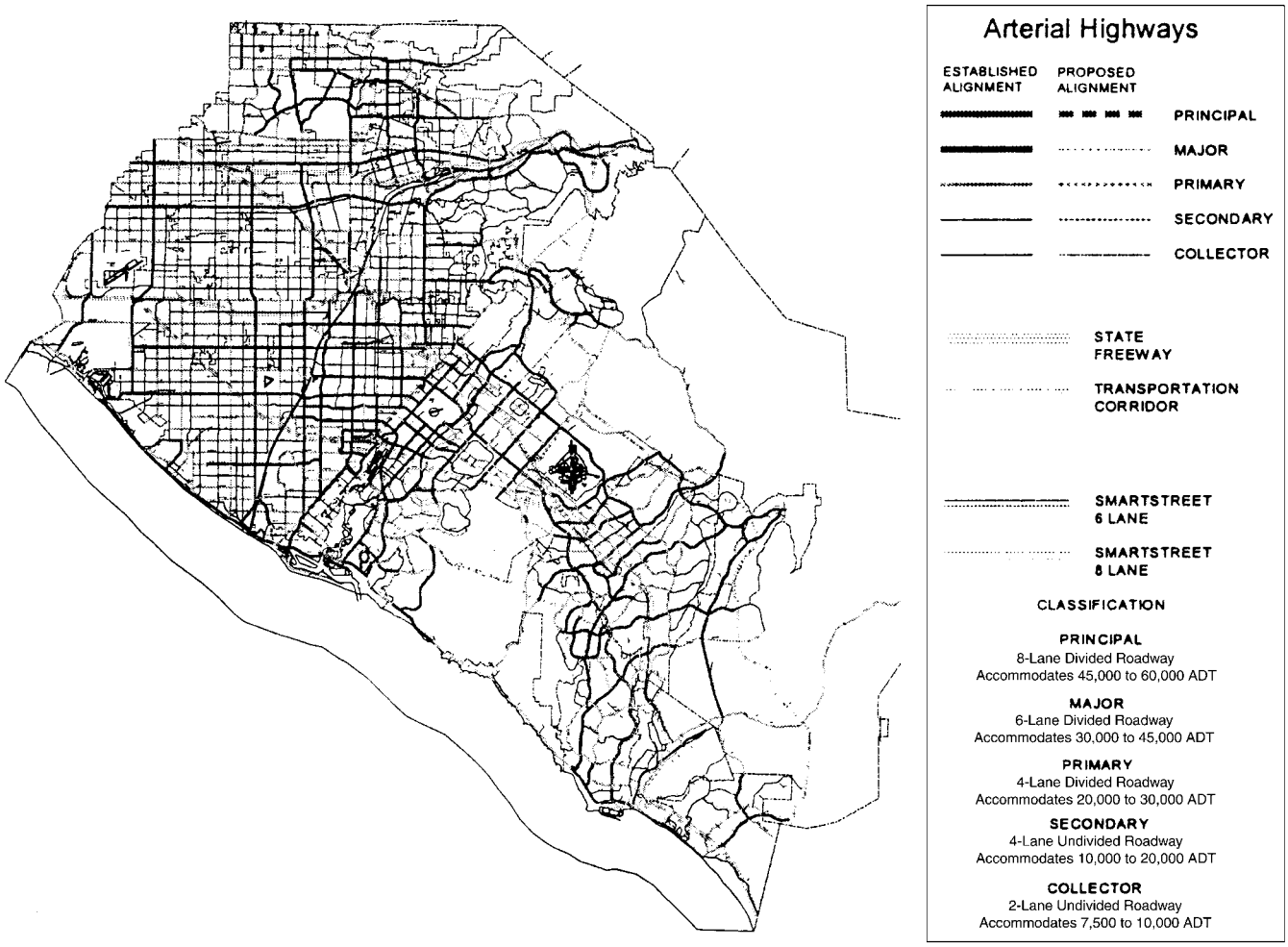

FIGURE 10 Master plan of arterial highways: Orange County. (ADT = average daily traffic.)

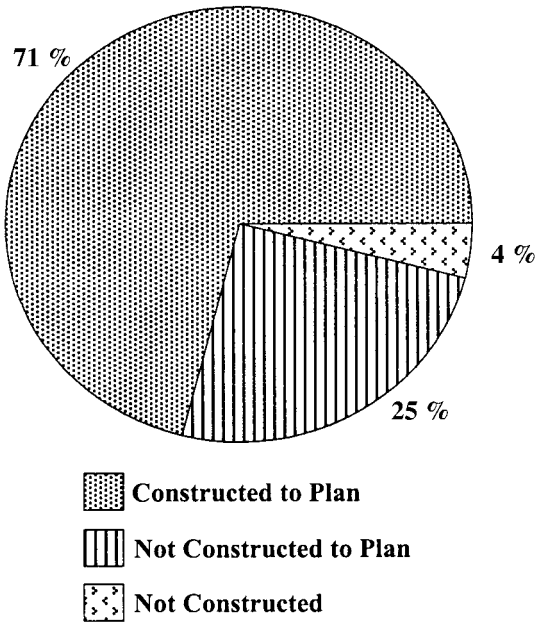

FIGURE 11 Orange County master plan of arterial highways (MPAH)—construction status.

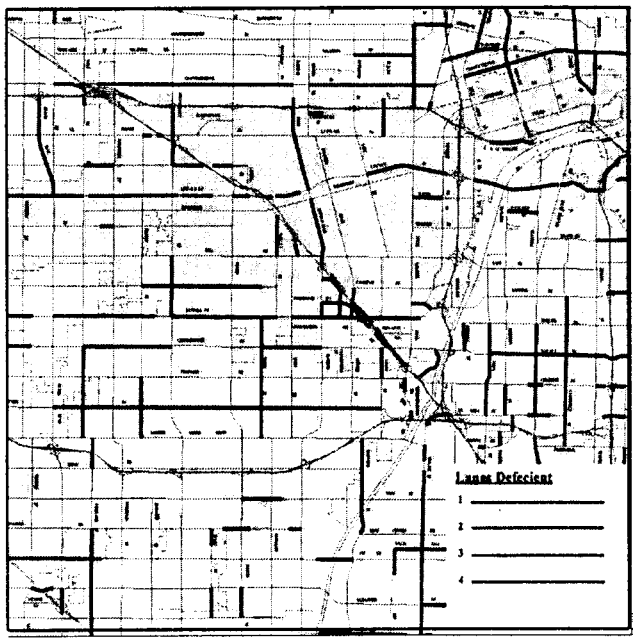

FIGURE 12 Lanes needed for full MPAH compliance, Orange County.

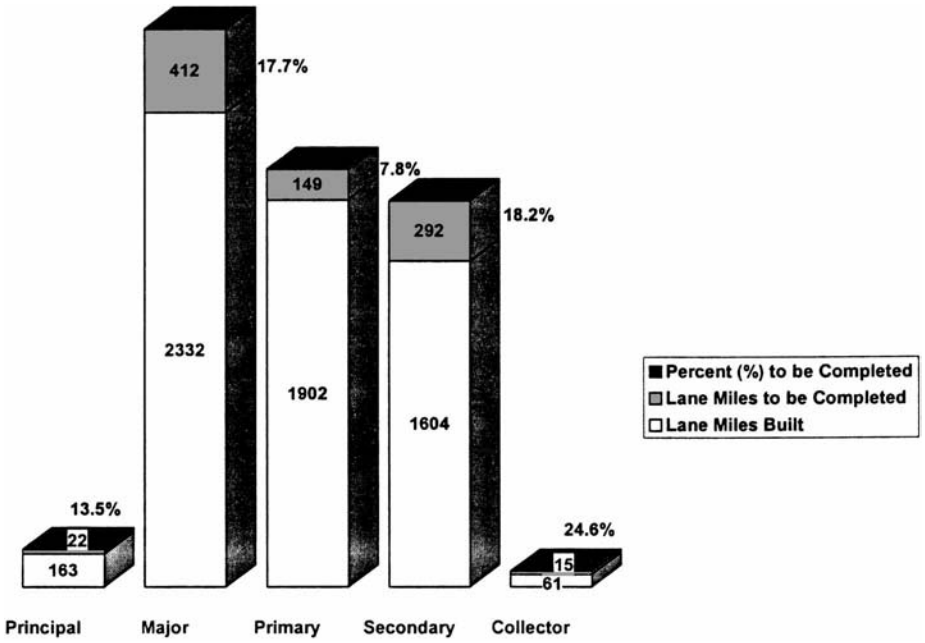

FIGURE 13 MPAH lane-miles by roadway classification: built and to be completed as of 1998, Orange County.

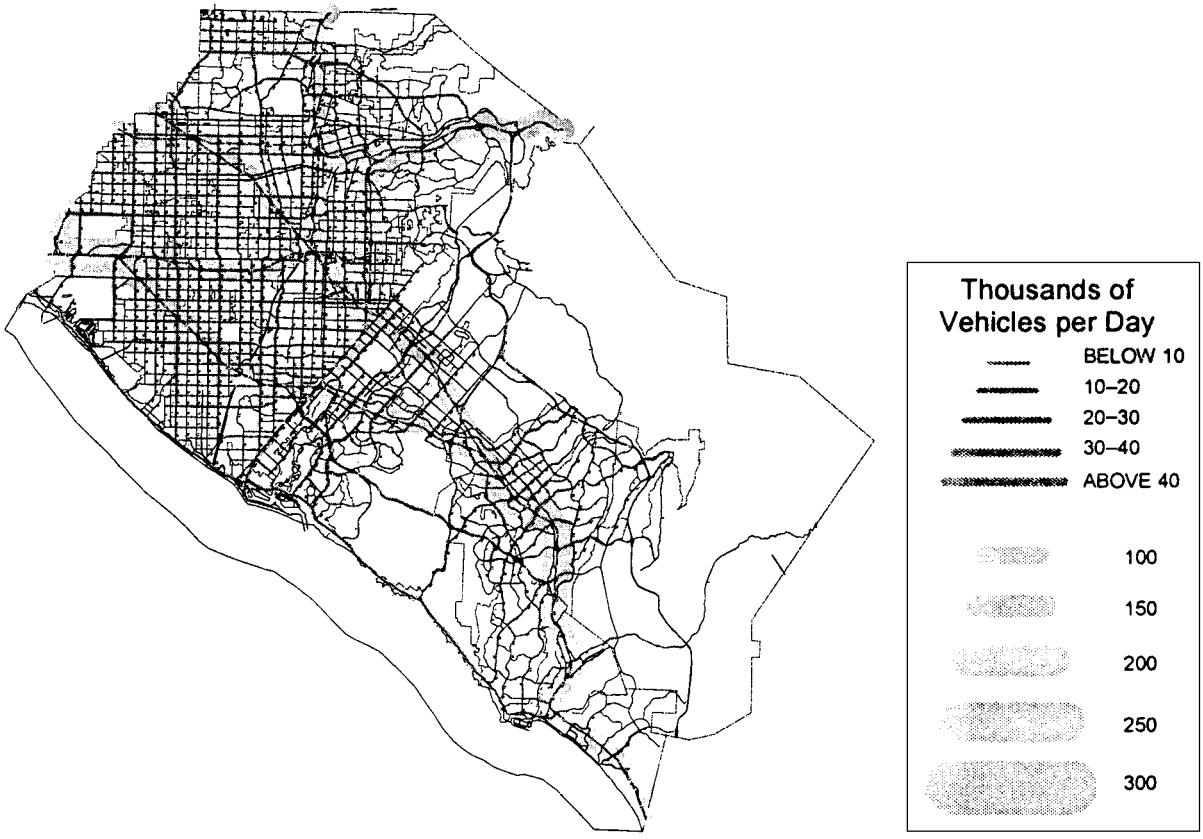

FIGURE 14 Orange County percentage over capacity.

