



## U.S. and International Approaches to Performance Measurement for Transportation Systems

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**CONFERENCE PROCEEDINGS 44**

# U.S. and International Approaches to Performance Measurement for Transportation Systems

*Summary of a Conference*

KATHERINE F. TURNBULL, Texas Transportation Institute  
*Rapporteur*

September 9–12, 2007  
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Irvine, California

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This report has been reviewed by a group other than the authors according to the procedures approved by a Report Review Committee consisting of members of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine.

This project was sponsored by the Transportation Research Board, the Federal Highway Administration, and the Federal Transit Administration.

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## Preface

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A Transportation Research Board conference on U.S. and international approaches to performance measurement for transportation systems was conducted September 12–15, 2007, at the Arnold and Mabel Beckman Center of the National Academies in Irvine, California.

The theme for this third in a series of international conferences, *Better Decisions and Better Communication*, was selected to highlight opportunities for and experiences in using performance measurement as a strategic tool to better communicate goals and objectives and results to a wide range of stakeholder groups. In particular, the communication theme was discussed in presentations by David Kuehn, Shintaro Terabe, and Daniela Bremmer. Throughout the program, presentations highlighted cases in which performance measures have proved useful in guiding resource allocation decisions, improving day-to-day operations, establishing and demonstrating agency competency and accountability and, in some instances, making the case for more resources.

TRB assembled a committee, appointed by the National Research Council (NRC), to organize and develop the conference program, which consisted of five plenary sessions, each followed by a series of corresponding, concurrent breakout sessions. The topics of the five plenary sessions are *Performance Measures as an Organizational Management Tool to Establish Accountability*, *Communicating Performance Results Effectively to Your Customers*, *Data and Tools*, *Hot Topics* (addressing the use of performance measures to gauge the effectiveness of tolling and congestion pricing and other innovative transportation strategies to

address sustainability and safety issues), and *Performance-Based Contracting and Measuring Project Delivery*. The Conference Planning Committee issued a call for abstracts, from which three submitting teams were selected to develop the conference resource papers, which are included on pages 109–144. Presentations based on these papers are included in the plenary sessions of this report as follows: *Measuring the Value and Impact of Agency Communication with the Public*, David Kuehn (Plenary Session 2); *Multimodal Trade-Off Analysis for Planning and Programming*, Mary Lynn Tischer and Kimberly Spence (Plenary Session 4); and *Performance-Based Contracting: A Viable Contract Option?* Sidney Scott III and Linda Konrath (Plenary Session 5).

The conference attracted 180 participants from Canada, Denmark, Germany, Italy, Japan, Mexico, Sweden, the United Kingdom, and the United States and featured 70 transportation specialists offering real-world expertise, from the application of performance metrics to case studies drawn from six countries. This range of experiences provided attendees with a comprehensive overview of the performance measurement techniques and approaches being applied to transportation systems in the United States and abroad.

The speakers reflected on the significant evolution of performance measures, as well as the advancement in their use throughout the transportation industry, that has occurred since the first conference was held in 2000. As a key tool for delivering results and establishing accountability for transportation systems worldwide, performance measurement is being applied to gauge and

evaluate a wide range of transportation activities—from the efficacy of transit operations, pavement durability, and congestion management to organizational excellence, program budgeting, and customer satisfaction. This conference summary report is based on the conference agenda and includes summaries of the presentations and discussions from the various sessions.

This report has been reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise, in accordance with procedures approved by the 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 the published report as sound as possible and to ensure that the report meets institutional standards for objectivity, evidence, and responsiveness to the project charge. The review comments and draft manuscript remain confidential to protect the integrity of the deliberative process.

TRB thanks the following individuals for their review of this report: John W. Fuller, University of Iowa; Mark

C. Larson, Minnesota Department of Transportation; Lance A. Neumann, Cambridge Systematics, Inc.; and Sandra Straehl, Montana Department of Transportation. Although the reviewers listed above 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 C. Michael Walton, University of Texas at Austin. Appointed by the NRC, he was responsible for ensuring that an independent examination of this report was carried out in accordance with institutional procedures and that all review comments were carefully considered.

The conference planning committee thanks Katherine Turnbull for her work in preparing this conference summary report and extends a special thanks to the Federal Highway Administration and the Federal Transit Administration for providing the funding support that made the conference possible. Thanks are also due to the members of TRB's Committee on Performance Measurement for their encouragement and many contributions to the planning of this event.

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## PLENARY SESSIONS

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OPENING PLENARY SESSION

# Performance Measures as an Organizational Management Tool to Establish Accountability

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Will Kempton, *California Department of Transportation*

Pete K. Rahn, *Missouri Department of Transportation*

Archie Robertson, *Highways Agency, United Kingdom*

John Gray, *Union Pacific Railroad*

The opening plenary session of the conference illustrated and discussed the ways performance measurements are being used to assess the effectiveness of organizational operations and service performance at the regional, state, and national levels in the United States and abroad. Suggested topics for further research are identified in the breakout sessions corresponding to each of the plenary sessions and are compiled in Appendix A, pages 147–149.

## CONFERENCE WELCOME

*Lance A. Neumann*

Welcome to the Transportation Research Board's (TRB's) Third International Conference on Performance Measurement. A special welcome is extended to our international participants who have traveled from Japan, Mexico, Canada, Great Britain, and Sweden.

I extend thanks to the members of the Conference Planning Committee, who did a great job of organizing informative and interesting sessions. I also thank the Federal Highway Administration (FHWA) and the Federal Transit Administration (FTA) for their financial support of the conference. Representatives from four FHWA offices—planning, asset management, operations, and safety—are participating in the conference. Thanks also go to the TRB staff that assisted with the conference, especially Martine Micozzi.

The use of performance measures by transportation agencies has increased significantly since the first confer-

ence in 2000. The first conference focused primarily on the theory and concepts of performance measurement. By the second conference in 2004, we were able to talk about the actual experience of applying performance measures in transportation agencies at all levels of government.

Speakers at this conference will highlight the use of performance measures as a strategic management tool at state departments of transportation, public transit agencies, railroads, other public agencies, and private businesses. Many agencies have fully recognized the power of performance management.

The Planning Committee has structured a mix of general sessions and breakout sessions to provide participants with the opportunity to engage in discussion and dialogue. We hope to generate an agenda of research needs, workshops, technical assistance, and other activities to promote the use of performance management concepts and performance measurement as a strategic management tool.

## WELCOME FROM THE CALIFORNIA DEPARTMENT OF TRANSPORTATION

*Will Kempton*

I thank TRB, FHWA, FTA, and Lance Neumann and the Conference Planning Committee for organizing this very important conference. It is vital that we take time to discuss performance management and the importance it has for all of us in the transportation field.

I welcome Pete Rahn and Rhona Faught, my counterparts in Missouri and New Mexico, respectively, who will also be participating in the executive roundtable discussion this evening. I also welcome Archie Robertson, the chief executive of the United Kingdom Highways Agency.

Why are performance measures so important? One of the concepts I learned from reading Peter Drucker's books on management is that "what gets measured gets done." I think that statement is true. I also think the public deserves to know that its money is being spent wisely. The public is beginning to demand to know more about how its tax dollars are being invested and is holding agencies more accountable for delivering on promises. As a result, government agencies have to be more efficient, more accountable, and more transparent. By transparent, I mean we have to provide information that demonstrates that we are spending the public's tax dollars judiciously. Whether we are involved in preparing for road closures, tackling major construction projects, or implementing measures to reduce congestion—an important focus here in California—performance measures ensure that we are operating more efficiently.

From the beginning of his term, Governor Arnold Schwarzenegger has reported to the public on performance measures. One of his first activities after assuming office was to create a California performance review exercise. This exercise brought together experts to examine current operations and to recommend ways to improve efficiency. More than just thinking outside the box, he wanted to blow up the box if necessary.

We are committed at the California Department of Transportation (Caltrans) to a new philosophy and approach to doing business in the state. We like to say we are no longer a transportation bureaucracy, rather we are a mobility company.

We have integrated key performance measures and strategies to help determine progress and success. There are three major components in our plan to implement performance management. First, we have an overall strategic plan. The strategic plan now drives the agency's budgeting process. Second, the annual operations plan provides the implementation document for the agency. Third, performance measures have been set to monitor and evaluate whether we are meeting our objectives. It is vitally important that we evaluate our performance.

Our strategic plan sets forth our vision, mission, goals, objectives, and strategies. It also includes Caltrans values. We felt it was important to communicate to our employees and the public that Caltrans stands for specific values. We offered employees the opportunity to participate in developing these values, and we have empowered them to promote actions that reflect these values.

Caltrans now has some 22,000 employees, including approximately 5,000 maintenance workers, whose access to e-mails is as frequent as for other staff. I communicate with all Caltrans employees every 3 to 4 weeks by video e-mail. This message is provided to maintenance workers on a DVD, so that they can watch it as part of their regular safety meetings. About 3,300 employees actively participated in the strategic planning process.

The Caltran's operational plan identifies specific projects, programs, and resources to meet the strategic goals and objectives. The performance measures are used to monitor progress toward meeting those goals and objectives. The performance measures also allow us to determine whether a target is met and how our resources are used. This process ensures that resources are allocated to the highest priority projects and programs.

For example, we work on programming and budgeting with the California Transportation Commission, which is the state's funding allocating agency. We use performance measures in the project selection process. State and regional agencies use the performance measures to link projects to their regional transportation plans, which strengthens the connection between long-range planning and programming. Caltrans representatives will be providing more information on these processes in the breakout sessions.

I will close by highlighting the governor's Strategic Growth Plan. The plan is a \$43 billion investment in infrastructure in the state. In November 2006 the voters approved a bond package for the program, which includes funding for highways, roadways, public transportation, ports, and other facilities. On the basis of the Strategic Growth Plan, we have an outcome-oriented program for transportation in the state. Outcome-oriented elements include reducing traffic congestion below current levels within 10 years. We have metrics in place to measure that outcome, and we have \$19.9 billion in approved bonds to fund a broad range of transportation projects to address congestion. The governor has promised on-time delivery, accountability, and transparency with the plan.

John Njord, director of the Utah Department of Transportation (DOT), has done an excellent job of communicating with the public and with policy makers. Utah DOT's objectives and performance measures are posted on the department website. The agency uses a dashboard to provide updated information on the status of projects and programs. This straightforward approach provides key information to various stakeholders.

The performance measures we are proposing for the projects funded through the bond program are performance driven and action oriented. We also have an

industry expansion exercise under way because we want to ensure that the industry is able to accommodate some \$20 billion in projects. We have also set targets for each of 12 Caltrans districts for program and project delivery. In the past 3 years, we have achieved close to 100% of project delivery commitments. In 2005 and 2006, of 174 major projects 173 met four specific project milestones, by quarter. Those projects were valued at about \$2 billion. In the past fiscal year, we delivered 100%—28 major projects, totaling \$32.2 billion.

Performance measures will play a key role in transportation agencies in the 21st century. Performance measures translate into better decisions and better communication. I hope you will take what you learn at this conference and apply it to the challenges you face in your own agency and area.

### USING PERFORMANCE MEASURES TO ESTABLISH ACCOUNTABILITY

*Pete K. Rahn*

I was probably an illogical choice when I was appointed as the secretary of transportation in New Mexico. I did not have experience in either transportation or state government. I have now been associated with the New Mexico DOT and the Missouri DOT. Both agencies were good organizations when I joined them. I believe the use of performance measures turned them both into superior organizations.

When I first started at New Mexico DOT, I met with all the various agency staffs, including the district maintenance workers. One of the first meetings was with maintenance personnel in one of the districts. I explained that it was the role of leadership to point out the direction for the agency and that we will provide a safe playing field, and people throughout the organization will understand where the boundaries are. I further explained that we will empower our employees to use their talents and initiative to move the agency in the desired direction and that we will have performance measures to hold people accountable and to ensure that the agency is head in the direction the leadership is pointing. I noted that I was going to hold managers accountable for providing the tools and training for our employees to be successful and that I expected our employees to challenge their supervisors for the training and tools they need.

An employee suggested that I was going to mess up the agency, because I would probably be gone in 4 years, after the next gubernatorial election, and their managers would remember the employees who had challenged them. This individual continued to challenge my comments during the meeting. It finally dawned on me that

he was doing exactly what I was suggesting, to challenge management. I told him I would give him a day off with pay for having the courage to tell me what he thought. Another individual immediately raised his hand and said, "I don't like you either." This story highlights my belief that performance measures have to play a key role in the leadership and management of an agency.

I will highlight how we are using performance measures in Missouri. First, leadership points out the direction for an agency. We establish boundaries for a safe playing field through the adoption of values. We empower our employees and we measure performance. In Missouri, we started with a strategic advance that involved 45 senior management personnel. After an extensive discussion, we agreed on a mission statement that states, "Our mission is to provide a world-class transportation experience that delights our customers and promotes a prosperous Missouri."