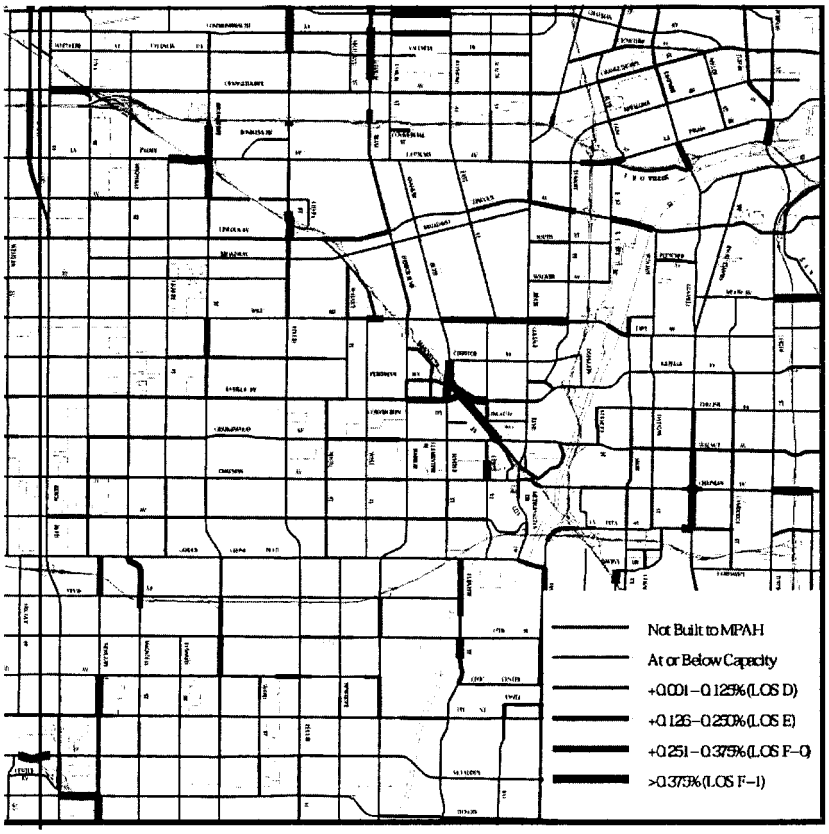

FIGURE 15 Orange County percentage over capacity of Level of Service (LOS) C.

quiring solutions. In some instances, higher-volume areas that are significantly over capacity may warrant a reassignment to a higher MPAH classification or to a restructuring of the MPAH network. That situation is especially true of some of the older developed areas of North Orange County. In all cases, collaboration of the Orange County Transportation Authority and county and city jurisdictions is required for effective solutions.

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Poster Session Summary

Using Transportation System Performance Measures to Evaluate Investments in the San Francisco Bay Area

The Metropolitan Transportation Commission (MTC) is the metropolitan planning organization for the San Francisco Bay Area. MTC developed the Bay Area Transportation Blueprint for the 21st Century to identify investments and funding sources beyond the regional transportation plan (RTP). The blueprint includes an evaluation of rail, bus, ferry, and highway expansion projects. The evaluation focused on the benefits and cost-effectiveness of individual projects and demonstrated the limitations of our investment options in the context of rapid growth (see Table 8). In the spring, MTC recommended a $3.8 billion implementation plan, based on the evaluation, for inclusion in Governor Davis's traffic congestion relief program. MTC completed the blueprint evaluation on the eve of two state legislative initiatives promoting performance measures in the RTP. MTC will respond to this interest in the upcoming 2001 RTP update. We

reflect here on the opportunities and challenges revealed by the blueprint exercise.

Blueprint Evaluation Outcome The outcome shaped MTC's recommendations for Governor Davis's Traffic Congestion Relief Program for the California Fiscal Year 2000–2001 budget. The principal finding is that the fastest-growing parts of the Bay Area are best served by a fleet of express buses operating on the region's expanding network of high-occupancy vehicle lanes. Table 9 offers comparisons of various transit packages that the blueprint revealed.

Sensitivity Analysis A sensitivity analysis revealed the impacts of land use changes and parking fees (see Figure 16):

- Illustrative land use scenario—densification based on uniform percentage growth rate throughout the region;
- Illustrative pricing scenario—$2.60 parking charge for all work trips; and
- Land use and pricing—generating pronounced changes in numbers of transit riders, although the transit mode share remains small.

Recent Legislative Interest

In the California legislature 2000 session, State Law AB 2140 was enacted. It encourages the use of performance measures in the RTP: mobility and congestion; maintenance and rehabilitation needs, mode share including bicycles and pedestrians, safety and security, and equity and accessibility to jobs. However, State Law SB 1995 failed to pass. It would have required MTC to develop

1. Measurable RTP goals and objectives,
2. Performance measures for project evaluation in the RTP, and
3. A congestion reduction plan with baseline measurements of congestion.

The 2001 RTP update will address system performance measures.

Challenges

- Using performance measures when real funding is on the line:
  –Mobility impacts of investments are overshadowed by regional growth; and
  –The RTP is a gateway to funding; project sponsors may resist quantifying impacts.
- Defining measures that give us direction to act where we have agency and authority:
  –Major investments equate to tinkering at the margins: $8 billion dollar regional rail investment reduces vehicle miles traveled by 0.7 percent;
  –Land use and pricing have a greater impact than do transportation investments, yet MTC cannot implement them; and
  –It is difficult to measure benefits of nonexpansion projects, although we know that maintenance and operations represent critical investments.

Opportunities

- Emphasize and expand the use of system-level measures, as encouraged by AB 2140;
- Extend the evaluation work in the blueprint, illustrating trade-offs among investment packages; and
- Invest in data-collection systems to provide a snapshot of existing system performance.

TABLE 8 Investment Alternatives: Metropolitan Transportation Commission, Oakland, California

Package	*Number of Projects*	*Capital Cost ($)*	*Performance Criteria*
Bus	41	745 million	Net new transit riders Cost per new transit rider
Rail	18	8.6 billion	Net new transit riders Cost per new transit rider
Ferry	23	395 million	Net new transit riders Cost per new transit rider
Roadway	15	1.4 billion	Vehicle and person trips Travel time savings Change in V/C ratio Cost per a.m. peak period trip

NOTE: V/C = volume to capacity.

TABLE 9 Comparison of Blueprint Transit Packages: Metropolitan Transportation Commission, Oakland, California

	RTP Base	*Rail*	*Bus*	*Ferry*
Capital Cost (million $)		$8,550	$745[1]	$395
Net Operating Cost[2] (million $)		$196[3]	$146	$88
Daily Transit Riders (2020)	1,608,900	1,661,800 (3.3%)	1,703,100	1,615,300 (0.4%)
Transit Mode Share				
Work	10.5%	10.5%	11.1%	10.6%
Total	6.2%	6.4%	6.6%	6.3%
Daily Vehicle Miles of Travel (2020) (million)	164,038	162,946 (−0.7%)	163,408 (−0.4%)	163,974 (negligible)
Daily Vehicle Hours of Delay (2020)	394,611	340,083 (−13.8%)	329,905 (−16.4%)	357,921 (−9.5%)
Air Quality: Reactive Organic Gases (tons/day in 2020)	35.03	34.81 (−0.6%)	34.82 (−0.6%)	34.96 (−0.2%)
Annualized Capital Cost/ Rider[4]		$41.43	$2.45	$16.41

NOTE: Numbers in parentheses are percentage change compared with the regional transportation planning (RTP) base.
[1]Assigns half of high-occupancy vehicle costs to bus and half to carpools.
[2]Annual operating cost minus fare revenues.
[3]Rail operating costs are from the Metropolitan Transportation Commission transit operations and maintenance cost model.
[4]Annualized capital $/annual new riders.

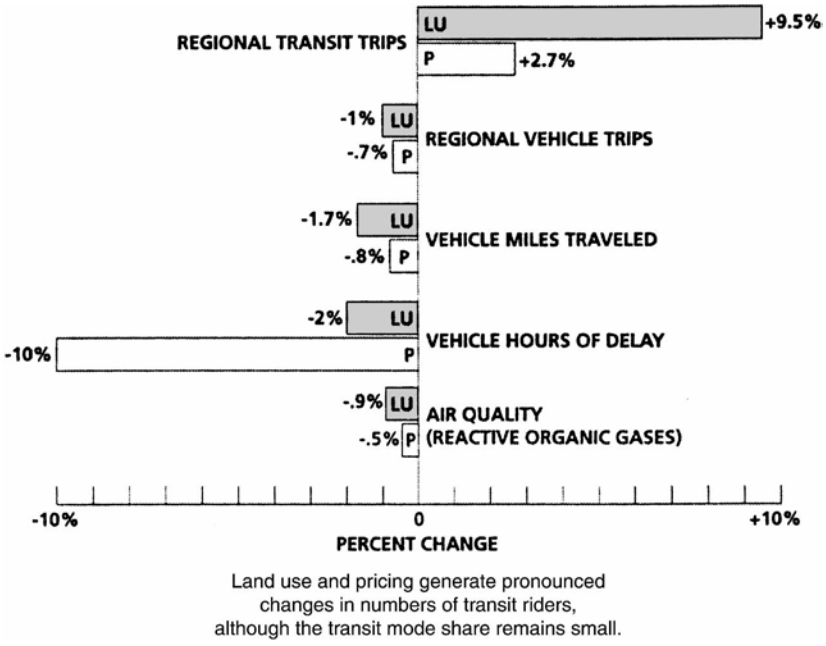

FIGURE 16 Impacts of land use changes (LU) and parking fees (P), Year 2000: Metropolitan Transportation Commission, Oakland, California.

Montana Department of Transportation

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Poster Session Summary

Performance Programming: Providing Accountability to Customers

The performance programming process (P^3) determines the best mix of highway projects offering the most long-term benefits given a set amount of funding. Because there will always be more needs than there is money to fund them, the P^3 provides a method for the Montana Department of Transportation (MDT) to develop an optimal investment plan and measure progress in achieving strategic transportation system goals. MDT's performance programming annual cycle consists of three modules: policy, funding plan, and program development. The policy module illustrates that the main focus of our transportation program starts with the statewide plan, which is updated every 5 years. From there, we get MDT's policy direction for all facets of transportation issues, as covered in TranPlan 21.

The funding plan module produces an approved funding plan determined by a coincident analysis of resource constraints and MDT's performance objectives that, when combined, generate an investment analysis. Performance programming uses the management systems of pavement (PvMS), congestion (CMS), bridge, and safety (SMS) to develop a funding plan and support capital program development. A funding plan prescribes the amount of pavement preservation versus rehabilitation versus reconstruction of, for example, $100 million available for pavement expenditures. Capital programs involve anything MDT does other than maintain what is already there, such as buying right-of-way to provide a new four-lane facility or building a road on a new alignment to improve safety.

The performance objectives for the State of Montana are as follows: PvMS uses the RIDE index, which measures pavement roughness. Pavement roughness is the most important indicator of pavement performance because it directly affects the way in which pavements serve the traveling public. The PvMS RIDE index is calculated from data collected in our road profile survey. The survey, which includes all lane miles of Interstate, non-Interstate, and primary highways each year, is performed using a road profiler equipped with laser and accelerometer devices. The purpose of the road profile survey is to collect continuous ride and rut data. The performance goals for pavements are as follows:

- Interstate: Average RIDE index of superior (RIDE > 80) or desirable (RIDE > 60) and less than 10 percent of miles with undesirable (RIDE < 60) or unsatisfactory (RIDE < 35).
- NI-NHS (non-Interstate National Highway System): Average RIDE index of superior (RIDE > 80) or desirable (RIDE > 60) and less than 20 percent of miles with undesirable (RIDE < 60) or unsatisfactory (RIDE < 35).
- Primary: Average RIDE index of superior (RIDE > 80) or desirable (RIDE > 60) and less than 20 percent of miles with undesirable (RIDE < 60) or unsatisfactory (RIDE < 35).

The bridge management system uses the concept of sufficiency established through the national bridge inspection system (NBIS). NBIS rates substandard bridges as functionally obsolete, structurally deficient, or both. Functionally obsolete means the bridge is either too narrow to allow traffic to flow over it, too low to allow water to flow under it, or both. Structurally deficient means that some aspect of the bridge—deck, piers, abutments—can no longer carry its traffic load. Performance goals (in percentages) for bridges are as follows:

Interstate	*Current*	*Year 2010*
Functionally obsolete	27	24
Structurally deficient	0	0
Percent substandard	27	24
NI-NHS	*Current*	*Year 2010*
Functionally obsolete	14	5
Structurally deficient	5	3
Percent substandard	18	8
Primary	*Current*	*Year 2010*
Functionally obsolete	11	8
Structurally deficient	2	2
Percent substandard	13	10

The performance goals of the SMS are somewhat less straightforward than the others, due to the nature of safety projects and how improvements can be measured. The safety management rating is calculated by weighing crash rate, severity rate, severity index, and number of crashes. A return of $3 million

to $6 million in accident cost savings for each $1 million dollars invested in the construction safety program was found from analysis of before-and-after safety reviews of correctable crashes at improved sites. Accident cost savings includes injuries, fatalities, and property damage.

On the basis of the existing annual funding level of $6.12 million, the goal is to allocate all available funding and improve the operating safety at intersections, interstate ramps, weaving areas, urban sections, and any location where an accident cluster has been identified. The following chart shows how many sites can be improved every 2 years:

Year	*Number of Sites Improved per Biennium*
1998	70
2000	67
2002	63
2004	60

The CMS uses level-of-service (LOS) criteria as its performance goal. In rural areas, LOS is currently used, whereas time of delay (under development) will be used in urban areas. MDT's goal is to never let any highway drop below LOS C and never below LOS B on the Interstate system. A factor called the congestion index (CI) has been developed, which translates the A through F scale of LOS criteria into a scale of 0 to 100. MDT's performance goals for congestion are as follows:

- Interstate—average CI of 70 or greater (LOS B),
- NI-NHS—average CI of 55 or greater (LOS C), and
- Primary—average CI of 55 or greater (LOS C).

In the future, a miscellaneous management system will be developed to establish performance goals on such items as guardrail, rest areas, wetlands, weigh stations, and rail crossings.

Resource constraints are determined by the amount of aid that MDT receives from federal funding bills, such as the Intermodal Surface Transportation Efficiency Act of 1991 and the Transportation Equity Act for the 21st Century (TEA-21). Under TEA-21, Montana receives approximately $260 million a year. That amount, combined with state contributions, brings in a total of about $310 million a year for transportation projects and related work, including right-of-way, planning, preliminary engineering, traffic studies, environmental mitigation, and incidental construction as well as construction and construction inspection. Historically, MDT spends about 66 to 70 percent of these funds on the Interstate, NI-NHS, and primary systems combined. Of this proportion, approximately 80 to 85 percent goes toward actual construction and construction inspection costs.

Resource constraints combined with performance objectives lead to an investment analysis, detailed in the following section. Through the analysis, it is determined how to maximize the performance of our systems (pavement, bridge, safety, and congestion) with varying amounts of funding, thus producing a funding plan.

Investment Analysis

The investment analysis is based on establishing the needs to address capacity improvements (thereby avoiding congestion) and maintaining the existing riding surfaces over a 5-year analysis period.

Under the CMS analysis, all capacity-enhancing projects are loaded into the future 5-year plan. These projects are selected based on their needs as compared with performance goals and other criteria such as route segment width design standards and amber route designation. Amber routes are a collection of roads that MDT has programmatically dismissed from improving capacity based on geographic limitations, political limitations, or both.

Under the PvMS analysis, all identified reconstruction projects over a 5-year period compete for dollars along with other projects, as identified by the CMS analysis, as well as with all rehabilitation and resurfacing project needs, as identified by PvMS. These needs are combined, and an analysis is done, which provides a prescriptive amount of funding by district, system, and treatment type for a given amount of funding.

The funding plan is then presented to district offices and to executive staff for approval. Once approved, project nominations are solicited from the district offices. These nominations are to follow the prescribed amounts of funding per system by work type, as found in the funding plan, to achieve the performance goals for that year. Note that the districts have control over which projects are selected. Performance programming serves as a tool to help them select the appropriate mix of projects.

MDT developed a performance query tool to help the districts keep track of all the data found in our management systems. The performance query tool is an interactive ArcView/geographic information system–based system that provides the districts with the same management system information used in the funding plan. Using the layering capabilities of ArcView allows the user to see overlapping needs on

any given route. After the final nominations are confirmed by the districts, they are reviewed and analyzed for conformity as compared with the funding plan and finally are put into the State Transportation Improvement Program (STIP).

Program Development

The program development module illustrates how the funding plan and system performance query tool are linked to determine project nominations, as previously mentioned. When the districts complete the project nominations, MDT headquarters conducts a technical review, whereby the project selections are compared with the funding plan and investment analysis. A certain amount of give-and-take is needed to maintain a consistent program in terms of resource and financial leveling. Concurrently, the nominations are circulated for public comment before entering the list of new projects to be programmed into the STIP.

Furthermore, features of the performance query tool include the following:

- An Oracle-based system;
- Data included from the bridge, congestion, pavement, and safety management systems;
- Inclusion of construction and maintenance projects as well as future construction projects;
- Examination of specific traits for a given site; and
- Various reports available for printing.

Also this performance query tool

- Is intended to be used in conjunction with ArcView-produced maps,
- Is designed to query sites from one of the four management systems and to display the corresponding needs from the other three systems,
- Allows individual sites to be chosen for further evaluation; and
- Allows project nominations based on selected sites to be produced.

The MDT poster session included a poster that illustrated the performance query tool and the needs screen of the performance query tool needs. On that screen, the route and segment length are shown, along with their pavement needs. Associated needs are shown below the pavement needs. In the example, congestions and safety needs are evident on the same sections identified as needing reconstruction due to pavement condition.

Also included was an example of what an ArcView map might look like. The boxes at the left side of the mapped image show which themes are turned on. In the example, past and future projects are plotted against current pavement reconstruction needs. Then, in a pop-up screen, the individual pavement characteristics are shown for a piece of road that needs to be reconstructed. It is also possible to cross-reference this piece of road with another database called road image viewer, in which a series of photographs could be viewed in succession simulating a windshield survey.

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Poster Session Summary

Oregon Department of Transportation (DOT) produced a report in June 2000 entitled ODOT's Strategic Direction: Reliable Innovative Solutions to Oregon's Transportation Needs. The report contains the following parts:

- Mission;
- Values;
- Goal 1: improve safety, vision and outcomes;
- Goal 2: move people and goods efficiently, vision and outcomes;
- Goal 3: improve Oregon's livability and economic prosperity, vision and outcomes;
- Key strategies; and
- Where do you come in?

Details on the report can be found on the Web at www.odot.state.or.us/comm./strategy.htm.

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Poster Session Summary

A summary of the Pennsylvania Department of Transportation performance measurement system and the exhibits from the poster session can be found under the panel presentations of Selecting Measures, Data Needs, and Analytical Issues of the main report.

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Poster Session Summary

The Metropolitan Washington Council of Governments, National Capital Region Transportation Planning Board, prepared a report in May 2000 titled A Regional Accessibility Analysis of the 1999 Financially Constrained Long-Range Transportation Plan and Impacts on Low-Income and Minority Populations. The purpose of this report is to

- Assess the performance of the constrained long-range plan over the next 20 years in terms of regional accessibility to jobs,
- Present a demographic profile of low-income and minority populations, and
- Review the impact that the plan has on low-income and minority populations to address environmental justice requirements.

The report is divided into four sections:

- Section I presents the financially constrained long-range transportation plan and the expected performance of the plan.
- Section II defines and illustrates regional accessibility to jobs by mode (highway and transit) and by fastest travel time comparing the current conditions with the conditions under the year 2020 long-range plan.
- Section III presents basic information on the regional demographic profile of low-income and minority populations.
- Section IV summarizes the performance of the plan in terms of the change in regional accessibility to jobs. The review of the results

> suggests that the change in accessibility to jobs is not disproportionately affecting low-income and minority populations in an adverse way. This review indicates that the benefits and burdens of the transportation investments appear to be distributed evenly across the regional demographic profile.

The poster session included numerous exhibits from this report. Copies of the report are available from the Council of Governments.

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Poster Session Summary

The customer comes first, thus reflecting a market orientation rather than production orientation.

- Questions for the service development include the following:
  - –What are the markets?
  - –Should service be provided and how much?
  - –What type of service should be provided?
- Performance evaluation helps answer these questions. These are the essential elements:

–Objectives,
–Performance measures, and
–Comparative analysis.

• Current performance measures include passengers per mile, subsidy per passenger, passengers per trip, and passengers per hour, depending on the type of service. Analysis applies standards to individual routes (or segments) or services and identifies for improvement those that are the least productive. The Regional Transit District also uses other standards to design new services and review the efficiency of current services.

• Consider a family of services, suited to a variety of markets, resulting in multiple domains of performance. To match the right service to a market or to determine whether service should be provided at all, a common performance system is needed. Objectives, measures, and analysis must be defined.

• Performance objectives and measures can be compared with those of a private firm:

Private firm	*Transit firm*
–Maximize profits	–Maximize ridership
–Subject to maximum available subsidy (budget)	–Subject to maximum allowable investment
–Measure: profit per widget	–Measure: subsidy per passenger

• The use of passengers per hour, to define productivity, and subsidy per passenger, to define effectiveness, to depict performance for all services on a performance evaluation chart (see Figures 17–19).

• Advantages are as follows:
–Is a simple, easily understood rationale for allocating financial resources;
–Measures the accomplishment of the objective (effectiveness);
–Allows comparison of similar, new, and alternative services; and
–Avoids difficulty of setting multiple standards at the policy or overall level.