We sent the mission statement out to all our employees and asked for their comments and reactions. I received 318 responses from employees. Most of those who responded did not like the use of "world class" because they thought we were setting ourselves up for failure. They also did not like the use of the word "delight." It was suggested that making customers happy should be good enough. There is a difference between being just happy and being delighted. It is our vision to delight our customers, not just make them happy.

After we agreed on the mission statement at the staff's strategic "advance" (a term I prefer to use to connote brainstorming exercises and progressive thinking rather than the traditional term, staff "retreat"), we turned our attention to developing the playing field through our shared values. We identified 18 value statements. These value statements are to support and develop employees, to be flexible, to honor commitments, to encourage risk and accept failure, to be responsive and courteous, and to empower employees. Other value statements are to not compromise safety, to provide the best value for every dollar spent, to value diversity, to be one team, and to use teamwork to produce results. Still other value statements are to foster an enjoyable workplace, to be open and honest, to listen and seek to understand, to treat everyone with respect, to seek out and welcome ideas, and to strive to work better, faster, and cheaper.

This list did not describe Missouri DOT at the time, and it does not describe Missouri DOT today. It does describe the organization we want to be, however. These values are used throughout the organization, including challenging leadership.

We then discussed what the mission statement means to our customers and how we describe it in tangible ways that are understandable to our customers. We agreed on a series of tangible results including uninterrupted traffic

flow, smooth and unrestricted roads and bridges, a safe transportation system, roadway visibility, and personal, fast, courteous, and understandable response to customer requests. Other tangible results are to partner with others to deliver transportation services, to leverage transportation to advance economic development, to use innovative transportation solutions, and to promote fast projects that are of great value. Still further tangible results include environmental responsibility, the efficient movement of goods, easily accessible modal choices, customer involvement in transportation decision making, and convenient, clean, and safe roadside accommodations. Being an advocate for transportation issues and providing the best value for every dollar spent, attractive roadsides, and accurate, timely, understandable, and proactive transportation information represent the final tangible results.

On our website, MoDOT.org, we track some 130 performance measures. We add and delete performance measures as appropriate. We provide updated information on how we are doing on all the performance measures. We also publish this information and distribute it to members of the state legislature, the governor, the media, and other groups.

In developing performance measures associated with smooth roads, we focused on customer expectations. Missouri DOT conducts road rallies, which involve driving randomly selected citizens and civic leaders along roads in the state. The participants grade road conditions related to pavement smoothness, lane and shoulder width, striping and signage, and other elements. This approach allows Missouri DOT to apply scores to what people find acceptable. The results were used to develop a baseline for measuring success. We also conducted surveys and focus groups to obtain more information from our customers.

The results from the road rallies were used to develop our customer expectation standards. It is interesting that some of the items our customers rank highly are different from those we thought were important to them. Features with the highest ratings included the physical condition of the roadway, how well intersections are marked, traffic flow and congestion, ease of getting on and off roadways, bridge width, and smoothness. Some of the features we typically think people view as important, such as mowing and trimming and clearing roadside litter and debris, were rated low by participants.

This information was used to define the characteristics of a good road and to develop benchmarks on how Missouri compares with other states. I have to confess; I do not believe in goals or in targets because agencies tend to set goals and targets they know can be met and then stop trying to improve once the target has been accomplished for fear of using up any performance they may have to deliver the next year. I believe in continuous improvement. Our goal is to be the best in the country

for every single measure. We will not let up until we accomplish that goal.

Using the results from the road rallies, we examined the percentage of highways in good condition. In 2004, only about 44% of our major highways were in good condition. We had the third worst pavement ratings among states in the country. We were not meeting our customers' expectations.

We were able to use available bond proceeds to undertake a Smooth Roads initiative to address this problem. We dedicated resources to improving roadways in the state. By 2006, 74% of our major roadways were in good condition. Georgia has the highest percent of major roadways in good condition. We have a plan to overtake Georgia.

We also examined the percentage of minor roads in good condition. We have experienced a slight decline in the percentage of minor roads in good condition—from 78% in 2002 to 69% in 2006—because of the higher priority of investing in major roadways. In 2006, a higher percentage of major roadways were in good condition. Georgia is also the best in the nation at maintaining its minor roadways. Again, we plan to overtake Georgia in that category.

We also track the percentage of vehicle miles traveled on major highways in good condition to understand how many customers we are keeping happy. We monitor the percentage of deficient bridges on major highways. We have to do something drastic if we are going to improve those measures. We are not making improvements in the percentage of deficient bridges on either our major roadways or our minor roadways. The need to do so has driven our behavior at Missouri DOT. We have been investing significant resources to bring deficient bridges up to standards. Our Safe and Sound Bridge Program targets 802 bridges in the state. We plan to contract with one team to reconstruct all 802 bridges within 5 years and to provide a 25-year warranty.

We do more than just publish Tracker and performance measures. We follow up with quarterly Tracker meetings. Typically these meetings last from 6 to 8 h. The drivers that are the personnel responsible for each performance measure provide updates on what has been delivered, not what they are planning to do. I do not allow staff to discuss what they are planning to do. I actually blow a horn if people stray from talking about what they have been doing to what will be done. We focus on accomplishments and the delivery of our promises. All drivers are required to attend and participate in the meetings. This approach creates a cross-divisions and cross-boundaries educational process for all staff. It provides personnel with a better understanding of activities throughout the agency. With 130 performance measures, the Tracker system provides a mechanism to hold people accountable. Through this approach we have been able to focus on our organiza-

tion and to significantly improve our delivery of services and programs to the citizens of Missouri.

## PERFORMANCE MEASURES: MANAGEMENT TOOL TO ESTABLISH ACCOUNTABILITY

*Archie Robertson*

I am passionate about the use of performance measures to drive an organization forward. Performance measures ensure accountability of the resources given to an organization. Performance measures provide focus for an organization. Performance measures enhance teamwork and ensure that you are satisfying your customers, that those who provided the funding are receiving good value, and that you are allocating resources appropriately.

The Highways Agency is an executive agency of the U.K. Department for Transport. It is responsible for the operation and stewardship of the strategic road network, which is England's motorways and major trunk roads, on behalf of the secretary of state for transport. I am the executive director of the agency and a member of the Department of Transport Board. Our funding comes from the U.K. government. We generate a small amount of funding from recovering the cost of building and operating bridges. Increasing amounts of revenue are generated from accommodating network enhancements for developers who want to develop property along our networks.

The strategic road network includes approximately 4,800 mi of motorways and all-purpose trunk roads, representing about 2.8% of all roads in England. The counties are responsible for most roadways in England. Although it is only 2.8% of all roads, the network carries 31% of all road traffic and 62.3% of all freight. The network is critical to the economic viability and social well-being of the country. In total, there are about 80 billion vehicle miles of travel every year. The value of the network is approximately £80 billion.

We describe our role as being a network operator, rather than a road builder and maintainer of roads. This transformation to a network operator has occurred quite recently. We have approximately 3,500 civil servants at the Highways Agency. This figure has doubled in the past 3 years because we decided there was good value in putting traffic officers on the road network. Those individuals are not police officers. Rather they focus on responding to accidents, clearing debris, and keeping traffic flowing. Approximately 1,500 staff are focused on road service and operate control centers.

We spend approximately £1 billion annually on capital projects and £1.2 billion annually on maintenance contracts and private finance initiative (PFI) payments. We have 13 PFIs in which we pay others to provide road services and information services. We are one of the lead-

ing users of PFIs in the United Kingdom and in the global roads business. I calculate that it takes some 30,000 people to operate our network, so we rely heavily on contracted employees. As a result, I see myself not only as the leader of 3,500 agency employees, but as a champion for 30,000 workers that keep the network operating.

Underpinning our work is our Customer Promise, which reinforces our commitment to put our customers first in everything we do. This promise focuses on helping our customers with their journeys. It states that we will help them make their journeys safely and reliably. We will provide value for money we receive and invest it in improved services. We will provide helpful information to enable our customers to make choices before and during their journeys. We will clear incidents quickly and safely. We will limit any delays when performing roadwork and improvements. We will play our part in protecting the environment. We will ask our customers for their views and act on feedback. We will deal with our customers promptly, courteously, and usefully.

Everything we do is focused on fulfilling this promise. We have been successful in meeting the promise. Customer-focused organizations must listen to their customers. We conduct national and area surveys involving more than 8,000 customers throughout the year. These surveys include questions on the last journey the individual made. We have found that this focus on the most recent trip provides very good information on our customers' expectations and satisfaction levels. The surveys provide an understanding of who uses our network and services and how they use them. The results allow us to compare performance against our objectives. The surveys also provide an indication of local concerns of road users and people living near our roads. Examples of issues identified by customers in the most recent survey include the number of roadwork projects under way, the accuracy of variable message signs, and concerns for the environment. Concerns about reliability, trip and travel information, and safety continue to be the three elements that are most important to our customers.

When I joined the Highways Agency in 2003, the agency had 21 performance measures, which were narrowed down to four—improving safety, improving journey time reliability, ensuring customer responsiveness, and supporting sustainability. As you know, unlike a rail or an airline network, a road network has no timetable. Travelers use the road network where and when they want. Providing accurate information to allow travelers to make decisions is an increasingly important part of our service. Travelers today are also much more concerned about the impacts of motoring activities on the environment.

Road safety continues to be a major concern of our customers. The network remains one of the safest in Europe. We continue to exceed our road safety targets. Recently, there has been a 33% reduction in fatalities or

serious injuries and a 10% reduction in the rate of slight injuries, but still more than 2,000 people a year die or are seriously injured on our network. We know that engineering solutions are not sufficient in themselves. Driver information and education are becoming increasingly important. Improving the safety of our people who are working on roads continues to be an important initiative.

We target journey reliability because that is what our customers tell us they want and because we feel we can make continued improvements through management and prevention of incidents on the network. Our target is to make journeys more reliable on the strategic road network by 2007–2008. This target is measured by improving in aggregate the slowest 10% of journeys for each of 98 routes, for each day of the week, for each time of day, measured in 15-min intervals, between the baseline period of August 2004 to July 2005 and the target period of April 2007 to March 2008. We manage this target through a subgroup of the Transport Board that meets on a monthly basis to review progress on various programs and projects. The group reviews the progress of interventions, the use of delivered interventions measured against a range of indicators, and the actual performance measured against the target and the forecast performance.

We have numerous efforts under way related to all our targets. As I mentioned, we are currently spending approximately £1 billion annually on capital projects. The road improvement program includes 113 schemes, involving roadway widening projects, bypasses, and junction improvements. A total of 47 schemes have been completed to date. Some 23 schemes are under construction, at a value £1.8 billion. We have 37 schemes in the planning stage, at a value of more than £12 billion. The projects include the widening from six to eight lanes of key motorways used by commercial vehicles.

We are working with suppliers and contractors to ensure that roadwork projects are better planned and executed through an approach I call “sweating the asset.” This involves increasing nighttime-only work to minimize the impact of roadwork on our customers, providing better information to help our customers plan their journeys to minimize disruptions, using innovative equipment to speed up roadwork and improve safety, and making the best use of road space at all times.

A number of initiatives under way are related to enhanced information services. These initiatives include providing real-time traffic information by digital radio, making real-time closed-circuit television images available on our website, broadcasting quality images to travel news providers, and extending the trial of providing journey and delay information on motorway message signs.

We are also focusing on active traffic management, including the use of shoulder lanes as traffic lanes during

peak periods. We use technology to assist with that process. We use variable speed limits during peak periods and open the shoulder lane to general traffic. Computers monitor the entire roadway so that we are able to respond quickly to accidents or incidents. We have increased capacity on the network through this approach, without any new construction.

We have learned a great deal during the past few years from asking our customers about their expectations and their satisfaction levels. We have learned that reliability is more of a concern to our customers than are actual travel times. Our experience indicates the importance of understanding performance measures before targets are set; targets should not be set hurriedly. In addition, the quality of data is important, as is ensuring that there is a reliable baseline to measure against. Finally, measures and targets should be kept simple.

#### PERFORMANCE MEASURES AS AN ORGANIZATIONAL TOOL TO ESTABLISH ACCOUNTABILITY: PRIVATE-SECTOR COMMENTS

*John Gray*

In providing a private-sector perspective on the use of performance measures, my comments will focus on the performance measures associated with the freight industry in the United States, particularly the railroad industry.

Let me begin by providing an overview of Union Pacific (UP) Railroad. We are a freight rail carrier with 32,300 mi of track. Our annual revenues are approximately \$15 billion, including some \$100 million generated by contracted passenger service. We operate in 23 states. UP owns approximately 105,000 freight cars and 8,500 locomotives. We operate some 2,700 freight trains on a daily basis and have approximately 50,000 employees and 25,000 customers. Our annual capital improvement budget is about \$3.2 billion, and our maintenance budget this year was \$2.3 billion.