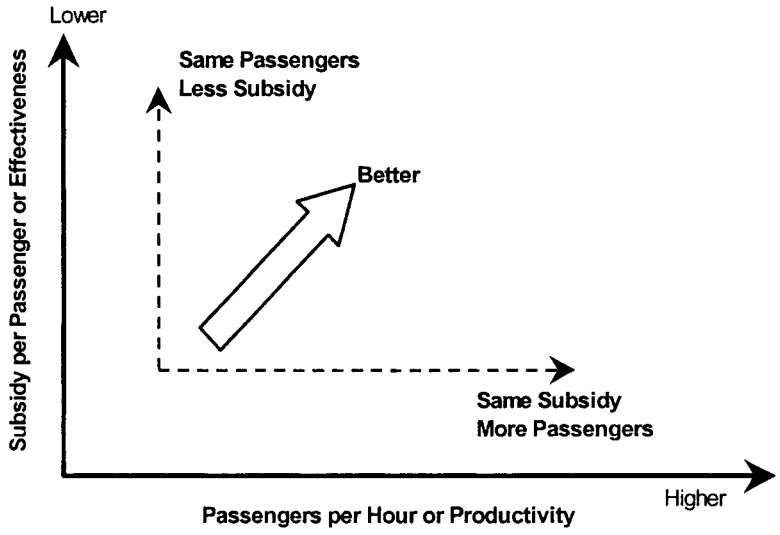

FIGURE 17 Denver's Regional Transit District performance evaluation: productivity–effectiveness chart.

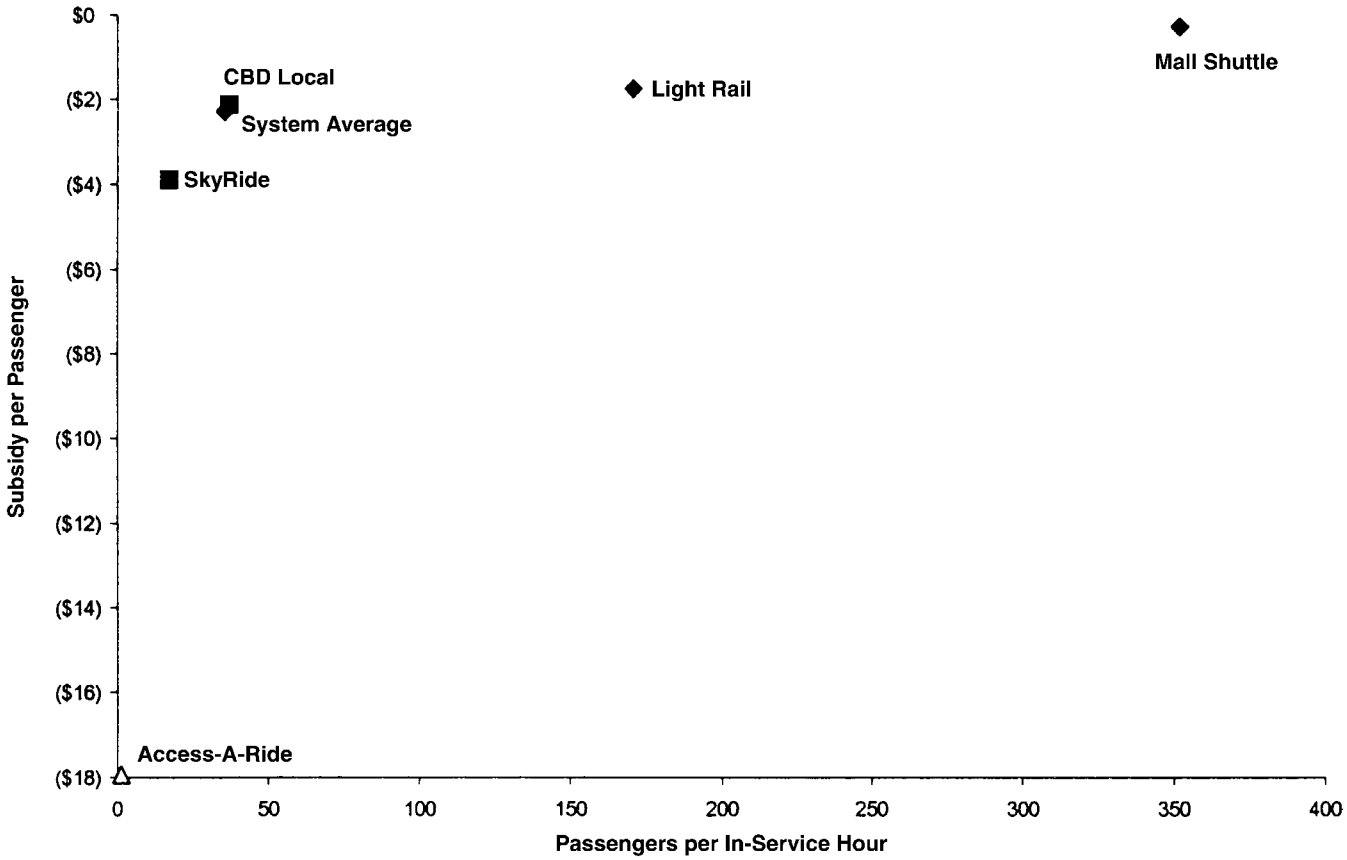

FIGURE 18 Denver's Regional Transit District performance evaluation: averages for family of services, January–December 1998. (CBD = Central Business District.)

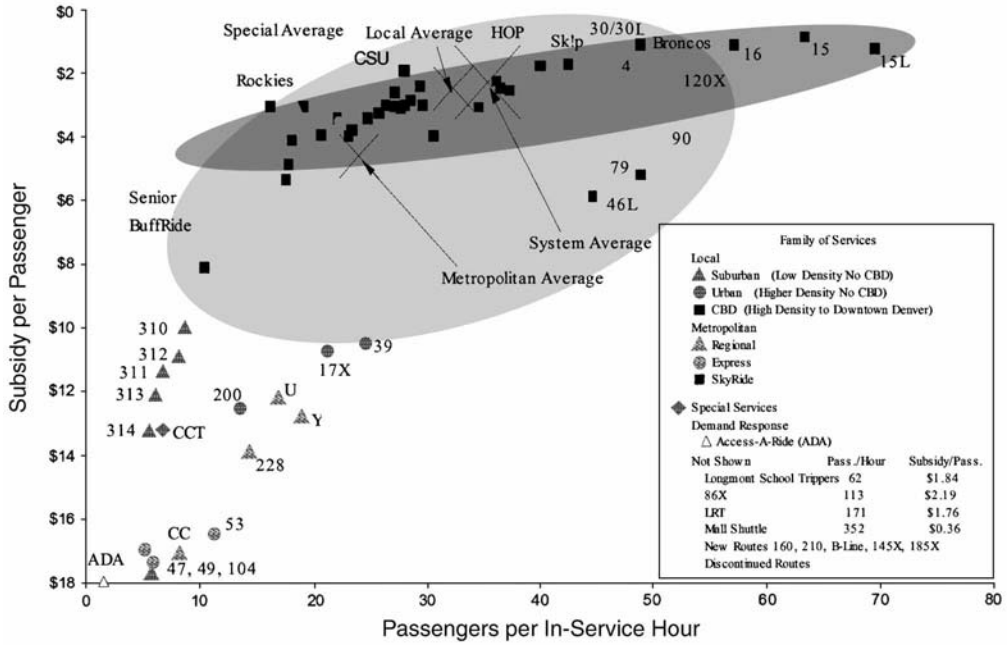

FIGURE 19 Denver's Regional Transit District performance evaluation: family of services for various routes and special service routes, January–December 1998. (CSU = Colorado State University; ADA = Americans with Diabilities Act.)

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Poster Session Summary

Some principles of performance measurement are as follows:

- There is a "law of measure perversity"—there is an inescapable inverse relationship between the importance and the controllability of outcome measures. The more important a measure is, the less control any one entity has over it. Therefore, outcome measures, being the most important, are the least controllable. This means that a set of measures, with each measure having a differing degree of controllability, will usually be required to explain the whole picture.
- It can be demonstrated that a robust measurement system can be built from a small number of individually imperfect measures. For example, if the coldness of a dog's nose means that there is a 70 percent probability that the dog is healthy, and if the dog's eating well means that there is a 60 percent chance of its being healthy, then if both conditions are positive, there is an 88 percent joint likelihood that the dog is healthy.

In a large organization, a call for measure nominations can produce a large number of measures. These measures must be culled to produce a workable number of more strategically oriented measures. The Texas Department of Transportation (TxDOT) found that this culling could be done efficiently by using a combination of the balanced scorecard categories with cause-and-effect diagrams. An original set of 178 measures was reduced to a set of 40 strategic measures. They were organized on a framework of four report cards:

- External result—customer satisfaction,
- Internal result—employee actualization,
- Internal process—internal process efficiency, and
- External process—outreach effectiveness.

When there are multiple measures of performance, a new technique called data envelopment analysis (DEA) can be useful for assessments of overall performance efficiency over time and for comparisons among several like operations. This technique, now available in commercial software, offers the following capabilities:

- Allows a comparison of similar production units or one unit over time,
- Handles multiple inputs and outputs,
- Avoids subjective weighting of inputs and outputs,
- Quantifies results of efficiency improvements,
- Compensates for external factors affecting efficiency,
- Does not require that data need be in dollars, and
- Makes comparisons to the most efficient operating units.

The principles of the technique are discussed in "DEA: A New Tool for Multidimensional Productivity Assessment," by Ron Hagquist of TxDOT. There are numerous websites and books (such as *Public Sector Efficiency Measurement* by Ganley and Cubbin) on the subject.

APPENDIX B

Summary of Peer Exchange on Data for Performance Measures

Madison, Wisconsin, August 25–26, 2000

Members of TRB Committee A1D09, Statewide Transportation Data and Information Systems, convened a peer exchange meeting on August 25 and 26, 2000, in Madison, Wisconsin (see sidebar, page 200). The theme of the peer exchange was performance measures in transportation and in particular the data and data systems that underlie performance measures in a multimodal system planning and management context. Members representing nine state transportation departments described how their agencies developed and used performance measures and how these efforts have shaped data collection, processing, and analysis activities.

- Ronald Tweedie, chairman of the Committee of Statewide Transportation Data and Information Systems (A1D09), opened the peer exchange with references to the origins of the meeting. Other TRB committees have availed themselves of the opportunity to meet in conjunction with their summer meetings to promote additional dialogue, coordinate related activities, and share a wide variety of information on topics of interest to members. By nature, the peer exchange format emphasizes open sharing of practical information: for example, how new ideas are being tried and tested, what is motivating states and others to try new methods, what is working, and what problems have developed. The August 2000 meeting was the first one specifically involving A1D09. Its focus on performance measurement systems was in part intended to provide useful information in advance of several relevant upcoming conferences and workshops. Those events included the North American Travel Monitoring Exhibition and Conference (NATMEC), TRB Conference on Performance Measures to Improve Transportation Systems and Agency Operations, and the Conference on Remote Sensing and Spatial Information Technologies for Transportation.[1]
- This written summary of the peer exchange was proposed as a way of extending the discussion to others. The following section provides a synthesis of recurrent issues and themes that emerged during the meeting. This synthesis is followed by a description of each of the states' presentations, including related discussion. Peer exchange participants also wished to generate a list of issues and challenges to help guide a research agenda for short- and long-term data-oriented projects. A summary of the list appears as an appendix to these proceedings.

SECTION 1: SUMMARY OF ISSUES

Presentations included discussions of several important topics related to the use of performance measures, including data requirements and difficulties associated with data collection and analysis, public and political acceptance of performance data, and the overall agency strategy for using performance data. The following major issues surfaced during the weekend workshop.

[1]The NATMAC meeting took place August 27–31 in the Madison, Wisconsin area. The TRB Conference on Performance Measures was held October 29–November 1, 2000, in Irvine, California. The Remote Sensing Conference took place December 4–5, 2000, in Washington, D.C.

PEER EXCHANGE ON DATA FOR PERFORMANCE MEASURES
COMMITTEE ON STATEWIDE TRANSPORTATION DATA AND INFORMATION SYSTEMS
MADISON, WISCONSIN, AUGUST 25–26, 2000: PARTICIPANTS

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Data Quality and Integrity

Data quality is a significant concern of every agency that participated in the exchange. There are several aspects to data quality: currency (or timeliness), consistency (whether two sources agree) between different published data sources, precision (level of detail or "grain"), and accuracy (whether data are correct or not). Expectations of public access to high-quality transportation data have grown as more data have been made accessible over the Internet. Such expectations include demand for accurate, real-time data by those interested in assessing current traffic conditions and for comprehensive traffic counts and long-term forecasts, often for project or development-related analysis. Agencies need to anticipate and budget for public access to avoid public relations problems.

Specific concerns expressed by meeting participants include the following:

- As mentioned, data accuracy is a significant concern. Agency staff acknowledge that they may sometimes have to make available data that they know are imperfect. A good Department of Transportation (DOT) staff continually corrects or improves their data sets. One way to achieve better data accuracy is to expose it to the light of day. As more data are made available and put to use, there will be more public pressure and hence management support for data quality, timeliness, and accuracy.

• How good is good enough? Some data uses have financial effects for the public or private sector. Although most DOTs continuously strive for better-data quality, it is also advisable that they establish appropriate disclaimers.

1. The quality of data made available to managers, decision makers, and the public continues to be a significant concern to most DOTs. The level of attention focused on data quality may be growing due to the greater accessibility to data that has been made possible by posting data on public agency web sites. Workshop participants cited examples of external data users finding different values and different formats for the same data in various places within the agency's web site. In other cases, data made accessible through electronic formats such as web sites may differ from traditionally published data sources. Although there will always be the possibility that some data sources are more recent than others or may be formatted for different purposes, there is a need to ensure that the data users obtain are consistent across the board with what is available from all sources within the DOT.
2. The currency of data is also a concern, partly due to the increased accessibility to data via the web and the availability of more frequently updated information made possible by greater use of automated data-collection and -reduction techniques. Problems were reported, such as when two users tapped into the same data source and obtained data from different time periods. DOTs need to establish guidelines and protocols that will determine when and how frequently their data sources are updated. Users who access agency data need to know what period the data represent. Agencies should establish a procedure for periodically updating published data and ensuring that users understand the time period represented by the latest update. Pennsylvania (PennDOT) has addressed this problem by restricting public access to data from the most recently completed and published collection period. With this approach, a DOT may update internal databases continuously but release the new data summaries only periodically (e.g., monthly, quarterly) to reduce the proliferation of conflicting data sets.

• Some DOTs expressed the concern that the inherent inaccuracies and imperfections in their data limit the useful application of performance measures in critical decisions. We need to be careful to avoid creating a false perception of perfection or greater expectations for data quality and accuracy than we can deliver. For example, if specific project decisions with clear financial or safety implications are based too heavily on performance measures, the outcome can be undesirable. Decision makers should use data as indicators of conditions and performance trends, for example, rather than as yes-or-no decision points. The opinion was expressed that we should let people make decisions, using indicators to guide them, but that we should not absolve them of the responsibility that comes with the decision-making authority.

3. There is concern that DOTs may be using relatively coarse and imprecise data to drive highly specific decisions, for example, to select one project or design solution from among several possibilities. Although often there is no better method, decision makers need to be made aware of the quality of the data that they are presented. We should do a better job of defining the variability of a given set of performance data or the range of valid estimates rather than provide a single data point for a given measure. It should be the role of the data community to ensure that managers and decision makers understand these data characteristics and the consequences of data variability. It was suggested that this is something the data community can actually do something about, even though we may not be able to change the way in which decision makers use the data in their decision process.

Customer Perspectives

Most agencies acknowledge the importance of understanding the audience for performance data. The audience can vary greatly, from internal group managers and staff to executive management teams to elected decision makers, to private-sector system users (e.g., freight carriers, land developers), to the motoring public, and to the general public, including "nonusers." Some recurrent themes included the following:

1. Defining the audience for performance measurement is desirable and will help shape data-collection and -reporting programs. It is not always easy to agree on who the customers are for a particular data product, however. Careful thought on that point is needed before data are developed and released.
2. Although market research is conducted by many DOTs, it is not necessarily accepted by all managers or decision makers as accurate or representative. Due to a lack of standardized methods or established regular survey programs, DOTs have often found it difficult to combine or even compare results from different surveys.

3. Market research can be used successfully to identify the key concerns, needs, and expectations of different customer groups. Segmenting the broad base of customers into more specific market segments will help to refine an understanding of needs and to focus on solutions.

Use of Performance Measures

After several years of discussion and debate over the merit of "output" versus "outcome" measures, agencies seem to be settling on a blend of the two. They are balancing the customers' expectation for outcome-related performance information with the agency's need for useful output data that have meaning for managers and decision makers. Although outcome measures may more accurately reflect what the customer sees and expects regarding performance, the role of the DOT as a long-term conservator and owner of the system demands a broad range of measure types. In addition to meeting expectations about system outcome expressed in terms that the customer can readily identify, DOTs need to measure the efficiency of their programs and their progress on fronts that are not readily visible to the public. For example, the public may be more likely to notice and relate to outcome measures, such as systemwide accident rates or generalized pavement condition ratings. But the agency needs to know something about specific high-accident locations, bridge structural condition, or predictive pavement condition indicators such as cracking and rutting. Customers are perceived to focus on programs with near-term, visible impact and to undervalue long-term investments in underlying system integrity and maintenance. Whether that situation holds true in a certain state or region should be confirmed through surveys. Still, planners and engineers do recognize the importance of balancing the customer imperatives with longer-term system preservation requirements.

- Use of performance data requires an evolutionary approach to the process. There seems to be a natural progression or trend within some agencies using performance data to proceed from detailed, technical, or system management applications to more strategic, business-planning applications.
- Several DOTs with significant experience in the application of performance measures are moving toward true multimodal applications—a situation that creates added challenges to data collection and maintenance; that is, different owners and operators are involved other than the state DOT.
- Performance targets are becoming more prevalent, that is, identifying a desired level of achievement on a specific performance measure by a particular date or period of elapsed time. Unlike the use of continuous but nonspecific improvement goals over time, the use of performance targets helps to identify performance gaps, which can then be linked to business planning and budgeting.

1. There is a particular interest in measures of mobility but also in more limited hands-on experience in developing and using such measures. For one, agencies need to be sure to define what mobility means to their managers, decision makers, and customers. Agencies report that mobility takes on many different meanings, depending on the audience, and it may incorporate distinct adjunct characteristics, such as accessibility and reliability. If mobility is to be measured across multiple modes, this further complicates the situation. That is because the DOT is often not the direct operator of some of the modes and thus does not own the data. The Florida DOT provides one particularly structured approach to defining and quantifying mobility, dividing it into the four dimensions of quantity, quality, accessibility, and utilization (see the detailed discussion in Section 3).
2. There is considerable interest in mobility indices—aggregated measures that consider several different components of mobility rolled up into a single measure or index. Opinions were divided, however, as to whether single indices are appropriate for describing mobility and perhaps for other system focus areas. Mobility may be particularly resistant to meaningful indexing because it is a complex concept measured in such a wide variety of ways in different states. More states seem to have pursued development of indices in other system areas, such as safety, system condition, and maintenance, rather than in mobility.

Data Integration

- Data integration is a major undertaking for many agencies that have brought performance and condition data into their everyday planning and management strategies.
- An important feature of data integration is the transfer of data from legacy systems to integrated systems. Dealing with legacy systems, nonstandardized reporting dates, data formats, collection methods, and so forth, is a problem at one level or another for most agencies. It is too easy to inadvertently draw different conclusions about a condition or trend if the results depend too much on when a data request is

filled or the particular source of the data. This situation can lead to credibility problems with legislators and other outside stakeholders.

• For effective and efficient use of various data sources and types for decision support, different databases and analysis tools need to be brought together and made to appear as a single, well-integrated information center. Data integration promises to significantly increase the value of data from the DOT and other transportation agencies to a broad base of internal and external users. For large and small agencies, true data integration is a significant undertaking with major resource implications.

New Data Needs

1. Changes have been made to preexisting data-collection programs and processes to address the new data requirements of performance measures. However, DOTs report that additional funding for enhanced data collection is uncommon. Some larger DOTs report increased spending in strategic market research or economic analysis, but this was generally not coupled with additional funding for traditional data-collection and -analysis programs.

2. New sources of data need to be tapped to support new measures and augment limited data-collection budgets. Some DOTs report teaming up with university research centers to improve data-collection and -analysis capabilities. Standardized methods for collecting new types of data are desirable. Some states report using variable collection methodology for collecting data, such as travel time, with the result that even within an agency, different data sets cannot be directly compared or merged. This is probably more the case in areas such as mobility and accessibility, in which agencies are collecting a type of data that was not previously collected on a widespread or systematic basis.

3. Freight-related data are in growing demand by agencies because the public-agency role in providing freight mobility and reliability is becoming more important. A wide variety of data on freight movements at the commodity and vehicle level as well as safety-related information are of interest to agencies. Currently, many DOTs find it difficult, expensive, or both to acquire those data, nor are they well equipped to forecast future truck volumes or freight movement patterns.

Section 2: Research Agenda

On the second day of the peer exchange meeting, the group worked on summarizing key challenges in the area of data to support performance measures. Nine areas of interest and concern were discussed in detail. It was agreed that follow-up is desirable in each area. The following is an outline of these areas of interest, indicating the people identified in the group to initiate the appropriate follow-up actions.

It was agreed that the research statements would be completed and combined for review by the Statewide Data Committee at the TRB annual meeting in January 2001. Additionally, the individuals assigned agreed to conduct research and report at the annual meeting on these topics: mobility, freight, sustainability, and safety.

Market Research

Market research is desirable to obtain customer feedback (internal and external) regarding the selection and use of performance measures. This activity is beneficial to agencies in prioritizing workloads. The group agreed that the following points would be worth researching: how to use existing surveys, lessons learned from existing surveys, understanding when market research is the right tool and when not to use it, and how to develop satisfaction indicators. An outcome of the research could be standardized indicators, methods, and questions. It was agreed that Ed Christopher would prepare a research proposal in this area.

Mobility

Regarding mobility measures, it was agreed that some standardized approaches might be appropriate. The Texas Transportation Institute (TTI) Urban Mobility Study is looking into such approaches. It was agreed that Anita Vandervalk would be the liaison between the Data Committee and the TTI team and report back as appropriate. She would be assisted by Tremain Downey and Rob Bostrom.

Freight Mobility

As the development of freight performance measures was discussed, it was discovered that there are several studies going on in this area. The question was posed: What is used, should be used, or could be used, and what are the implications for data collection? The following points were considered to be important: travel times, ton miles, market segmentation, truck type, business travelers, different perceptions of measures (e.g., pavement condition for cars versus trucks), and connectivity between terminals and cor-

ridors. It was agreed that Rob Bostrom, Mark Larson, and Ron Tweedie would bring the issues before the TRB Freight Data Committee.