Given these costs, you can see that we invest heavily in our infrastructure every year. Understanding the allocation of this capital is a critical issue for UP. The availability and allocation of capital are essential issues in how one measures and looks at business. Although we operate in 23 states, including California and Texas, the state of Wyoming constitutes approximately 20% of our business. The major products are coal and soda ash, which are used at power plants that produce about 15% of the country’s electrical capacity.

UP has a diversified business mix, which provides some balance in times of adversity in one area. In 2006, industrial products accounted for 21% of our business, compared with 20% for energy, 10% for intermodal,

16% for agriculture, 14% for chemicals, and 10% for automobiles. This year, our industrial business is lower, but our energy and intermodal businesses are higher.

All components of the freight industry—rail, truck, water, and air—must measure operations and equipment utilization. For UP, measuring the infrastructure utilization in our terminals is critical. With the exception of rail and trucking, investment in transportation terminals for most modes is conducted in conjunction with one or more public agencies. Airports and water ports involve public agencies and public financing. The railroad industry is the only freight industry with a private line-haul infrastructure. For the most part we build, operate, and maintain our rail lines without public assistance.

When we examine performance and effectiveness measures at UP, we have to deal first and foremost with the physical movement of commodities through our network. The value of the cargo is important, but is somewhat secondary to the physical quantities and configuration of the cargo. The critical issue is how cargo is moved through the network. The value of cargo relates to mode selection, service selection within modes, and performance requirements. Network performance is an output measurement. Cargo value is one of the input requirements that define performance objectives.

Ultimately, industry performance must be based on measures that will drive capital investment and the efficient management of network operations. Thus, performance measurements reflect the need to understand the efficiency of private capital utilization and the need for capital creation if the network is to be sustained. Performance measures also need to reflect requirements to maintain some degree of redundancy and network reliability within the limitations of network structure and capital availability.

I would echo Pete's comments related to basing the performance measurement structure on customer requirements. We have to deal with the same issue. Other than the measures related to the efficient operation of the network, our performance measures focus on our customers' needs.

Performance measures need to reflect the use of private capital. They also need to reflect the ability to drive management performance. Performance measures should reflect flexibility in the way the network operates.

We have a number of measurement objectives at UP. We use them to describe network fluidity, network efficiency, and service expectations for customers. Other objectives address providing physical components for asset utilization and productivity measures, identifying opportunities for network management improvements, and identifying opportunities for capital investment.

We have a number of network measures. Examples of these measures include 7-day vehicle loading rates, network vehicle inventories, network velocity, terminal

dwell times, and terminal throughput versus terminal assets. Other measures are vehicle or shipment movement performance versus the plan, vehicle productivity, network assets unavailable for use, network mileage under constrained use limitations, vehicle delay time, and assets required to meet demand. Many of these measures are examined for the total system and for specific components. Further, some measures are examined daily, some are examined over longer time periods, and some are meaningful only as a time series.

One of the breakout sessions focuses on the limitations of performance measures. It is important to remember that performance measures do have limitations. Performance measures should also be used judiciously. They represent only part of the measurement equation. Financial and economic components are also needed. They are usable over time only to measure the performance of a single carrier, network, terminal, or operation. They cannot be used to compare carriers or modal performance. They cannot be used to compare performance between networks.

Performance measures do not reflect the complexity of service and vehicle interchange between networks, either intramodal or intermodal. They do not reflect the impact on network performance of factors outside the control of the carriers or network managers, such as customer facility design or customer equipment utilization. Measurements typically have difficulty reflecting the impact of common network costs and the management decisions and policy making associated with, and derived from, the allocation of those costs.

Ultimately, measurements must have a financial or economic component to be meaningful. They must relate to the cash flow production of assets, both network and vehicle. Usually a time component is needed because capital costs tend to be time related. They need to reflect performance issues that drive customer satisfaction, customer costs, and customer logistics requirements. We have found that no single measurement is all-encompassing. The measurements must be used in concert along with management judgment of their relative importance at a particular time or under particular circumstances.

Examples of measurements used in the freight industry include vehicle revenue or margin productivity over time and operating ratio, which is the ratio of revenue to operating cost either in total or for discrete operating entities. Other measures are return on assets, either in total or for discrete operating entities, and return on equity. Revenue or margin productivity of terminals over time, line segments or service offerings and revenue, and cost or margin per unit of production over time represent still other measures.

The Association of American Railroads website includes the rail public performance reports, which pro-

vide useful information. Performance measures in the private sector continue to focus on capital components, network performance, and manager performance.

*Lance A. Neumann, Cambridge Systematics, Inc., moderated this session, and Katherine F. Turnbull, Texas Transportation Institute, served as rapporteur.*

## PLENARY SESSION 2

# Communicating Performance Results Effectively to Your Customers

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G. J. (Pete) Fielding, *University of California, Irvine*  
 David Kuehn, *Federal Highway Administration*  
 Shintaro Terabe, *Tokyo University of Science, Japan*  
 Daniela Bremmer, *Washington State Department of Transportation*

This plenary session discussed methods, techniques, and applications used by public and private agencies in the United States and abroad for implementing performance measures to assess customer satisfaction. Research needs are identified in each of the corresponding breakout sessions on pages 55–68 and in Appendix A, page 147.

## COMMUNICATING PERFORMANCE RESULTS

*G. J. (Pete) Fielding*

My comments focus on the presentation of performance measure results to different audiences. I will also discuss benchmarking and potential issues associated with the use of transportation performance measures. Figure 1 illustrates transit performance concepts. It highlights the three dimensions of transit performance, service efficiency, service effectiveness, and cost-effectiveness. Service efficiency relates to how well transit agencies and operators are using public investments. Service effectiveness relates to how well the service is used by customers. Cost-effectiveness represents the link between the services provided and ridership levels. Numerous performance measures can be used with each of these three categories. I recommend using a small number of key performance measures.

Figure 2 illustrates road maintenance performance concepts. It includes the same three dimensions, service efficiency, service effectiveness, and cost-effectiveness. Public investments are used to develop and operate the

road network, which is used by customers. A variety of performance measures can be used with roadway maintenance and operation, including maintaining the condition of assets to a specified level, clearing incidents within a certain length of time, and reducing fatalities.

Performance measures may be focused internally and externally. Customers for internal measures are agency staff; customers for external measures are policy makers, other stakeholders, and the public. Different methods of reporting performance results should be used with these groups. Different methods should also be used within an agency. Technical staff need more detailed information, whereas senior management personnel are interested in key trends. The challenge is to develop a small set of critical performance indicators for each of the three dimensions of performance. Information on these indicators can be displayed using different formats depending on the audience.

Two international examples contributed to the performance measures presented in Figure 2. First, the Organisation for Economic Co-operation and Development (OECD) established an expert group to examine performance indicators for road sectors in 1996. The report prepared by this group identified 15 performance indicators. Examples of these indicators are expenditures for maintenance and operation per vehicle kilometer, value of assets, roughness by road class, kilometer of congested roads, travel time variability, and fatalities and serious injuries per vehicle kilometer. Second, Transit New Zealand, the agency responsible for the highway network, has gradually shifted management of road maintenance to suppliers. The agency is using long-term

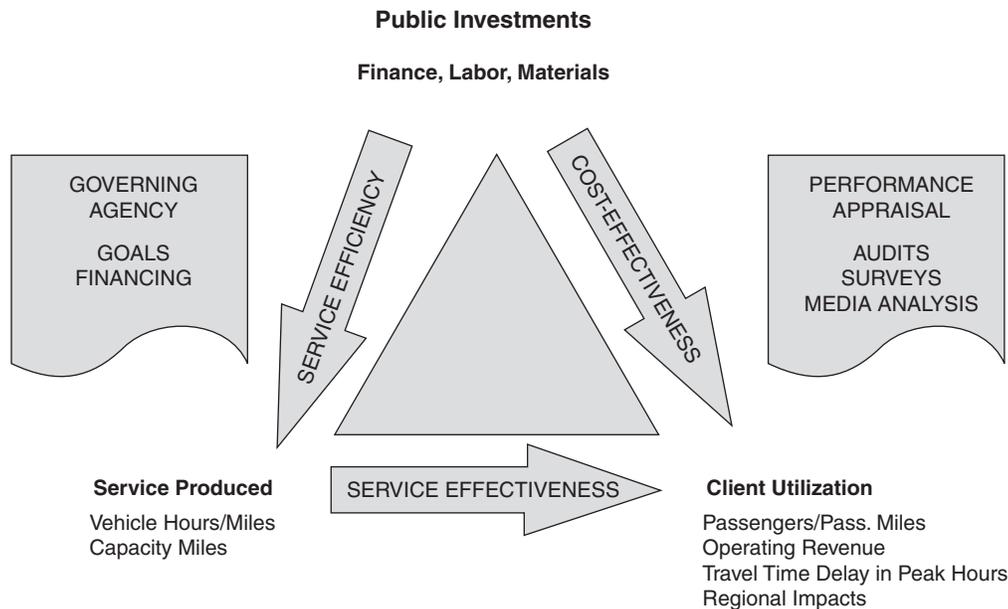


FIGURE 1 Transit performance concepts.

contracts in which the contractor is responsible for both management and physical work for a lump sum price. These contracts use performance measures to ensure compliance with effectiveness objectives, while leaving service efficiency to profit-maximizing contractors. The performance measures focus on planning and supervision, including timely inspections and processing of applications for activities in the corridor, operational

measures related to routing maintenance, and measures related to long-term pavement management.

It is always an advantage to provide information on improving conditions and to use higher numbers for improving conditions. Typically, we associate higher numbers with better performance. Presenting the number of lane miles of roadways with pavement in good condition is more effective than presenting the number

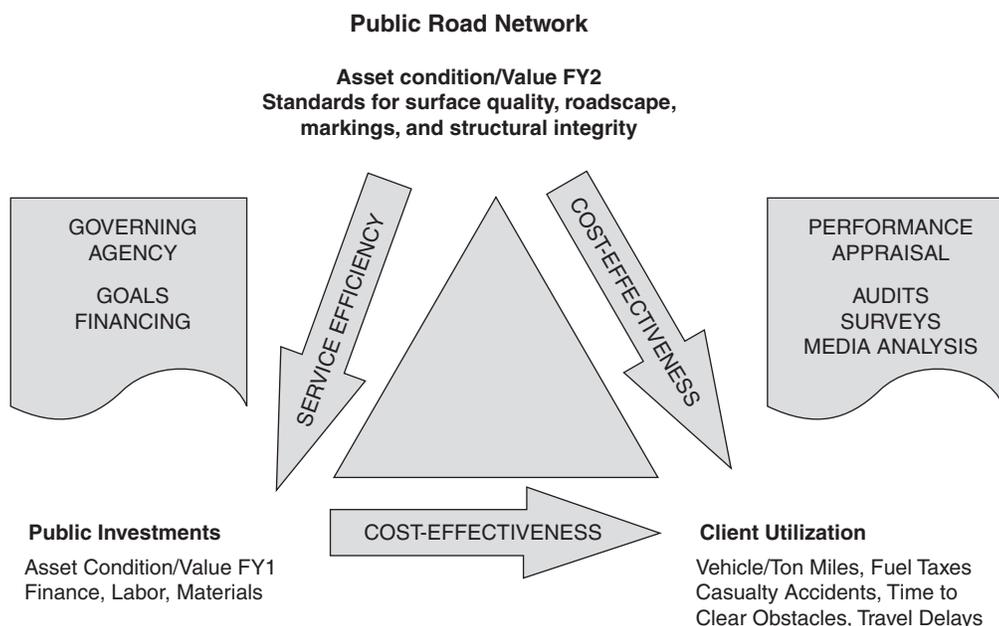


FIGURE 2 Road maintenance performance concepts.

of lane miles that are in poor condition. In addition, presenting information graphically is more effective than presenting it with data tables.

I think it is more effective to combine measures than to use ratios. For example, typically transit performance measures focus on vehicle hours of service and the cost to operate service. It is also important to address the impacts of inflation when using financial information over time. For example, examining the operating costs of one transit provider during a 10-year period without accounting for inflation would indicate that operating costs have increased from \$70 to \$90 per revenue vehicle hour. When the effects of inflation are removed, however, the increase in operating cost during the 10-year period was from \$90 per revenue vehicle hour to approximately \$95.

Other typical measures used in public transportation include operating expenses per vehicle revenue mile, operating expenses per passenger mile, and unlinked passenger trips per vehicle revenue mile. Displaying the trends in these performance measures in graphs can be effective because they represent the major dimensions of transit operations. Information on these key measures can be used internally and externally. Internally, transit agencies are highly interested in monitoring operating costs. Performance measures help identify where cost increases are occurring and why they are occurring. Providing this information to policy makers and stakeholders is also important to sustain the ongoing funding of transit services.

Often, an examination of absolute measures provides findings different from an examination of relative measures. For example, the annual number of assaults on transit passengers and operators during a 10-year period is related to the amount of service provided. As a result, examining passenger trips per assault may be a more appropriate measure than total assaults.