Intelligent Transportation System

Data from intelligent transportation system (ITS) sources were discussed. There was agreement on the need for a consensus on the types of planning data that are needed from ITS. Questions were asked regarding how to use the data and what ITS can do. Issues such as data capture, formats, software for processing, dictionaries, reliability of data, and integration with planning data all need to be explored. It was agreed that Bill Walsek and Jonette Kreideweis would prepare a research proposal.

Use of Performance Measures in State Governments

It is not clear where or how performance measures are being used in state governments. The following questions need to be answered: Have performance measures had an impact on policy decisions? What is the payoff for policy-level measurement versus engineering-level measurement? Jonette Kreideweis was tasked with preparing a research statement.

Safety Measures

It was agreed that another level of measures beyond fatality and crash rates is necessary. The example of high-accident locations was discussed. A research statement should outline how safety measures are used in the states and what the data issues are. Roger Petzold was tasked with preparing this statement. He would also work with the TRB Safety Task Force, and Tremain Downey would assist.

Sustainability Measures

Measures of environmental justice, equity, and growth management were determined important. Questions such as these were asked: What are the data implications? What new measures do we need to support the programs? Ed Christopher and Tremain Downey were tasked with bringing this topic to the TRB Urban Data Committee.

Summary of States' Goals, Objectives, and Performance Measures

The group discussed state goals and how they relate to federal goals and measures. The question of aligning goals from 50 states, approximately 350 metropolitan planning organizations (MPOs), and the federal level was raised. In discussing the need for common indicators, it was decided that we should learn from other states rather than attempt to standardize goals and measures. Ed Christopher, Roger Petzold, and Tony Esteve were tasked with investigating this question from the federal perspective and reporting back to the TRB Urban Data Committee.

Quality Assurance of Data

The discussion began with a focus on data quality issues and quickly evolved into several other important data issues, such as integration, standardization, and privatization of data collection. The following questions were raised: How do you set up a relationship for data collection? How do you relate the data? Who is the data owner? Who coordinates integration of the data? How are partnerships with MPOs, localities, and the private sector formed? What are the effects of data integration on data quality and integrity? The discussion centered on the changing role of state DOTs regarding data quality, due to new performance measures and the need to compare methods of quality assurance. It was agreed that Anita Vandervalk and Ron Tweedie would prepare a research statement on this topic.

Section 3: Summary of States' Activities

Minnesota's Performance Measurement Directions and Issues

Mark Larson of the Minnesota Department of Transportation (MnDOT) described the direction that performance measurement has taken at MnDOT and some of the key issues the agency has been required to address. As an early leader in the field of performance measurement in general and customer-based measures in particular, MnDOT's experience is relevant and useful even to those agencies that have already made considerable progress in performance measurement.

Evolution

The MnDOT department-level performance effort was introduced in 1993 following pioneer work in the maintenance area. It has since developed and begun to fold together a number of focus issues and structural concepts, including the family of measures concept—a relatively sophisticated market-research orientation—as well as targets and now business-planning applications. The original family of measures program focused on the transportation system, public values, and organizational performance. The program is now adding strategic emphasis to areas including interregional corridors and program delivery. According to Mark Larson, attention to the new program emphasis thus far has been mostly internal to MnDOT and has not yet generated significant attention among the general public or the state legislature. The following components of MnDOT's performance measurement effort were presented.

Current Performance Planning Process Some of the tools, techniques, and applications now being pursued by MnDOT include the following:

- Strategic objectives,
- Customer market segmentation,
- Business planning,
- Activity-based costing,
- Targets and measures, and
- Application of performance targets to budget and investment decisions.

Business Planning MnDOT's application of performance measurement to their business planning process was described as a means to deploy assets and resources to create value for their customers. Steps include the following:

- Identify customers and their needs,
- Establish target levels of service (LOS),
- Identify products and services to meet needs,
- Determine resources needed, and
- Request resources through the budget process.

Measure Results and Adjust Strategies and Resources to Customer Needs These are the five highest-level key customer needs identified by MnDOT through substantial market research:

- Predictability of travel time,
- Smooth uninterrupted trips,
- Safety,
- Timely and accurate traveler information, and
- Responsible use of resources.

Long-Term Outcomes and Strategic Objectives

MnDOT has also identified desired long-term outcomes and strategic objectives for the program. It is interesting to note that they are not all necessarily couched in terms that customers use. Rather, the outcomes and objectives speak to the special role and responsibilities of the DOT as the owner and conservator of the transportation system. These include desired long-term outcomes, such as economic vitality, adequacy of infrastructure, and travel options. Strategic objectives of the current program include progress toward a more multimodal orientation, special focus on significant interregional corridors, and delivery of the construction and maintenance programs. These objectives represent a leadership thrust by the current administration to focus on strategic transportation needs in the future and on streamlining organizational performance.

Alignment of Needs, Outcomes, Objectives, and Targets

MnDOT recognizes the need for alignment among customer needs, outcomes, and strategic objectives. Targets and measures are then developed to bring about the alignment. Relative to past years, emphasis at MnDOT has shifted from measures to specific targets, for example, a defined LOS for a specific date or period of time. The use of targets helps to identify the performance gaps that need to be addressed in the business plan. Targets need to be aligned internally as well. Departments, groups, districts, offices, and work units all have targets that must address common objectives but that also recognize the different levels of detail or aggregation of information required to meet the various needs of these groups.

Interregional Corridor

MnDOT's Interregional Corridor (IRC) Program was singled out to provide current examples of how it is using performance measures and targets. Performance targets have been set for three different levels of corridor. Average speed is the measure, derived from estimated travel time over route distance. Higher target speeds are established for the higher-priority IRCs. Strategies to meet IRC targets include highway design, access management, growth management, and integration of ITS techniques and

freight and transit planning into system planning and operation.

New Directions

One important new direction at MnDOT is increased segmentation of the customer market. By disaggregating their market research and focusing on distinct groups of users, more can be learned about the unique needs of these segments, and thus better solutions can be devised. Examples of customer market segments include commuters, farmers, emergency vehicles, freight carriers and shippers, and intermodal trip makers.

An emerging area of emphasis is freight movement. MnDOT's private-sector Minnesota Freight Advisory Committee has proposed several performance measures. The measures focus on several important outcome areas, such as economics, IRC travel time, safety, removal of impediments, and reliability of travel time. Freight measures are divided into groups according to use of the measure, for example, MnDOT's use of investment prioritization and design versus the use by the freight community and policy makers. These are the examples of proposed freight measures for project selection and design:

- Economic cost-benefit ratio,
- Shipper point-to-point travel time on IRCs, and
- Number of design impediments slowing access to modal and intermodal terminals.

The following are examples of proposed freight measures for policy makers:

- Public transportation investment as the percentage of the state economy,
- Travel time to global markets, and
- Congestion compared with that of other major metropolitan areas.

Data-Management Issues

The following data-management issues were identified:

- Need for standard methods for collecting new data for new measures, such as speed and travel time.
- Legacy systems, nonstandard reporting dates, and other factors. It is too easy to inadvertently draw different results depending on when a data request is filled. This can lead to credibility problems with legislators and other outside stakeholders.
- Current versus consistent. Data customers want the data to be current yet also want them comparable with other data sources. This is a data-archiving and -synchronizing issue.
- Need for different data sources to be better integrated, so that different users retrieving data at different sites are drawing on a single, consistent data source.
- Need for quality assurance. Data users want assurance and validation that the data provided are accurate. A growing importance is placed on data accuracy. The more that data are reported and used, the more the accuracy is scrutinized. There is a need to move out of data reporting and into data analysis.
- Commercial customers' request for more accurate real-time data on speed and travel time. The data need to be accurate to be marketable.

Other Issues

MnDOT has not received more money for data collection, generally speaking. Greater resources have been put into strategic market research, economic analysis, and strategic planning but not necessarily into traditional data collection and analysis. There is also more emphasis on organizational performance, efficiency of projects, and program delivery. Some states noted that they have relied more on university research centers to improve data collection and analysis.

Defining the customer is not as obvious as it seems. Market research is being used to better identify the customer market segments, to identify what is important to them. Tennessee DOT also is reported to be applying market segmentation techniques.

There is some concern over whether market research results are accurate and actually speak for the population as a whole. Combining or even comparing results from different surveys has proven problematic.

Travel speed in MnDOT is an estimate arrived at through travel time and distance estimates. Travel time was measured by probe vehicles, but collection methodology is variable. Some data came from in-ground monitoring devices as well.

At the legislative level, there may be a concern about or lack of familiarity with DOT's move into business methods and tools. One perspective is that the process bypasses elected officials and the political process. This may also be true of market research because elected officials see themselves as the pulse takers of public needs and opinions.

There is a legitimate concern about becoming too technical with decision makers. They want measures

that tell the story as clearly as possible, answering questions such as these: Are we doing well? Do people think we're doing a good job? Yet engineering and planning departments have a tendency to want to make measurement precise and specific, resulting in too much data potentially being heaped on decision makers.

Illinois DOT

Jim Hall, formerly of Illinois DOT (IDOT) and now with the University of Illinois at Springfield, gave an overview of the status of performance measurement at IDOT. According to him, IDOT has not yet pursued performance measurement to the same extent as have other states. The presentation and discussion emphasized some of the concerns at IDOT that may be barriers to adopting the concept of performance measurement, both in decision-making applications and in giving the public detailed system performance data.

Concerns of Management and Others

Several concerns were expressed:

- There is concern over growing public expectations for access to accurate, real-time data, particularly from the Internet and web sites. Currently, IDOT gets most requests for information about snow-related lane closures. Greater public use of those data raises the expectation and requirement for data quality and timeliness, and IDOT would have to anticipate and budget for those areas to avoid public relations problems.
- Even more in demand are traffic data for use by developers (presumably in preparation of impact analyses and other items). Rather than seeking real-time data, these users want comprehensive traffic counts and forecasts. Thus, similar concerns are raised about the currency of counts and the credibility of and assumptions behind traffic forecasts.
- Some measures can be a two-edged sword, for example, congestion. Over time, congestion will gradually worsen, but there is the possibility that customer satisfaction with congestion levels will remain generally constant as expectations are adjusted. DOT needs to be able to reconcile these kinds of discrepancies for decision makers.

Data Needs and Integration

Several points were raised:

- The geographic information system (GIS) is the main data integration tool at IDOT; most databases are tied to the GIS framework. When the system is better integrated internally, IDOT expects to see more public demand for data over the Internet.
- The technology is available; it is just a question of how much data DOT chooses to make readily available.
- Truck-related data are needed for more than just the highway performance monitoring system (HPMS). There is interest in gathering more truck-related crash data by area and corridor. IDOT is investigating sampling methods that focus on what the state needs rather than considering HPMS reporting requirements alone.

Data Quality Issues

Discussion ensued on issues of data quality and the public use of DOT data:

- One way to attain better data accuracy is to expose it to the light of day. As more data are made available and put to use, there will be more public pressure and hence management support for data quality, timeliness, and accuracy.
- Sometimes one must put data out even if it is known to be imperfect. This situation too may bring about more pressure for improved data.
- How good is good enough? Some data uses have financial impacts for the public or private sector. There is a need to have appropriate disclaimers in addition to striving for better data quality.
- Due to inherent inaccuracies and imperfections in data, data should be used for indicators rather than as hard-and-fast decision points or determinants of funding. Let people make decisions using data indicators to guide them. Even a very good data system should not absolve people of the responsibility that comes with decision-making authority.
- Say that someone is constantly uncovering errors in data or areas that need improvement. How does one address that situation when data are used to support critical decisions with financial or safety implications? There is the need to be careful to avoid creating a false perception of perfection or greater expectations for data quality and accuracy than we can deliver.
- Are DOTs and decision makers using relatively rough indicators to drive specific decisions? For example, are indicators based on estimates or are rough measurements used to make fine design decisions? Sometimes there is no better method; in which case, the best approach is to make sure that the decision makers are presented with and understand the variability in the data, range of valid estimates, and other

factors, as opposed to taking one data point and overapplying it. This situation is something the data community can do something about, even though we may not be able to change the way in which decision makers may use or misuse data.