Making comparisons between transit agencies or other agencies is not recommended. Differences in operating objectives, operating environments, and other factors make meaningful analysis of performance difficult. Comparisons between transit agencies were attempted in the 1990s as part of a congressional mandate for triennial audits of transit agencies. Although peer comparisons may assist in establishing reasonable benchmarks for performance goals, detailed comparisons between agencies is not effective. Comparing one agency over time is a much more effective way of encouraging improvement in public agencies.

It is important to be honest in reporting performance. The most important use of performance measures is to improve an agency's internal performance. Maintaining the trust of policy makers and the public by presenting accurate performance assessments is also critical. Be honest with the use of performance measures.

## MEASURING THE VALUE AND IMPACT OF AGENCY COMMUNICATION WITH THE PUBLIC

*David Kuehn*

At the conference 3 years ago three gaps in research related to communication were identified—assessing various communication methods, examining how performance measures influence behavior, and exploring the difficulties in communicating risk. This presentation focuses on examining research and transportation agency practices during the past 3 years that are related to those gaps.

It is important to start by asking why we want to communicate performance measures. Although the answer may seem self-evident to most of us, focusing on the different reasons for communicating performance measures provides a common basis for discussion. Seven reasons for communicating performance measures were identified through a review of recent research literature. The reasons identified are legislative direction, public awareness, support for new revenue, customer feedback, accountability, trust building, and collaboration.

It is important to first define the audiences you want to communicate with concerning information on performance measures. I have used a very broad definition of customers for performance measures. Certainly, decision makers and partner agencies are key customers, as are businesses, shippers, residents, and suppliers. Travelers, which include commuters, visitors, transit riders, cyclists, and pedestrians, are also customers. Individuals obviously may be in more than one of these groups.

The Florida Department of Transportation (DOT) conducts customer surveys of residents, local officials, visitors, seniors, and commercial drivers. These targeted surveys provide important feedback from these different customer groups, which have different needs and perspectives. The City of New York has used the American customer satisfaction index survey. Results are captured by borough, ethnicity, and income. The results are used to better understand the needs and priorities of different groups. For example, results indicated that residents in the outer boroughs and those with lower incomes view transit services as important. FHWA has partnered with the Gallup organization to conduct surveys of staff at other agencies related to the environmental process and environmental stewardship.

Communicating performance measures can enhance partnerships among agencies. This communication can improve cooperation, build new partnerships, and expand on existing partnerships. The Wilmington Area Planning Council (WILMAPCO), a bistate metropolitan planning organization in the Wilmington, Delaware, area, provides one example of using performance measures to enhance partnering and coordination. The long-

range transportation planning process at WILMAPCO coordinated performance measures and data from the Delaware DOT, the Maryland State Highway Administration, and other agencies. Addressing safety performance measures in most areas requires multiple agencies and groups to work together, including nontraditional partners.

The value of communication performance measures to customers can be thought of as stair steps, with benefits progressing from building awareness, to developing trust, to obtaining support for specific measures, programs, and policies. Different performance measures may be appropriate at these different levels. Different methods of communication may also be appropriate at the various levels. The City of Baltimore uses CitiStat, a database linked to a geographic information system, to monitor street repair, snow removal, and other maintenance and operational activities. Presenting the results of these measures to the mayor and other policy makers regularly has been very effective in building support for transportation projects and programs. Surveys used as part of the Tracker system at Missouri DOT ask residents specifically about their perception of the agency's transportation expertise. Responses to this question provide an indication of the public's trust in the Missouri DOT. The Canadian Smart Commute Initiative provides an example of developing and using a benchmarking tool to track support for a program among the business community and employees.

The impact of customer communications has been examined in a few cases. Impacts represent a long-term or outcome measurement. FHWA used a quadrant analysis to assess some elements of the 2005 national survey of travelers. This analysis was used to focus on the critical weakness area, which is the quadrant of high importance, but low perceived performance. By examining the differences between the expectations for and the delivery of the program, FHWA was able to refocus delivery of the program.

A variety of methods and techniques can be used to communicate performance measures to different customers. Although there is no right or wrong method, some approaches are more appropriate for various audiences. Charts, tables, dashboards, score cards, report cards, system maps, and narrative summaries represent some of the commonly used communication methods. More detailed information is provided to technical staff, decision support information is provided to policy makers, and more general information is provided to the media and the public.

A number of transportation agencies use dashboards for communicating performance measures. Dashboards provide high-level, up-to-date information on key performance measures. Dashboards are linked to automated databases, so the information is updated on an

ongoing basis. Score cards or report cards represent another high-level approach. This technique, which typically assigns a letter grade to different measures, tends to be updated periodically. The use of interactive maps appears to be increasing. These maps provide system information, usually in real time. Users are often able to obtain more specific information on the website, which provides feedback to the agency on what is important to users.

In conclusion, I think we will continue to see an increasing use of performance measures as a marketing tool, especially to promote a strategic partnering. Using performance measures to coordinate system operations, environmental stewardship, safety, and other multi-agency topics will increase. Second, I think we will see the use of performance measures to communicate customer choice in transportation and other public service, focusing especially on quality-driven measures. Finally, I think communicating performance measures will be used more to support data-driven decisions and shared outcome orientations.

## PERFORMANCE MEASURES AND CUSTOMER SATISFACTION IN THE JAPANESE ROAD SYSTEM

*Shintaro Terabe*

To provide an international perspective on the use of performance measures, I will discuss the performance indicators used in Japan and how they relate to customer satisfaction.

Performance-based management at the national level in Japan started in 2003. The policy evaluation law was approved in 2002, and legislation addressing the long-term plan on the major development of infrastructure was approved in 2003. The central government currently uses 21 performance measures focusing on seven categories or policies. These categories are international competitiveness, traffic congestion and linking regions, safety, environment, asset management, use of the highway network, and road administration.

A systematic approach is used with performance measures. A base value from 2002 was identified for each measure, and targets were established. Progress on meeting each measure is tracked. Many of the measures are similar to those used here in the United States.

Different approaches have been used nationally to measure customer satisfaction with various elements of the transportation system. An Internet survey is used annually, with some 20,000 residents completing the survey each year. The survey includes 15 questions, using a 5-point scale for responses. Overall, customer satisfaction has been improving. The overall rating was 2.6 in 2003, 2.7 in 2004, 2.9 in 2005 and 2006, and is esti-

mated to be 3.0 in 2007. Low satisfaction levels were recorded on tolling of the expressways, however.

As you might expect, customer satisfaction levels vary by different elements of the transportation system and by geographic regions. In 2004 the overall customer satisfaction rating was 2.7. Ratings are higher in rural areas in which congestion levels are lower. Customer satisfaction related to tolling of the expressways was 1.8. Customer satisfaction related to road construction improved from 2.2 in 2003 to 2.3 in 2004, partly as a result of changes in the way construction activities are undertaken.

Performance-based management is also important at the prefecture, or local government, level. A total of 47 prefectures will develop their own performance measures. Of these, 44 prefectures have completed the initial development of performance measures, which focus on regional characteristics. Some 272 performance measures have been developed in the 44 prefectures. More than half of these measures are unique to individual prefectures. Examples of unique measures in the traffic safety area include the percentage of safe routes in school zones and the elimination of dangerous roads due to passing trucks. Customer-related measures at the prefecture level also reflect unique local characteristics. Examples of local measures include the number of users of information kiosks, the distance between roadside parking for cellular telephone use, and the number of sight-seeing spots accessible within 30 min from the expressway exits.

The Japan Highway Public Company was privatized in 2005. It was divided into three separate companies covering the eastern, central, and western parts of the country. A customer satisfaction Internet survey has been conducted since 2004. Some 8,400 individuals responded to the survey, which included 48 questions and used a 5-point scale.

The survey addressed customer satisfaction in a number of categories. Elements in the safety and comfort category focused on markings, maintenance, lighting, shoulder width, visibility, snow and ice, cleanliness, vegetation, and scenic visibility. Measures in the reliability category addressed congestion, lanes for slow traffic, number of toll booths, frequency of road closures, and clearance time for accidents. Measures in the information category focused on accuracy, highway telephone services, information available through the Internet, congestion forecasts, information boards, information kiosks, highway radio, information by ITS, and signage. Measures addressing roadside rest areas focused on congestion in parking lots, number and cleanliness of restrooms, safety, lighting, pavement, and vegetation.

Survey results are used to track changes in customer satisfaction over time. The results indicate that customer satisfaction related to reliability has improved during the past 3 years. Results are also examined to identify areas

in which improvements should be made to effect improvements in customer satisfaction. The customer satisfaction surveys provide insight into communication with the public. Customer satisfaction is based on the level of service, but public investment is limited. Communication with customers is very important. This communication should focus on providing information on current conditions and future plans. It should be used to obtain feedback from customers, input on possible projects, and ideas for new activities.

One example of a recent method to enhance communications with customers is providing real-time traffic information through the Internet and mobile devices. Information on future plans for the expressway network is also posted, including schedules for the opening of different road sections. Another example is providing ongoing press releases and newspaper articles on specific projects, such as the opening of a new tunnel and the positive impact on traffic after it was opened. Another method, which has been in use since 1998, is driver hotlines. Some 31,500 calls were received in 2006. An emergency hotline for road maintenance was established in 2005. About 30,000 calls were made to this hotline in 2006.

Other techniques that can be used to communicate with customers include meetings and site visits, adopt-a-highway programs, and public involvement strategies. Examples of site visits include a road day and a civil engineering day. Adopt-a-highway programs focus on road cleaning and vegetation management. Collaborative planning represents a public involvement technique that has been used recently.

A number of issues should be considered in monitoring customer satisfaction levels and communicating with the public. First, Internet-based customer satisfaction surveys may introduce a bias because to participate individuals must have access to the Internet. This limitation can be addressed through the use of additional telephone or mail-based surveys. Second, the ability to change customer satisfaction levels depends on the ability to make changes and improvements in services. These services can be divided into two groups—providing the right service and providing attractive service. Both types of services need to be addressed to improve customer satisfaction.

## COMMUNICATING MAXIMUM THROUGHPUT: THE DOUG MACDONALD CHALLENGE

*Daniela Bremmer*

My comments focus on the difficulty of communicating transportation performance measures to the public and the experience in Washington State with a contest on techniques to effectively communicate the concept of

maximum throughput. The contest highlighted the importance of effective communication with the public, the media, and policy makers.

Effectively communicating transportation principles, measures, and results to the public can be a difficult task for many transportation agencies and transportation professionals. We have a tendency to use technical jargon to explain performance measures to diverse audiences. It is difficult to present complex performance data in easy to understand formats. Simple questions relating to why the transportation system performs in a certain way, whether performance is improving or getting worse, what transportation agencies are doing to improve performance, and whether taxpayers and decision makers are getting their money's worth are not easy to answer.

Concepts of system efficiency and maximum throughput can be especially problematic to explain to the public and policy makers. Washington State DOT emphasizes system efficiency in its management of congestion on state highways and in investment decisions. The department uses maximum throughput as the basis for measuring system efficiency. Maximum throughput is defined as the maximum number of vehicles that can pass through an individual lane every hour, which is approximately 2,000 vehicles per lane per hour on highways and is achieved when traffic on a roadway is traveling at approximately 70% to 85% of the posted speed limit.

Washington State DOT publishes a comprehensive annual congestion report and has explored different methods to communicate system efficiency issues and results to policy makers, the media, and the public. To highlight congestion and delay levels, we have used three-dimensional graphics modeled after the delay maps that have been used in Japan. We have also used other approaches to present information and to help tell our story.

It is difficult to communicate to citizens the concept of managing the flow of traffic on highways by regulating vehicle volume and speed. We are asking the public to accept congestion thresholds and strategies that do not manage the system to free flow or posted speeds, but rather to a perceived standard. Further, maintaining maximum throughput may require the deployment of operational strategies, such as variable pricing and tolling, which may be controversial in some areas.

Douglas MacDonald, the former Washington State DOT secretary, attempted to address this dilemma in a unique way. He announced a contest, called "The Doug MacDonald Challenge," to find an effective communication tool for conveying the concept of maximum throughput to the general public, the media, and policy makers. The contest guidelines allowed each entry to submit a 175-word description, with an additional chart or graph to supplement the written explanation. The contest was sponsored by TRB and the TRB Congestion

Pricing Committee. The prize for the winning entry was \$1,000, which was donated by Mr. MacDonald. The winner was announced at the 2007 TRB annual meeting.

A total of 110 people took on Doug MacDonald's challenge and submitted entries. The finalists used a number of innovative techniques to explain maximum throughput. A few entries explained the "clogging" concept through examples such as using grass clippings in a lawn mower. Other entries were more theoretical and demonstrated the physics and logic behind the concept of maximum throughput. Still others suggested more practical solutions for achieving maximum throughput, such as adding toll lanes adjacent to existing highways to lower the overall volume on the highway.

The winning entry was submitted by Paul Hasse, a freelance writer from Sammamish, Washington. He demonstrated the concept of maximum throughput by pouring a bag of dry rice through a funnel. If too much rice, denoting vehicles, is poured into the funnel, denoting the highway system, at one time, the spout of the funnel, or the highway, becomes clogged, and very little rice makes it through the spout, representing traffic congestion during peak periods. By pouring the rice slowly through the funnel, the rice organizes itself in a more efficient manner and flows out of the spout at a more rapid rate of up to 33% faster.

The media, including television stations, featured the winner and Secretary MacDonald pouring rice through a funnel to demonstrate the concept. The winning entry demonstrated that controlling the volume and flow of traffic through a highway system is essential to achieving maximum throughput and efficiency. It demonstrated to the public how Washington State DOT may control volumes and traffic flow through ramp metering, HOV-HOT lanes, variable congestion pricing and tolling, and variable speed limits.

The challenge had some interesting secondary effects. Soon after the contest was announced, the *Seattle Times* erroneously reported that the contest was for the best idea for relieving traffic congestion, rather than explaining maximum throughput and efficiency. In response to this misinformation, Washington State DOT received an impromptu opinion poll from more than 250 individuals. This unsolicited information provided the agency with valuable insight on the public's views and knowledge of transportation issues in Washington State. Some of the suggested ideas included eliminating HOV lanes, teaching drivers how to merge, lowering speed limits, raising speed limits, and tolling of highways. In addition, 16 entries suggested building more roadways.

The experience with the challenge provides benefits to ongoing communication methods. First, communicating difficult-to-understand concepts, such as maximum throughput, and politically sensitive subjects, such as tolling and congestion pricing, is best done in an engag-

ing, humorous, and disarming manner. Second, using a presentation to engage a wide variety of audiences, such as engineers and the general public, is useful in implementing new and complex transportation concepts. Third, the demonstration was presented at the White House, to the governor and legislators, at national transportation conferences, and at chamber of commerce meetings, building interest and support for transportation. Finally, it helped in creating a successful partnership between the city of Seattle, King County, and the

Puget Sound Regional Council for a multimillion dollar grant from the U.S. Department of Transportation for tolling SR-520 in King County.

*Howard Glassman, Florida Metropolitan Planning Organization Advisory Council, moderated this session, and Katherine F. Turnbull, Texas Transportation Institute, served as rapporteur.*

## EVENING SESSION

# Perils and Pitfalls of Organizational Measures

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Pete K. Rahn, *Missouri Department of Transportation*

Archie Robertson, *Highways Agency, United Kingdom*

Rhonda Faught, *New Mexico Department of Transportation*

This session featured an international roundtable of senior transportation executives who shared their insight and experiences and described the challenges they encountered when introducing and sustaining the use of performance measures in their respective transportation agencies.

## USING PERFORMANCE MEASURES IN A NEW ORGANIZATION

*Pete K. Rahn*

When I became Director of Missouri Department of Transportation (MoDOT), I was not sure how my experience at New Mexico Department of Transportation (NMDOT) would relate to a new organization. I had a very positive experience with the development and use of performance measures at NMDOT. I was unsure whether the same approach would produce similar results in Missouri.

I am pleased to note that state departments of transportation face very similar issues. When I began promoting the use of performance measures at NMDOT in 1995, there were no public-sector agency models available to use as examples. We were really creating a new model. At that time, there was distrust, and even some fear, among employees within NMDOT that the performance measures would be used against them. We implemented the program on sheer will. Finding the right person to manage the development and implementation

of performance measures is critical to the success of the effort. I was fortunate to have an individual who did an excellent job of shaping the program.

When I became director at MoDOT in 2004, the department had been working on performance measures for several years. Support from the director appeared to be lacking in the effort, however. I had to overcome skepticism on the part of some employees who viewed performance measures as just a passing fad. Convincing midlevel managers that I was serious about performance measures took time and effort. Midlevel managers in many state departments of transportation have assumed the role of protecting lower-level staff from the whims of new secretaries or directors after changes in governors. Gaining and maintaining the support of midlevel managers is critical to successfully developing and using performance measures.

## CREATING A CULTURE OF PERFORMANCE MEASURES

*Archie Robertson*

Performance measures are just one part of the management package. You also need to establish the agency mission, culture, and vision. Creating a new culture at a public agency can be challenging. There is a need to continually reinforce the vision and the culture.

We have an additional challenge at the Highways Agency with the large number of contract workers. Our

contractors are well in tune with our performance measures. The performance measures process at the Highways Agency has gone very well.

## BUILDING ON EXISTING PERFORMANCE MEASURES

*Rhonda Faught*

I was fortunate to follow Pete as Director at NMDOT. Although performance measures were well established at NMDOT, there was a need to ensure support from the new governor. We have been able to sustain and build on previous efforts.

Although state departments of transportation face many similar issues, we all do things a little differently. For example, as part of an AASHTO-sponsored effort, we examined how seven states assessed on-time and on-budget measures. We found that each state was using a different approach. We can learn from each other and improve the way we deliver projects and services.

## ADDITIONAL DISCUSSION

After the opening comments, participants and the speakers discussed a wide range of topics. The following topics were covered in the session:

- Participants discussed the challenge of maintaining a commitment to performance management at state departments of transportation and other transportation agencies when there is a change in governor, mayor, or other elected officials. Suggestions for maintaining an ongoing commitment included establishing a strong agency culture focusing on performance measurement and maintaining support at the commission level. Another suggestion focused on (a) developing a strong relationship with the legislature or other policy body so that performance measures are expected to be used or (b) linking performance measures to specific legislative reporting requirements. It was also noted that support from midlevel managers, as well as top agency leaders is critical.

- Another suggestion was to be proactive when there is a change in the agency director, commissioner, or commissioners after an election. An example of agency staff taking the initiative to meet with a new commissioner to discuss the use of performance measures and their importance was provided to support this suggestion. Conducting periodic meetings with policy makers to review performance measures was noted as another strategy. It was also noted that goals, policies, and direc-

tions may change with new leadership, but the performance measurement process should be robust enough and strong enough to be maintained.

- The differences in the organizational structures of state departments of transportation were discussed. These differences will influence the application of performance measures and the ability to sustain their use overtime. It was suggested that no one approach fits all situations. Rather, the measures, benchmarks, and milestones need to be tailored to the characteristics of individual states.

- The need to develop performance measures related to climate change, sustainability, transportation and land use, and transportation and economic development was discussed. Sharing examples of currently used measures, as well as those in the development stage, was identified as important. Examining the experience in some European countries with these types of measures was suggested as a possible follow-up activity.

- Participants discussed the approaches that have been used at different federal agencies during changes in administrations. Focusing performance measures on the core mission of an agency or organization was noted as an important approach to maintaining continuity. Although goals and priorities may change with a new administration, the performance measures process remains intact.

- The role performance measures can play when agencies are facing reduced funding levels, as well as increased funding, was discussed by participants. It was suggested that measurement systems based on accurate data are needed in both situations. Performance measures provide the basis for sound decision making. Although it was suggested that performance measures, in and of themselves, will not result in increased funding, performance measures can be used effectively to establish the need for increased funding with policy makers and the public. Performance measures provide valuable information to communicate with policy makers on transportation funding needs. Keeping the message simple by focusing on a few critical measures was noted as important.

- Participants discussed the use of different methods to communicate with policy makers, the media, the public, and other stakeholders. Methods noted as effective included dashboards, charts and graphs, summary tables, brief narrative summaries, and other techniques. Exploring the use of other visualization techniques was suggested as a follow-up activity.

- Using performance measures to forecast future trends was discussed. The approach can be used to focus the attention of decision makers on the need for changes in current approaches, new initiatives, or other programs. Different future scenarios can also be presented

on the basis of different courses of action and federal funding levels.

- Participants discussed recent experiences with legislation and voter initiatives to increase transportation funding in different states. In many cases, suggested efforts have been linked to specific projects. Many of the measures also include specific reporting and accountability requirements. State legislatures and other policy bodies are demanding more accountability as part of increased funding. Participants discussed the safety area as an example of how performance measures can be developed and applied to build support for increased funding.

- Participants discussed the use of performance measures tied to personnel evaluations and pay in public agencies. There are examples of bonuses or merits being applied in the public sector if targets are met or exceeded. Participants noted the experience at MoDOT, FTA, and the U.K. Highways Agency. Sharing information on

these approaches was suggested as a follow-up activity. Examples of bonuses tied to both individual and to group performance were noted. The need to explore what is allowable in different states was noted as important.

- Participants discussed the roles state departments of transportation may play on multiagency teams focusing on broader issues. Examples of these types of groups include corridor coalitions, economic development initiatives, and environmental coalitions. The benefits of participating in these types of efforts were described, along with some of the issues that may need to be considered.

*Lance Neumann, Cambridge Systematics, Inc., moderated this session, and Katherine Turnbull, Texas Transportation Institute, served as rapporteur.*

## PLENARY SESSION 3

# Data and Tools

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Timothy J. Lomax, *Texas Transportation Institute*  
 Mark E. Hallenbeck, *University of Washington*  
 John J. Collins, *Traffic.com, Inc.*

**T**his plenary session addressed data needs and tools required to construct performance measurement systems, as well as different types of data and the process of integrating such data into performance measurement systems. The practice of data sharing among public and private agencies in the United States and abroad was discussed, including the need for data at the corridor and regional scale. Research needs are identified in each of the corresponding breakout sessions on pages 69–81.

## DATA FOR BETTER PERFORMANCE MEASUREMENT (AND BETTER DECISIONS, TOO)

*Timothy J. Lomax*

To help set the stage for the breakout sessions, this presentation will discuss the recent TRB transportation information needs assessment. I worked with Johanna Zmud from NuStats, Joe Schofer from Northwestern University, and Tom Palmerlee from TRB on the assessment.

The TRB transportation needs assessment was initially intended to support a policy study mandated by the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users. The assessment was undertaken to better understand the role of data and information in the transportation decision-making process, including problem identification, planning, operations, prioritization, and resource allocation. A second intent of the assessment was to establish an ongoing process to monitor and assess data needs. A third intent

was to raise the awareness of the importance of data in transportation planning, programming, operations, and decision making.

The assessment began with a survey distributed to TRB committees. Some 650 ideas were submitted from 144 TRB committees. We used these ideas and other information to create a framework to consider data needs. The framework, which is contained in TRB Circular E-C109,\* is illustrated in Figure 3. Objective and subjective information, as well as policies, feed into the decision-making process. We hope that over time, the information gaps will be identified, providing a feedback loop to improve transportation data.

We also created an information needs framework. As illustrated in Figure 4, the subject areas of the framework include data items, tools, access to information, and improvement of the practice. The framework also addresses information needs subjects, which include the physical inventory, travel data, condition and performance characteristics, and externalities. These information needs exist in both a national and a regional framework. In many cases, these two levels feed back and forth. They can also be divided into physical and operational characteristics.

We examined situations in which the use of data made a difference in the decision-making process. Interviews were conducted with key decision makers in the case study examples to obtain a better perspective on the use of data and to help establish a context for data and deci-

\* *Transportation Information Assets and Impacts: An Assessment of Needs*, <http://onlinepubs.trb.org/onlinepubs/circulars/ec109.pdf>.

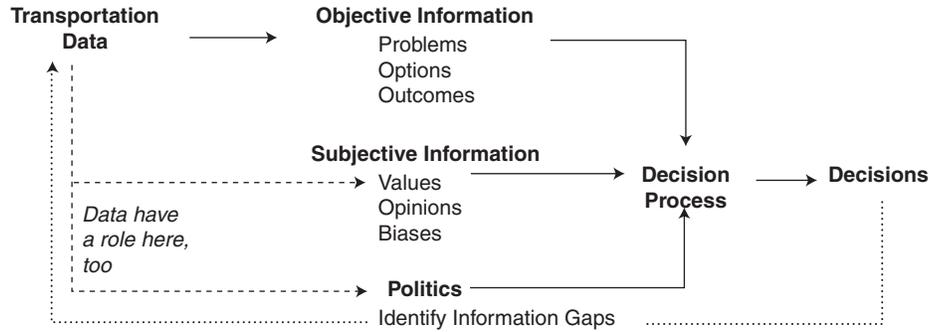


FIGURE 3 Data needs framework.

sion making. A number of common themes emerged from the interviews. First, the interviews established that data are important in the decision-making process. It is also clear from the interviews, however, that decisions will be made with or without data. If accurate, credible, and understandable data are available at the time a decision is being made, the data will be considered in the decision-making process. This theme speaks to the need to have accurate and up-to-date data sets. It also suggests that we should focus on providing the best available data to answer specific questions rather than trying to develop perfect data. This approach supports the need for a feedback loop to continue the investments in transportation data. Providing accurate and timely data to policy makers reinforces the need for better data for future decisions.