Florida's Mobility Performance Measures Program

Anita Vandervalk, manager of the Florida Department of Transportation (FDOT) Transportation Statistics Office, presented an overview of the Mobility Performance Measures Program. Florida is another state with substantial experience in the development and application of performance measures to transportation system planning, evaluation, and management. Among the motivating factors for FDOT is the state's performance-based budgeting process, which requires each agency in Florida to identify and apply measurable performance objectives. Performance measures are used to link planning and budgeting with improved accountability.

Mobility Measurement

FDOT has developed numerous measures related to goals and objectives in four main areas: safety, preservation, interconnectivity of the system, and mobility. Mobility is a particular concern of the department because it is so difficult to measure. External factors, such as economic growth, land use, and personal preferences of travelers, combine with internal factors, such as infrastructure investment and management, to determine mobility performance for the user. One difficulty is that FDOT does not have direct control over all of the factors influencing mobility.

Mobility Defined

FDOT defined mobility as "the ease with which people and goods move through their community, state and world." The department identified several distinct components or attributes of travel and the transportation system that contributes to mobility. FDOT has a responsibility to provide the following for its customers:

- Modal choice,
- Accessibility,
- Adequate travel time and speed,
- Affordability,
- Equity,
- Knowledge of the system, and
- Reliability.

Dimensions of Mobility Performance Measures

To allow for objective, structured quantification of mobility, FDOT identified four dimensions for measurement: quantity, quality, accessibility, and utilization. Specific measures are identified for each dimension:

- Quantity reflects the magnitude of the use of the facility or service and thus the demand and utility of the service. Examples of measures include person miles traveled (PMT), vehicle miles traveled (VMT), and ridership. Unlike at some states or MPOs, these measures are not indexed to population or other normalizing descriptors, and thus PMT or VMT would be expected to rise along with growth in population, employment, and other factors.
- Quality of travel is related to the conditions of travel from the user's perspective. Depending on the mode or system, different measures are applied. On state highways, average speed and delay are measured. In corridors, average travel time and reliability of trip time are measured. In transit modes, the ratio of auto travel time to transit travel time for the same trip is estimated.
- Reliability of travel in corridors is expressed as the percentage of travelers whose travel time is significantly worse than should reasonably be expected. Reliability is therefore defined as "the percent of travel that takes longer than the average time by no more than a certain acceptable additional time." The average time is the median travel time during the time period analyzed. An initial value is 5 percent, but surveys of users will determine an acceptable percentage. Notably, travel time data influenced by traffic accidents were retained in the sample when determining performance. The component of travel time variability attributable to nonrecurring incidents is considered part of the reliability performance. One drawback to reliability measures is the data requirement. Corridor-specific data are required for the measures to be meaningful, and the state is currently concentrating on key urban corridors.
- Accessibility describes the ease with which people can connect to the multimodal transportation system. For state highways, measures include dwelling unit proximity, employment proximity, and percentage of route miles with bike or pedestrian facilities. Accessibility of the Florida Intrastate highway system is particularly important because it links the state's commerce and tourism destinations. Nearly 90 percent of significant intermodal facilities, two-thirds of

the population and jobs, and 80 percent of industrial warehouse facilities are within 5 miles of the highway system. For metropolitan transit systems, accessibility measures include coverage, frequency, and span of service. These data are generally available from existing sources.

- Utilization measures relate demand to capacity and describe the efficiency with which the system provides mobility. These measures tend to reflect the department's perspective rather than that of the customer, and they include the percentage of the system that is heavily congested, vehicles per lane mile (a density measure), duration of congestion, and transit load factors.

Data Issues

Data Collection FDOT applies a combination of estimated and observed data at the system level and primarily observed data at the corridor level. The department focuses on data that are already being collected, with refinement as necessary to meet the needs of the performance measures. Some special data collection is required to support the measures, such as vehicle occupancy, as well as speed and volume data to support reliability measures.

Changes to FDOT's data-collection program required to support the mobility program measures include implementation of a short-term traffic monitoring system (TMS) to extend the time period for which traffic data are collected and eventually a permanent TMS that can provide 15-minute interval polling on demand.

Data Modeling Issues Consistency across the statewide system is deemed more important than greater precision on local segments. To help manage expectations, FDOT advises against mapping data at a level that would generate suspicion or complaints. Such a strategy helps to ensure that data are used at the statewide system level for which they are intended. Traffic congestion spillbacks are not yet considered by FDOT's travel models; thus, congestion statewide may be underestimated by the models. Nonetheless, trends rather than spot values have the most value.

ITS Data Integration

An effort to integrate data collected through the state's ITS infrastructure is under way. FDOT is developing statewide data architecture, addressing the following needs:

- Data retrieval: there is a proliferation of detectors and sensors, but can they provide needed data?
- Data storage: what data should be kept and by whom? How should data be stored and for how long?
- Data reporting: who are the users, and how does FDOT need to package the data for them?

FDOT acknowledges the need to identify both architecture and protocols for data sampling and manipulation to distill the vast pool of ITS data for planning and monitoring activities.

Data Quality Florida has a well-established quality assurance and quality control program, and it uses other sources and validated models to supplement and check its data quality.

Audience for Performance Measures and Reporting Mechanisms FDOT's audience includes the general public, department staff, elected officials, legislative staff, and other decision makers. Legislative staff are taking more interest in the program and are starting to appreciate the results and benefits.

At the district level, staff want more detailed information than is currently generated for the department level. There are three areas of reporting:

- Entire state highway system,
- Florida Intrastate highway system, and
- Corridors, particularly those connecting major urban areas.

Future Directions FDOT will continue to improve and develop its performance measurement program. Among those areas identified for development are the following:

- Person-trip–based measures,
- Dynamic display of measures,
- Refinement of reliability measures,
- Corridor-level reporting,
- Incorporating ITS data and analysis, and
- Wider distribution of results.

Additional Isues

Other members of the committee expressed interest in FDOT's substantial reliance on outside consultants to help design and implement highly technical and labor-intensive programs. It was apparent from the discussion that some states do not do this to the same extent as FDOT or are not able to do use consultants in this fashion. FDOT considers the use of ongoing

consultant support an extension of its staff. The current privatization initiative at the state level in Florida further supports such an approach.

California Department of Transportation's System Performance Measures

Tremain Downey, chief of the Office of Performance Measures and Data Analysis, presented the performance measurement effort of the California Department of Transportation (Caltrans), focusing on the accomplishments to date and status of implementation. Objectives were established through committees with broad representation from outside the department. There was acknowledgment that performance measurement can focus on department performance, modal system performance, or multimodal system; Caltrans chose to focus on the multimodal system.

Uses of Performance Data

Caltrans intends to monitor and evaluate system performance in a way that is complementary to what is already under way at several major MPOs in the state. The department intends to share existing data and future forecasts of performance. Objectives include development of mode-neutral customer and decision-support information. Caltrans hopes to improve consensus-building efforts in the transportation planning context by providing objective, understandable information. Although part of the motivation is to improve accountability by the department, there is also an attempt to improve information on those elements of performance for which Caltrans is not directly responsible.

Key Elements of System

The performance measurement system builds on five important concepts:

- Outcome based,
- Multimodal in scope,
- Easy to understand,
- Supportable with existing data, and
- Useable to monitor and forecast performance.

Caltrans is well into its three-phase project: spanning design, proof-of-concept testing, and incremental implementation.

Performance Outcomes and Current Measures

Caltrans has defined nine outcome areas that guide selection of measures. Among them are mobility and accessibility, reliability, cost-effectiveness, safety, equity, economic well-being, and environmental quality. Candidate measures or indicators have been defined in each area. Thus far, Caltrans has fully tested three measures: mobility and accessibility, reliability, and environmental quality. Other measures are currently undergoing testing.

The measures of mobility include average point-to-point travel time and travel delay. Because of the data-intensive nature of this travel time measure, the focus is currently on travel delay. Delay is estimated as the difference between free-flow travel time and average observed (or projected) travel time.

Caltrans's reliability measure is based on variability in service between the expected and actual travel times. Testing of the reliability measure in major metropolitan areas of the state reveals that peak period variability ranges from 10 percent to 50 percent, with most segments experiencing variability within 30 percent of expected travel time. An interesting observation is that reliability is not necessarily correlated with delay. Some segments or corridors may have high delay but relatively low variability in travel time. Among the factors that Caltrans has identified in contributing to reliability and variability are distances between interchanges and highway geometrics.

Data Issues

Caltrans embarked on an aggressive data-integration system. It will provide integrated data on performance, physical characteristics, boundaries, environmental, and financial aspects of the transportation infrastructure. Data collected by TMCs will be routed to a single centralized location rather than to district offices, as at present. Through this centralized clearinghouse, users and customers will have access to a broad array of data by way of user-friendly interfaces.

Several steps remain in designing and implementing the system, including making decisions on what information should be collected and stored, what technology will be used to collect and manage the data (particularly in expansion areas not currently served by TMCs), how to convert data to useful information, and how to best provide user access to the data.

Relationship to Decision Making

Caltrans believes that integrating data, as previously described, is the biggest challenge and most impor-

tant task to undertake. Integrating the data into the planning and programming processes will follow. California is not yet using data to prioritize or to program system projects and services but instead to evaluate existing projects and to provide information to local decision makers and customers to use as they wish.

Kentucky Transportation Cabinet

Rob Bostrom, transportation engineering specialist with the Kentucky Transportation Cabinet (KyTC, the state's DOT) presented information on Kentucky's use of performance measures in the planning process and their relation to KyTC's quality initiatives. The main goals of the quality initiatives are to ensure mobility and access, support economic development, continually improve organizational performance, and strengthen customer and stakeholder relationships. Overall emphasis is placed on improved performance in the areas of project delivery, safety, human resources, and system preservation.

The presentation of KyTC's performance measures efforts emphasized three units at KyTC: the Division of Multimodal Programs, the Division of Planning, and the Kentucky Transportation Center (a research unit affiliated with the University of Kentucky).

Division of Multimodal Programs

Performance measures are used in a range of planning and analysis support functions, including the following:

- Travel demand modeling;
- Air quality (including emission reduction and state implementation plan compliance);
- Traffic forecasting (timeliness, charging costs to projects);
- Mobility (cost of congestion); and
- Small urban area studies.

Pilot mobility evaluation programs are under way, testing measures including travel time, travel reliability, and congestion.

Division of Planning

The planning division at KyTC encompasses numerous analytical support functions including GIS, highway information systems, and TMSs. Performance measures are used in each of these systems to improve performance and quality of data provided for use by others. They include organizational performance and program quality measures, such as degree of accuracy of data sets, timeliness of inventory, and number of mistakes.

Kentucky Transportation Center Research Unit

The transportation center has numerous planning-related studies under way or ongoing, such as vehicle classification analysis, load spectra development, and cost of construction delays. For example, the growth rate analysis study will improve estimation capabilities for vehicle miles traveled and involve more sophisticated forecasting and analysis techniques. Studies such as this are measured in terms of their timeliness and usefulness.

Pennsylvania Department of Transportation's Strategic Agenda

Barbara Mason Haines of the Pennsylvania Department of Transportation (PennDOT) presented information on the department's "strategic agenda," a scorecard of the measures information system, and state data currency issues.

Strategic Focus Areas

The strategic agenda is based on vision, mission, and value statements developed through a typical strategic planning process. The eight strategic focus areas encompass most of the issues of interest tackled by other state DOTs, such as mobility, customer focus, and safety. Of special interest in the PennDOT effort are strategies such as a "maintenance first" agenda, singling out the importance of innovation and technology and building stronger relationships with partners such as customers and suppliers. Each focus area is associated with one or more goals and corresponding objectives, which tend to be high level or strategic in nature. That is, they emphasize relatively broad results and are aimed at departmentwide processes and activities. Also noteworthy in PennDOT's agenda is that each strategic focus area has an owner or leader who is responsible for the results.

Scorecard of Measures Information System

The PennDOT strategic agenda includes a well-organized scorecard of measures that clearly lays out strategic focus areas, goals, measures, measurement tools [the actual metric, e.g., international roughness

index (IRI) or ISO 14001 environmental criteria], and targets. A distinction is made as to whether a goal supports external customer needs or internal needs (e.g., department support).

PennDOT has developed an electronic version of this scorecard of measures, providing a significant amount of structured, detailed performance data. This CD-based program stores and provides links to information on a wide variety of performance fronts. The user can zero in on a specific measure (e.g., IRI), observe performance by engineering district and county, or find out which particular pavement type or traffic routes are contributing to a problem.

Data Issues

Traffic volume and other highway statistics are available on the Internet and draw from the same database as does the state highway performance measuring system. PennDOT resolved the data currency versus reporting cycle issue. All users draw from the same database, which is updated quarterly. Actual data in the database are updated continuously, but only owners can access the latest data that have not yet been summarized for the most recent quarter. Nonowners have access only to the latest quarter. The result is eliminating or minimizing the problem of different users citing data from disparate time periods.

Maryland Department of Transportation, State Highway Administration: System Performance Report

William Walsek, division chief of the Highway Information Services Division at the Maryland State Highway Administration (SHA), presented the state of Maryland's Highway System Performance Measurements Program and SHA's 4-year business plan. The business plan identifies eight key performance areas for department focus: mobility, highway safety, system preservation, economic development, community enhancement, environmental responsibility, customer service, and managing resources.

Business Plan

Within the mobility performance area, several goals and corresponding measures have been identified. Although some measures are similar to those used in several other states, there are notable innovations. Among them are the following:

- Reduce the time required to restore normal traffic flow after an incident, and
- Provide timely and reliable mobility information to the traveling public.

These goals suggest an unusual degree of emphasis on incident management and real-time information collection and distribution.

As at PennDOT, each goal is assigned one or two senior managers, whose job it is to establish measures and monitor progress. The performance measures are tied to specific numeric targets that quantify the desired level of service or improvement and identify a specific target date.

The SHA objectives (targets) are a blend of external measures of outcome (results), such as "improve average clearing time of incidents by 5% by June 2001" and internal measures of agency output, such as "provide more real-time information on the Web by FY 2002."

Highway System Performance Measurements Program

A work currently under development, the Maryland Highway System Performance Measurements Program will provide an annual report on system performance. The report will include data on system coverage, utilization, capital investment, demand, condition, and community enhancement. The system performance measures and indicators are generally time based; that is, system condition or performance is expressed as trends over time. Among the current measures in use are track capital investment, lane miles, and vehicle miles traveled; and relevant contextual information, such as population, number of licensed drivers, size of labor force, and others. These context measures provide a quick way to assess how transportation system trends (e.g., vehicle miles traveled) relate to general state trends (e.g., population or labor force participation). Most of the data are derived from existing sources, and to date, the report focuses largely on historical trends rather than projected future trends.

Maryland DOT Program

Because it is a work in progress, to date the annual performance report has not experienced a great deal of external exposure or review. The agency is concerned about consistency with other data distributed to the public by SHA. Participants discussed the pros and cons of delivering a single annual report covering all of the topics, as opposed to, for example, quarterly reports covering a percentage of the topic areas.

There is a concern about the need to manage information flow and prevent data overload, particularly at the level of senior management and elected officials. Furthermore, there are related benefits to a more distributed approach to dissemination, such as managing peak workload at the staff level and improving currency of the reported data.

Texas Department of Transportation

Kim Hajek, director of data management in the Transportation Planning and Programming Division, presented information on performance measurement at the Texas Department of Transportation (TxDOT).

Performance Measures: Who Is the Audience and How Is Reporting Done?

The performance measurement program serves the Governor's Office of Budget and Planning and the Legislative Budget Office. Reporting is relatively formal and structured as a result and is fed directly into the budgeting process. TxDOT reports regularly to legislative finance committees on financial performance. Overall, the performance measurement process in Texas has a strong financial component, relative to the process in other states. The financial staff and committees are among the main target audience for the data and measures. A balanced scorecard approach is used, including internal and external measures alike, process, and results. Measures attempt to be explanatory and to gauge the efficiency of the system. Department output is measured as well as outcomes or results "on the street."

Strategic Plan

TxDOT's strategic plan incorporates performance measurement to determine whether specific goals are met. The plan has a 5-year horizon but is updated every 2 years. The new plan defines 4 goals, 16 strategies, and approximately 120 measures. Each performance measure reported has corresponding fiscal analysis, describing what resources will be required to deliver the targeted level of performance. This is an important component of the plan that other DOTs may wish to review. Also of interest are objectives and measures on the fringe of TxDOT's ability to influence outcome—reduction in auto theft, for example.

Discussion

There was a spirited discussion over whether it is appropriate to measure rates (e.g., number of fatalities per million vehicle miles) or absolute values (e.g., total number of fatalities). Proponents of absolute values argue that indexed rates mask poor performance. For example, even though a state's population and vehicle miles traveled are growing, a modest reduction in fatality rate will still result in more absolute fatalities per year, which would be considered poor or unacceptable performance by some. The corresponding counterargument is that measures should focus on aspects that the department can more directly influence, such as the accident rate, not total accidents, because they cannot really influence to a large extent population growth or even the growth of vehicle miles traveled. Proponents of the rate approach would point to an improved (reduced) fatality rate. People say that measures should be attainable and that it is not likely that absolute fatalities can reasonably be expected to hold or drop in a high-growth state such as Texas. The opposing argument is that the rate hides the truth, which is that more people are killed per year, and that is what the public and elected officials concentrate on.

This was an interesting debate because it called into question the notion that you should not measure what you cannot influence but instead measure what customers think is relevant or important. The compromise and consensus opinion is that you need more than one measure for the most important items. It also helps to have diagnostic measures and indicators (e.g., causes and particulars behind fatalities, not just totals and rates).

New York State DOT Performance Measures

Ron Tweedie of the New York State Department of Transportation (NYSDOT) described the state's use of performance measures in its capital programming efforts. Performance measures are used in development and monitoring of the Capital Program. They are used for project selection and monitoring and to gauge the customer satisfaction with the results of the program. Performance measures are applied in four traditional areas of system programming: pavement, bridge, mobility, and safety.

Pavement measures include pavement condition, with priority given to the national highway system and major truck routes, paving cycle (how long it takes to return to a specific segment), treatment life, and percentage of single course overlays. The mea-

sures also compute the ratio of treatment life to paving cycle.

As for bridges, according to Ron Tweedie, New York "has lots of old ones." A bridge condition index is used to track the 7,600 state highway system bridges. Primary concerns are safety, preservation, and serviceability. Safety measures include vulnerability to erosion and structural condition.

Mobility, as NYSDOT defines it, is the ability to move people and goods conveniently, reliably, safely, and at a reasonable cost. Measures used include those related to congestion. NYSDOT is interested in developing measures based on the value of time in addition to travel time itself. The department is also interested in ton-miles of delay due to the importance of shipping time but acknowledges the difficulty in obtaining good data about shipment travel times.

Safety issues revolve around reducing the number of high-accident locations (HALs), the number of highway safety inspections conducted, and inclusion of HALs in the annual work program.

A discussion ensued regarding the use of mobility indices, that is, aggregated measures that consider several different components of mobility rolled up into a single measure or index. Opinions were divided, with a slight majority of the group seeming to agree that single indices are inappropriate for describing mobility and perhaps other system focus areas. Mobility may be particularly resistant to meaningful indexing because it is a complex concept and measured in such a wide variety of ways in different states. More states seem to have pursued the development of indices in other system areas, such as safety, system condition, and maintenance, than in mobility.

APPENDIX C

Research Statements Developed During Peer Exchange

At the conclusion of the Statewide Transportation Data and Information Systems (A1D09) Peer Exchange on Performance Measures, five draft research statements were prepared. The following is a brief synopsis of the research statements.

1. Freight Performance Measures. Transportation systems must address the needs of shippers, carriers, logistics firms, and others who move goods on the nation's transportation network. Specific issues include travel time to markets, congestion costs, public transportation investments, and cost and benefits to the freight sector of major state transportation projects. Development of freight performance measures and new technical tools to assist states, metropolitan areas, and others in the analysis of goods movement programs and projects would have a high payoff.

2. Intelligent Transportation System Archived Data and Requirements from a Planning Perspective. Intelligent transportation system (ITS) centers across the nation are becoming a rich new source of empirical data concerning traffic flows on highway systems. As they build data archives, the challenge will be to identify with great specificity the requirements that others have for these data. Examples of such requirements include travel times, link speeds, delay, reliability, and congestion. Research is needed to define a set of common requirements for transportation data from ITS data archives. This effort would provide a template for developers of ITS data archives and avoid costly duplicative work by system developers.

3. Market Research for State Departments of Transportation. Although state departments of transportation (DOTs) have considerable experience in measuring their transportation services and quantifying their resources, they have limited experience in measuring themselves against their customers' expectations and satisfaction. Learning what the customers want, learning their levels of satisfaction, and getting customer feedback are subject areas with which public agencies have little experience. A synthesis effort is needed to assess the role and state-of-the-practice of market research within state DOTs. The synthesis should document current experiences and serve as a primer on the use of market research in the public sector.

4. Integration and Quality Assurance in Transportation Data. The transportation community constantly demands more data. Those data need to be accurate, be able to meet customer needs, and be geared to measuring performance and providing accountability of transportation programs. Also, the data must be obtained under tight budget constraints. A growing number of transportation agencies are exploring the acquisition and integration of data across federal, state, and local levels of government and with the private sector. This possibility raises issues regarding standards, quality assurance, privatization, and intergovernmental relationships. The research conducted would identify best practices at all levels of government with respect to transportation data integration, data quality assurance, and other data relationship issues.

5. Performance Measures and Their Applications and Impacts on Transportation Decision Making. In recent years, there has been a growing interest in the

establishment of performance measures for transportation. The use of these measures can enhance accountability, improve quality of products and services, determine investment priorities, align resources with strategic goals and objectives, and manage assets. As state DOTs gain experience with performance measures, research is needed to examine the impact, value, and benefit of these measures on actual transportation decision making. Issues include the influence on transportation policy, role of allocating resources, process improvements, and organizational or institutional changes.

APPENDIX D

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