A variety of information needs were identified in the interviews. Examples of needed information included demographic trends, infrastructure conditions, and traffic volumes. Information on system performance and the outcomes of previous actions was also noted as important. Key information attributes were identified; infor-

mation should be timely, responsive, meaningful, simple, and concise. These attributes do not mean that the data should be less complex. Rather, they suggest that we need to funnel the data into performance measures that can be understood by different audiences.

This approach focuses on data as assets. Data add value and contribute to the decision-making process. Obtaining, analyzing, and maintaining data also require financial and personnel resources, time, and commitment. Good decisions are the hallmark of an effective information program. There is a critical need for sustained national data sets for national and local use. In many cases, regions are using the national data sets as default values because they do not have local data.

There is a need to obtain feedback from policy makers on what data are of benefit and how the data can be improved. This feedback can then be used to improve data collection and analysis tools and techniques, along with presentation methods.

We are seeing a growth in the use of partnerships for transportation data collection and analysis. These partnerships include public-public partnerships, as well as

Type	Information Needs Subject	National		Regional	
		Physical	Operation	Physical	Operation
Data Items	Inventory, Travel, Quantity	Miles	Persons, Freight	Miles	Persons, Freight
	Condition	Pavement, Bridge		Pavement, Bridge	
	Performance		System, Users		System, Users
	Externalities			Emissions	
Tools	Procedures, models, estimating, forecasting				
Access	Data, archiving, data, and methods				
Practice	Programs, funding, variety of actions				

FIGURE 4 Information needs framework.

public–private partnerships. The notion of sharing data—both within agencies and across different agencies and private-sector groups—is becoming more important. This trend minimizes data collection efforts, maximizes the use of data, and increases the value of data.

Advances in technology are enhancing data collection, data analysis, and data sharing capabilities. For example, new techniques allow the tracking of trip time reliability, which is a measure of interest to the public and policy makers. Technology and partnerships are improving data acquisition efficiency and allowing the use of new performance measures.

It is important to understand how data are collected and analyzed. We call this “collecting and connecting.” And it shows up in a number of situations. The results from travel surveys provide information on travel behavior and the movement of goods. Household travel and commodity flow surveys provide information on current and future demands. Asset history is important for understanding the condition and needs of different facilities. Real-time traffic data and weather and incident monitoring data should be tied together.

Transportation policies and decisions should not be made in a vacuum. Decisions should be based on an understanding of current conditions. Combining transportation and land use information can provide powerful decision support tools.

My challenge to you is to examine the data sources you currently use. Discuss these sources with personnel at other agencies, private-sector groups, and policy makers. Encourage other businesses and leadership groups to participate in this discussion to expand your potential sources of data and user groups. Recruit representatives from agencies, businesses, and community organizations to use your data and information.

## COOL THINGS YOU CAN DO WITH DATA AND WHAT THAT MEANS TO YOU

*Mark E. Hallenbeck*

My comments focus on the importance of data in the decision-making process. There is much we can learn from the private sector concerning the use of data for management and operations.

Successful, well-run companies such as Wal-Mart, UPS, and FedEx have excellent data systems. These companies use their data systems to make informed business decisions. Without accurate data systems it is difficult for a business or an agency to know what is working, what is not working, and what can or needs to be done better.

No one, including businesses and public agencies, likes to pay for data. Data collection is expensive. Further, data collection, in and of itself, is not a source of

revenue. In a well-run business, data are collected for a purpose. That purpose must be important enough to warrant the expense of collecting and processing the data. The value of the data has to be more than the expense of collecting it.

In the business world, most data collection is done as part of the routine business process. It is rarely collected as part of a special study by a specialized data collection division. Furthermore, good businesses are always exploring new applications that take advantage of the data currently collected. The intent of the applications driven by their data collection is to use those data to generate revenue for the company or to reduce the company’s cost of doing business. The benefits of the data collection, which include revenue generation or cost reduction/containment, must exceed the cost of data collection, or the company stops collecting those data. For example, the data system at Wal-Mart tracks inventory, allowing individual stores to maintain adequate, but not overstocked, supplies of products. This process ensures that the least amount of money is spent on maintaining inventory, while ensuring that items desired by customers are available in the store.

Typically, in businesses data systems are used for many different management purposes. Thus, Wal-Mart uses these same data to manage its general purchasing decisions on what products to buy, to forecast revenue, to plan store layouts, and to manage profits.

Few public transportation agencies, including state departments of transportation and public transportation agencies, are run like businesses. The attitude at many transportation agencies is that funding is not available for data collection and analysis. Most transportation agencies have limited budgets and significant, obvious, needs. Allocating limited funding for data collection is often viewed as an unnecessary luxury. I would suggest that transportation agencies often make decisions based on public and political influence. I would also suggest that transportation agencies would benefit from being managed more like private businesses. Although transportation agencies must respond to multiple goals and objectives, good data systems can aid in the decision-making process.

There is a ballot measure this November in the Puget Sound region on funding for Sound Transit and the Regional Transportation Improvement District. There has not been a great deal of data presented as part of this ballot measure. It is difficult to respond to questions raised by this measure relating to how current funding is being spent, whether agency goals and objectives are being met, and how the transportation system could be operated more effectively, without having data systems capable of addressing these subjects.

For example, congestion is common on most roadways today. Yet, in many cases, road performance is not

measured. As a result, funding and performance are not always linked. Typically, funding priorities focus on roadway construction and roadway maintenance. Funding for operating roadways efficiently is not usually a priority. Public spending is typically aimed at maintaining public support. Public support is not tied directly to the actual performance of the system. Rather, public support is often based on the visible results from the expenditures of tax dollars. Many significant operational improvements are not readily apparent to the public, but could be measured and reported, thus gaining public visibility and support. By not measuring and reporting roadway performance, we help ensure that the public does not connect congestion with suboptimal operation of the transportation system. It is also hard to show or explain congestion that does not occur as being the result of an operational improvement or action. As a result, the transportation system may not be operated as efficiently as it could be, with many roadways operating below capacity.

You can ask whether the transportation system would function differently if a transportation agency's funding was a function of roadway performance or whether your salary was based on how well roadways actually operated. Would transportation agencies operate the system differently if revenue was directly generated by roadway use? What if additional revenue was generated by improved roadway performance? Would more funding be spent on operating facilities we already have more efficiently if the pay of transportation agency personnel was also related to the performance of those facilities? If revenue increased if more people could use the roadway system during peak periods, would transportation agencies do things differently to maximize the number of peak-period travelers?

If revenue, or your salary, related to performance, the first task those involved would need to perform would be to define good performance. It would also be necessary to report actual performance, and there would be significant incentive to determine the causes of poor performance and then to remove or mitigate those causes. Transportation agencies would continually be looking for ways to improve performance and would more closely assess the expected benefits of proposed improvements. I predict that under that scenario, roadway operations would be a priority, travel choices would expand, and resources would flow to enhancements.

Managed lanes, HOT lanes, and congestion pricing reflect that approach. They also provide the financial incentives that help drive its success. In addition, they provide tools that help make active management of the system possible. Active operational management means understanding current conditions, predicting future demands and conditions, analyzing the impacts of alternative management actions, and selecting and implementing the best actions. To adopt active traffic management,

the necessary agency or jurisdictional agreements for implementing these actions must also be in place.

Agencies must also determine exactly what goal they wish to actively manage to achieve the desired results. Possible goals of active operations management might include maximizing the number of vehicles served, maximizing the number of people served, maximizing the revenue collected, minimizing delays, or maximizing the benefits gained from available funding. One might suggest that the current goal of our transportation system management is more closely tied to providing everyone with equal access to congestion.

Data are key to making active system management work. Data are needed on system demand, or road use, and on road performance, such as speed and delay. The actual versus optimum performance of a roadway can then be computed. Systems to better detect use and performance are needed, as are more flexible operational controls and more capable analytical systems. Data on facility operation would include volume by vehicle type and performance data related to speed, delay, and congestion. The status of control and enforcement systems would be needed, as would data on external events such as weather, incidents, construction, and special events.

Data collection needs to be a routine element, rather than a special activity. Data should be collected once, but should be used many times. Data should be viewed as an asset, not just a cost. In many cases, the secondary uses of data may be more valuable than the preliminary uses. For example, we may collect truck weight data to enforce weight laws, but by using those data to support pavement warranties we may save hundreds of millions of dollars. Software is available for archiving, retrieving, analyzing, and reporting data. Decision support software is also available.

Traditional uses of roadway data include identifying where congestion is occurring, analyzing the causes of congestion, and assessing changes in congestion based on system expansion and operational improvements. Examples of operational improvements that may be monitored include incident response programs, changing traffic signal timing plans, and dynamic message signs. The effectiveness of changing traffic control settings for different weather conditions, including rain and snow, can be monitored. Traffic data can also be used to analyze changes in pricing, including increasing or decreasing tolls and varying tolls by vehicle type or time of day. Still other uses include assessing incident response staff utilization and response times and examining the effectiveness of routing plans.

Operations data are important for more than just making operating decisions. Operations data can be used to analyze pavement warranties to determine whether actual traffic volumes meet the warranty targets. Operations data are important in analyzing the effectiveness of spe-

cific safety treatments and the factors influencing crashes. Operations data are also important for system planning.

Using data and performance measures reflects a proactive business culture. This culture actively analyzes and reviews performance against goals, uses objective data to judge performance, rewards good performance, and changes business practices that cause poor performance. Most transportation agencies do not reflect this proactive business culture. Moving toward this culture involves setting operational goals and establishing incentive and disincentive systems so that the agency works toward these goals.

### INDUSTRY VISION FOR REAL-TIME PERFORMANCE MEASUREMENT

*John J. Collins*

This presentation focuses on the role private industry can play in collecting data on various aspects of the transportation system. As has been noted, the use of performance measures based on reliable and accurate data is a key attribute of successful businesses. Performance measures are becoming more widely used in the public sector, including transportation agencies at all levels.

It is important to collect data once and use them for multiple purposes. Avoiding “stovepiping” of data collection, which can sometimes occur in agencies and businesses, is also important. Given the expense of gathering data, the private industry vision is to collect the key data, making sure there are multiple customers for those data. We follow this approach in our business. We could not run a successful business if we sold our data only to one television network. Our customers include multiple television networks and radio stations. We also use the data in other ways.

Multiple users of data collected by public agencies maximize resources and build support and champions. On the business side, it is important to have enough customers to keep the cost to individual users reasonable. Collecting data once and using it multiple times is important in the public and the private sectors.

The private sector can assist public agency data collection efforts in a number of ways. First, private businesses can add data to the data public agencies currently collect. For example, under a contract with FHWA, we have added sensors to fill gaps in 27 areas across the country. We also bring agency data into the same database to avoid stovepipes. Further, the private sector can provide additional applications and tools to enhance the use of data in the decision-making process.

Private industry uses numerous methods to collect transportation-related data. Examples include fixed sensors, Global Positioning System (GPS) data from truck-

ing firms, and cell phone data from cellular telephone providers. We collect data from these and other sources, process the data, and provide the data to state departments of transportation and other customers in usable formats. We can compare current and historical data, provide short-term and long-term forecasts, and conduct other analyses. It is important to turn data into intelligence that can be used to make better individual and agency decisions.

NAVTEQ owns and operates traffic sensors on more than 2,500 lane miles of roadways. These sensors provide volume, speed, length-based vehicle classification, and lane-occupancy data. GPS and cell phone coverage are used in areas to augment sensor data, providing additional spatial and temporal verification and accuracy. Real-time information can be provided on websites, historical data can be analyzed, and future trends can be examined. Data can also be used for planning and operations. For example, the Illinois Tollway uses our data summarized in Excel spreadsheets to determine lane closures for construction and maintenance. More detailed analysis can also be conducted, including examining traffic patterns by time of day and day of the week. Friday afternoons used to be the busiest traffic period on the toll road. With more people working alternative hours or taking 3-day weekends, the heaviest traffic now tends to occur on Thursday afternoons. The tollway also used our data to adjust the hours during which contractors are permitted to close lanes for road repairs.

Under our contract with FHWA, we are required to provide 95% availability. Every morning we examine all the sensors across the country to identify problems. Missing data means unhappy customers. From a business perspective, we cannot afford to have sensors malfunction. We are in the data business; not the sensor business. The heart of what we do is data processing and data storage. We follow the previously described approach of collecting data once and using it for multiple purposes. We develop specialized delivery systems for different customers.

For the Winter Olympics, Utah DOT developed an extensive real-time information system with more than 2,000 sensors. Although it is a very robust system, it was not designed to serve all Utah DOT’s current data needs. We were able to assist the agency by working with the Bureau of Transportation Statistics and Performance Measurement System (PeMS) applications to add applications that Utah DOT wanted to our data warehousing system. The methodology is relatively simple. NAVTEQ is collecting data under the federal program. Agency data and other data collected by NAVTEQ enhance the database. PeMS provides the additional traffic management tools and transportation applications. There are multiple uses for the data. The uses include monitoring the status

of sensors and traffic operations, analyzing performance measures, and supporting policy decisions.

The program with FHWA was modeled after the FAA map that shows congestion levels in the nation's airspace. It provided a powerful tool to show policy makers the need for improvements. FHWA did not have anything similar to highlight traffic congestion across the country.

Private industry can be an important partner in collecting, archiving, and analyzing transportation data. We

can add value by providing new data sensors and access to intelligent transportation system data. We can also provide new tools and applications. Remember, collect data once, but use it for multiple purposes.

*Johanna Zmud, NuStats, served as facilitator for this session, and Joe Zietsman, Texas Transportation Institute, served as rapporteur.*

## PLENARY SESSION 4

# Hot Topics

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Kotaro Nagasawa, *Mitsubishi Research Institute, Inc.*  
 Steven Gayle, *Binghamton Metropolitan Planning Transportation Study*  
 Mark Larson, *Minnesota Department of Transportation*  
 Kimberly Spence, *Virginia Department of Transportation*

**T**his plenary session presented current and upcoming innovative practices in performance measurement applied both in the United States and abroad, including Japan's *shakai-jikken* evaluative process used in project decision making; goal setting at the metropolitan planning organization (MPO) level; a tradeoff analysis method used to measure the performance of a multi-modal system; and target setting and techniques used in planning and evaluating sustainable transportation systems, road pricing, and safety and freight planning. Research needs are identified in each of the corresponding breakout sessions on pages 82–97 and in Appendix A, page 148.

## SOCIAL POLICY EXPERIMENTS IN ROAD MANAGEMENT: INTRODUCING JAPAN'S APPROACH TO ACHIEVING BETTER PERFORMANCE

*Kotaro Nagasawa*

My comments focus on an interesting road management strategy in Japan called *shakai-jikken*. The term *shakai-jikken* means a short-term trial with stakeholders' participation. The concept is close to a social policy experiment, but it is more practical and less theoretical. Before-and-after comparisons are conducted as part of the strategy.

Although the road network in Japan has improved over the past 30 years, problems related to traffic management are becoming more complex and more serious.

For example, traffic congestion is a problem in metropolitan areas, particularly during the peak commuting periods. Road safety in all parts of the country is also a concern. In most areas, constructing more highways is not possible. Consensus building with stakeholders is a key part of the process of addressing these concerns.

In Japan, we typically rely on computer simulation when we try to introduce a new policy in traffic management. Using a report based on that computer simulation, we start discussions with stakeholders to build a consensus and to move to the next stage of implementation. Performance measurement is a major element of the implementation phase.

However, questions may be posed regarding whether the proper policy has been selected for implementation. Computer simulation may not be fully reliable, particularly in complex cases such as demand management. It is against this the background that the concept of *shakai-jikken* emerged in Japan. Stakeholders are unable to forecast what will happen when a new policy is introduced. The *shakai-jikken* concept, which focuses on testing and evaluating a new approach or concept, was first proposed by the Road Committee in 2001. The first *shakai-jikken* was introduced in 2003. The first step in the process is a conference with stakeholders and academics organized by the local government. The conference participants develop the plan and run the *shakai-jikken*. The central government subsidizes the *shakai-jikken*.

I will highlight a *shakai-jikken* related to charging or pricing on expressways in Japan. The cost to use an expressway is normally approximately 30 cents per mile, yet there is no charge to use local roadways. As a result,

local roads are congested, especially during peak commute times. The expressways have capacity at these times. The idea of reducing the expressway charge to encourage traffic to move from the local roads to the expressway and to better use the infrastructure represents one shakai-jikken.

The shakai-jikken of flexible charges started in 2003. There were 22 trials in 2003, 41 trials in 2004, and 12 trials in 2005. These 75 trials are located in different areas and test different ways of introducing flexible charges for use of the expressways. Issues examined in these trials include the most effective time periods to reduce charges, the level of the reduction, and the type of vehicles to target for the reduced fees. Different methods for stakeholder participation in the shakai-jikken are also being explored to help identify the most effective techniques.

Examples of the time periods tested for the reduced fees on expressways included 7:00 a.m. to 9:00 a.m. and 5:00 p.m. to 7:00 p.m., 6:30 a.m. to 9:30 a.m., and all day. In the trials providing reduced charges during the morning and afternoon peak periods, traffic on the local roads was reduced by 3% to 6%. The length of traffic congestion or queuing also decreased.

In addition, the most effective discount rate was examined. Although drivers would welcome no toll at all, this change is not realistic to consider. The elasticity of the charges was calculated on the basis of the result of the surveys conducted with some of the shakai-jikken trials. When the discount rate increased from 30% to 50%, the elasticity went up slightly. The elasticity went down, however, when the discount rate went from 50% to 70% based on one sample. I do not think we have enough data to confirm the most desirable discount rate is 50%, however.

Information was also obtained on drivers' reactions to different discount rates. Approximately 30% to 60% of the drivers reported satisfaction with a discount rate of 30%. Some 80% to 90% of drivers were satisfied with a discount rate of 50%. These results suggest that there is no reason to set the discount rate higher than 50%.

The trials also highlighted the importance of public relations and public information in successful projects. The first stage of public information on one project included press releases and a website. At the end of the first stage, only 10% to 30% of local drivers knew that there was a plan to reduce road charges in the area. To increase public awareness, the organizers used a large banner, distributed fliers, and placed a newspaper advertisement. Four weeks after these approaches were implemented, the number of local drivers who knew about shakai-jikken increased to 90%. Experiments with congestion charging have also been conducted in Sweden

and other countries. In September 2002, the Swedish government and the Stockholm City Council proposed to introduce congestion charges in the Stockholm area. The congestion pricing system was introduced during the first half of 2006. The infrastructure included an IBM electronic toll collection system. The results during that trial period indicated that ridership on public transportation increased by 6%, and road traffic decreased by 25%. The pricing system was supported by approximately 53% of Stockholm residents, but residents in suburban areas did not favor the program.

Shakai-jikken should be considered in the context of policy management. There are three key points to the use of this approach. First, shakai-jikken is a strong tool to ensure more realistic plans that can be implemented. Second, shakai-jikken provides a method to introduce new types of policies. In Japan, it was difficult to predict what would happen when expressway charges were changed because there was no prior experience. The shakai-jikken approach provides a way to test these approaches. Third, shakai-jikken provides the opportunity for stakeholders to communicate with each other. Cooperative processes enhance the chances of successful implementation of new policies.

Shakai-jikken has been discussed at some academic conferences in Japan. Some elements need to be examined more closely. First, the costs and benefits of each shakai-jikken should be evaluated. Second, there may be a bias in the result of shakai-jikken, because stakeholders are highly motivated while a trial is in operation. Third, more thought needs to be given to the consensus-building process included in a shakai-jikken. Although the shakai-jikken research has a strong practical side, theoretical research is going to become more and more important.

#### USING TRANSPORTATION SYSTEM PERFORMANCE MEASURES IN PLANNING: METROPOLITAN PLANNING ORGANIZATION PRACTICE

*Steven Gayle*

My comments focus on the use of transportation system performance measures in the planning process conducted by metropolitan planning organizations (MPOs). I highlight examples from MPOs throughout the country. System performance is important to MPOs for several reasons. First, MPOs are stewards of the multimodal metropolitan transportation system. Second, MPO board members, who are mostly local officials, understand the importance of measuring performance. Third, the public, who are MPO customers, know when the

transportation system is not working because of congestion, mistimed signals, and other problems.

MPOs have traditionally been involved in measuring and monitoring the performance of physical assets, including pavement deterioration and deficient bridges. The modeling and forecasting process used by many MPOs has historically been based on recurring congestion. We are just beginning to examine how measuring the operational performance of the system can benefit MPO planning tasks.

System performance measures have many uses and applications. They can be used to identify the attributes of the transportation system that are most important to a metropolitan region. Performance measures provide information on current system conditions and performance. They provide a metric for communicating with decision makers and the public about past, current, and expected future transportation system conditions. System performance measures also serve as criteria for investment decisions made in the transportation planning process, and they can be used to evaluate the success of projects and programs.

The Chicago Metropolitan Agency for Planning Regional Transportation Plan (RTP) provides one example of the use of performance objectives. One objective in the RTP is to develop a transportation system that (a) facilitates management and operation communication abilities and real-time decision making; (b) improves the transportation system information available to travelers and system operators; (c) reduces nonrecurring delay by reducing the number and duration of highway incidents and improves transit system on-time performance; and (d) reduces recurring delay through access and speed management, value pricing, improved design, and incentives encouraging alternate modes of travel.

Another objective in the RTP is to promote transportation proposals that (a) reduce highway congestion; (b) improve system reliability; (c) provide improved transportation management capabilities; (d) maximize performance benefits through intensive management, (e) increase person throughput in congested corridors by increasing vehicle occupancy, providing transit options, and encouraging transit use; (f) increase the share of trips made by walking, bicycling, and transit; and (g) improve coordination and connectivity between and among different modes.

The Capital District Transportation Committee in Albany, New York, has a comprehensive measurement program that includes a series of principles. The first principle is that management of demand is preferable to accommodation of single-occupant vehicle demand growth. A second principle is that cost-effective operational actions are preferable to physical highway capacity expansion. A third principle is that incident management

is essential to effective congestion management. Still another principle is that any major highway expansion considered by Capital District Transportation Committee will include a management approach.

These principles are linked to performance measures, which focus on access, accessibility, congestion, and flexibility. The planning time index is a measure of reliability and predictability of travel time, reflecting the importance of nonrecurring delay on expressway segments. Expressway data come from the New York State Department of Transportation Management Information System for Transportation. This index is used with decision makers and other stakeholder groups.

The North Central Texas Council of Governments (NCTCOG) is the MPO in the Dallas–Fort Worth Metroplex. NCTCOG prepares and publishes an annual Transportation State of the Region, which is used by the policy board in decision making. Performance measures used by NCTCOG include the congestion index, fatal and injury crashes, air emissions, and transit ridership.

Metro is the MPO in the Portland, Oregon, area. Metro has freeway and roadway performance measures that use intelligent transportation system data. Examples of measures include the severity and duration of freeway congestion and the variability in speed. Travel time contours, which measure how accessibility is affected by congestion, are being developed. Metro is also establishing baseline performance measures.

The Metropolitan Transportation Commission (MTC) is the MPO in the San Francisco Bay Area. The MTC also operates elements of the transportation system. The MTC's Transportation 2030 report states that "Traffic management and operations strategies, such as incident detection and real-time information, and increased use of new technologies, are key to reducing the impact of traffic congestion on people's lives and businesses." The MTC's state-of-the-system report includes congestion measures that focus on peak period vehicle hours of delay, average commute time on specified routes, the buffer index, local road congestion, and transit on-time performance.

As other speakers have noted, there are challenges and limitations with the use of performance measures by MPOs. One challenge is selecting regionally important performance measures. Other challenges include instrumenting the transportation system, especially beyond freeways, to provide needed data; obtaining data on all transportation modes; and archiving and analyzing data. It is also important to consider the link between operation and management performance measures and modeling. In air quality nonattainment areas, travel models must be accepted in the conformity process, but many lack an accepted method for modeling the benefits of

operational strategies. A final challenge is the trade-off of credibility versus accuracy of real-time performance data.

## STRATEGIES TO ACHIEVE TARGETS: EXPERIENCE IN SAFETY

*Mark Larson*

My comments focus on approaches to setting aggressive performance targets and the strategies needed to achieve them. I will highlight the safety and the Toward Zero Deaths (TZD) program in Minnesota as a case study. I will describe elements of the program and the results experienced to date. I will also highlight possible implications of using performance targets in other policy areas, including economics and freight.

Performance targets provide a powerful tool for driving improvement. Performance targets provide a basis for establishing a common vision within an agency, across a state, or among multiple organizations. They can provide organizational motivation and mobilization of people, strategies, and organizations. Performance targets establish a basis for common action with partners. Measures and targets also provide a basis for data-driven analyses of factors that influence performance.

Performance targets and target levels can be based on a number of different factors. Historical trends can be used to establish baselines and predict future trends. Economic measures, such as benefit–cost ratios and life-cycle costs, may be used to establish performance targets. Fiscal measures addressing available resources and constraints provide input for establishing performance targets. Other sources for identifying performance targets include engineering factors and customer input or feedback. Performance targets should reflect the values and the vision of an agency, organization, business, or program. Legal or regulatory requirements may also be used for setting performance targets.

Transportation agencies, including state departments of transportation and MPOs, influence, but do not fully control, outcomes related to safety, freight, the economy, and sustainability. The public expects leadership from us in these areas, however. The lack of results on key public issues may undermine respect for governmental agencies, which may affect funding. Other countries and international bodies have measures and targets for safety, the economy, and the environment. For example, the United Nations Millennium Development Program has set aggressive targets for reducing poverty. Transportation is an important element supporting this effort because it provides access to jobs and health care. The transportation system is expected to contribute to broader societal goals.

Transportation organizations typically need to partner with other agencies, organizations, and the private sector to achieve the desired results for important societal measures. Transportation agencies may take the lead or may be a member of a coalition.

The TZD initiative in Minnesota provides an example of a coalition developed to reduce roadway fatalities. It was started in 2001 as a partnership between the Minnesota Department of Transportation (Mn/DOT), the Minnesota Department of Public Safety, the Minnesota Department of Health, counties, FHWA, the University of Minnesota’s Center for Transportation Studies, and 25 community coalitions. Other Mn/DOT initiatives support the effort. The Mn/DOT 2003 statewide plan sets targets for reducing fatalities. District plans and regular State Transportation Improvement Program “check-ins” support and monitor progress toward meeting these targets. The Strategic Highway Safety Plan includes customized analyses and strategies by district. It was completed this year, building on the Comprehensive Highway Safety Plan (CHSP) established in 2005. Minnesota was among the first states to create such a plan.

In 2003, Mn/DOT, under the leadership of then Commissioner Elwyn Tinklenberg, set its first target in the statewide transportation plan for the reduction of roadway fatalities. The absolute number of fatalities was selected as the measure, rather than the fatality rate, and targets were set for 20 years into the future. A straight-line trend projection showed a steady increase in fatalities from the base of 633. After extensive debate, two levels of targets were established for reduction in fatalities over 20 years—a moderate target of 600 and an aggressive target of 550. Later, a far more aggressive TZD target was set at 500 for 2008, on the basis of improving at a rate parallel to the FHWA target.

What strategies would be used to achieve such challenging targets? The CHSP started with data analysis of factors driving fatalities over the base period of 2001 to 2005. Factors influencing fatalities, such as driver behavior and infrastructure elements, were ranked. The top two fatality factors were related to driver behavior. A total of 52% of the fatalities involved unbelted vehicle occupants, and 36% were alcohol related. Further, 28% were speed related, and 24% involved drivers younger than 21 years of age. A total of 33% of the fatalities occurred at intersections, 32% were single vehicle run-off-the-road crashes, and 20% were head-on and sideswipe crashes.

This analysis was used by the CHSP multiagency team to develop strategies focusing on the top five critical emphasis areas identified from the data. The first emphasis area is to increase seatbelt use and reduce impaired driving. The second strategy targets improvements to intersection design and operations. The third strategy focuses on lane departure issues to reduce head-on and

across-median crashes, to keep vehicles on the roadway, and to minimize the consequences of vehicles leaving the roadway. The fourth strategy focuses on young drivers and curbing aggressive driving. The fifth strategy addresses increasing driver safety awareness and improving information and decision support systems.

In all, there are 15 critical strategies. Under enforcement, the strategies focus on providing adequate law enforcement resources, passing and implementing a primary seatbelt law, implementing automated enforcement, implementing a stronger graduated driver licensing system, supporting the enforcement of traffic safety laws, and targeting enforcement. The strategies under engineering address cost-effective lane departure improvements, cost-effective intersection improvements, roadway maintenance, and road safety audits. The education strategies include a communication and marketing taskforce, a high-level traffic safety panel and a legislative action committee, and enhanced driver education. The emergency medical services strategy is development of a statewide trauma system.

In the area of enforcement, a speed management strategy and program was created. The speed limit on 905 mi of two-lane, two-way roads with excessive average motorist speeds was raised from 55 to 60 mi per hour (mph) in 2005. At the same time, enforcement was increased on these segments and others where fatalities were increasing. A public education campaign was also undertaken. Mn/DOT provided supplementary funding to the state patrol for the increased enforcement. The results of these efforts, evaluated by the University of Minnesota Center for Transportation Studies, indicated a significant decline in vehicles traveling more than 70 mph.

To address lane-departure fatalities, Mn/DOT is installing cable median barriers on at-risk segments of freeways. Currently, 36 mi of cable median barriers have been installed in two districts. An additional 53 miles of cable median barriers have been planned and funded, and 155 more mi have been planned but are not yet funded. The installation cost for cable median barriers is approximately \$100,000 per mi. A preliminary evaluation indicates that at least two lives have been saved during the first year since the cable median barriers were installed.

A new local government partnership strategy has been initiated to fund safety projects in individual counties with \$4 million from a central safety fund. A total of 63 applications for project funding were received from 46 of 87 Minnesota counties; 40 projects in 34 counties were funded. Projects address lane departure strategies, intersection lighting, enhanced signing, guardrail upgrades, geometric improvements, and road safety audits.

It is important to monitor progress in achieving performance targets. Ideally, reports should cover the trend in the primary outcome measure compared with the tar-

gets and the outcome or output results broken down by causal factor or by strategy areas. Mn/DOT's Office of Traffic, Safety, and Operations reports annually on fatality trends to the executive staff, districts, and other stakeholders through the Safety Performance Report. The Freight and Commercial Vehicle Operations Office also reports annually on fatality trends versus targets.

Fatalities on roadways in the state have declined every year since 2003. There were 494 fatalities in 2006, which was the lowest number since 1945 and below the TZD's targeted number of 500 fatalities. A new TZD target of not more than 400 fatalities for 2010 has been set. Nonengineering solutions have played a major role in reducing fatalities, including the TZD partnership and the passage of .08 alcohol legislation. From a benchmarking perspective, in 2005, the Midwest states had lower fatality rates than the national average, and Minnesota had the fourth lowest fatality rate in the country.

Additional safety strategies will be implemented in the future. A primary seat belt law has not yet been passed by the state legislature. This law is estimated to raise seatbelt use from 83% to 93% and to prevent some 40 deaths a year. Implementation of the Statewide Trauma System is estimated to reduce fatalities by 9%.

Reducing truck-related fatalities in the state is also important. Mn/DOT's Freight and Commercial Vehicle Operations Office is responsible for heavy truck permitting and safety. The 2005 Heavy Vehicle Safety Plan includes a target for reducing annual truck-related fatalities from 81 in 2004 to 70 or fewer by 2008, building on reductions achieved the previous 5 years. The office is part of the Strategic Highway Safety Plan partnership. Strategies to reduce truck-related fatalities focus on law enforcement and inspection, cost-effective road and roadside improvements, stronger commercial drivers license requirements, and the use of four-cable median barriers.

I would like to briefly discuss insights from other policy areas, including economics and freight. The Minnesota State Aviation Plan, required by FAA and prepared by Mn/DOT's Aeronautics Office, provides an example of targets related to economics that are beyond the control of the department. One of the targets is that 90% of the state's population should be within a 60-min drive of scheduled airline service. Currently, 86% of the population has airport access within 60 min. Mn/DOT's Aeronautics Office is working aggressively with the Minnesota city of Marshall, a major employer (Schwan's Foods), and Northwest Airlines to try to fill a service gap in the southwest region.

Freight is another policy area where performance indicators for outcomes beyond agency control are being used. Freight tonnage in Minnesota is expected to increase by 60% overall by 2020. Freight tonnage carried by rail is forecast to increase by 36%, and tonnage carried by truck is estimated to increase by 80% by

2020. The impact of these trends on pavements and bridges, as well as the impact on congestion, has been discussed by senior staff. The discussion evolved into possible influences and roles the department could play to affect rail capacity and the railroad share of freight. The state currently has only a small grant program to help short-line railroads. If these indicators become performance measures at Mn/DOT, we would need to establish new partnerships and strategies.

In conclusion, I will suggest several elements of successful practice. First, set forth a vision and high-profile targets to motivate people. Second, analyze data to break down key factors driving results and identify strategies and champions. Third, develop partnerships—one agency does not always have all of the necessary resources to meet the targets. Steps in developing successful partnerships include opening discussion, developing a plan, developing measures and common targets, sharing technical resources, and sharing program resources.

### MULTIMODAL TRADE-OFF ANALYSIS FOR PLANNING AND PROGRAMMING

*Kimberly Spence*

I will discuss some of the key elements in the resource paper prepared for this conference on multimodal trade-off analysis for planning and programming. I would like to acknowledge the coauthor of the paper, Mary Lynn Tischer, who was unable to attend the conference. My comments focus on defining multimodal trade-off analyses, describing some of the barriers to multimodal trade-off analyses, and highlighting the state-of-the-art and the state-of-the-practice with multimodal trade-off analyses. I will also present examples from Virginia and describe our experience with the use of multimodal trade-off analyses.

I started my career as a consultant. I realized at the time that clients could get projects completed three ways—good, fast, and cheap—but they could only get two of the three. That is, clients could get a project cheap and fast, but they would probably not have a good product. They could get a project done well and fast, but it would probably not be cheap. These examples represent trade-offs. You have to identify what is important to you and whether you are willing to sacrifice performance in one category for performance in another category.

Multimodal trade-offs can be defined as the process of evaluating potential solutions by considering the trade-offs of investing in one mode or program over another to determine the best overall investment. Several potential barriers to multimodal trade-off analysis can be identified. First, there is limited flexibility in many

federal and state funding programs. Second, transportation planning tends to be organized around individual modes. That means planning and implementing multimodal transportation projects can be difficult because of the complex and cumbersome process of coordinating the efforts of multiple agencies and departments. Frequently, multimodal transportation plans are simply the aggregate of individual modal plans rather than an integrated analysis of multimodal transportation. Other barriers include the lack of mode-neutral performance measures and the lack of data and analytical tools to facilitate comparisons across modes. Performance data on different modes are available at various levels of detail. Finally, politics may be a barrier to multimodal trade-off analysis, because politicians may champion a specific project regardless of the analysis results.

A number of different approaches are being used by state transportation agencies to conduct multimodal trade-off analyses. Benefit–cost analyses are one of the most commonly used methods. This technique converts project benefits and costs to a single ratio. This approach converts disparate impacts to a common metric, so it levels the playing field. In practice, benefit–cost analyses can be data intensive and often require value judgments in assigning monetary values to qualitative measures. This approach can also disguise the magnitude of costs and benefits. For example, a high cost–high benefit project and a low cost–low benefit project may have similar ratios. There are different types of benefit–cost models. In Virginia, we have a benefit–cost model that is used to assess projects to be considered for rail enhancement funding.

Cost-effectiveness models represent a second approach. These models reduce complex impacts to a single monetary value. Objectives or outcomes are identified, and the cost to achieve each is compared. The models measure how closely a project corresponds to a goal in relation to its cost. The approach facilitates comparison of alternatives rather than identifying a single best solution. The Hampton Roads Planning District in Virginia uses a cost-effectiveness model to program congestion mitigation/air quality projects. The cost per ton of emissions reduced is identified for each project and compared.

Least-cost planning represents another approach. Least-cost planning is similar to benefit–cost analyses and cost-effectiveness models in that it converts project impacts to a single monetary value. It measures the degree to which a project meets a predefined goal. The difference from the other approaches is that least-cost planning identifies the lowest cost project that meets the performance goal. This approach enables comparisons of different types of projects. Least-cost planning is used in Washington State. The Puget Sound Regional Council

has developed a series of performance measures to prioritize highway, high occupancy vehicle (HOV), and transit projects in the congestion mitigation plan.

Mode-neutral approaches represent still another technique for conducting multimodal trade-off analyses. This approach facilitates the comparison of competing modes and permits an unbiased assessment of modal alternatives. Person miles of travel provide an example of a mode-neutral measure, compared with vehicle miles of travel, which reflects motor vehicle and roadway use. It is difficult to find measures that are not dependent on a particular mode or program category, however. Further, not everything can be measured the same way. For example, auto accessibility may be measured by auto ownership, whereas transit accessibility might be measured by the distance to a transit stop. Also, different geographic scales are frequently associated with different modes. Finally, this approach may limit the objectives that are addressed.

A final method that may be considered is multicriteria/goals achievement analyses. This approach measures the degree to which a given improvement meets broader goals. A scoring system is used to evaluate alternatives over a common set of evaluation objectives. This technique may incorporate weights to reflect policy objectives. The use of the goals-achievement matrix can be more transparent than other techniques because the simplified scoring scheme may be easier for policy makers and the public to understand.

Many state departments of transportation tie long-range goals to performance measures. Most states also monitor system performance. Some states use performance measures to identify projects for incorporation into the long-range plan. Further, some states use performance measures to identify projects for programming. In most cases, performance measures are used to compare projects within a specific funding program or category. States also use different approaches for conducting multimodal trade-off analyses. Oregon uses a benefit-cost analysis to assess trade-offs among 10 different facility types, including bus, rail, port, and air. The approach used in some states assigns additional points to projects that incorporate multiple modes.

The Virginia Department of Transportation uses performance-based planning. Virginia's long-range transportation plan, VTrans2025, addresses highways, rail, transit, ports, and airports. State legislation prohibited the plan from being just an aggregation of individual modal plans. It includes a long-range vision and goals to

guide transportation decision making in the state. Performance measures are identified for each goal.

The original intent of the plan was to identify major statewide multimodal corridors and to prioritize projects within the corridors. A goals-achievement matrix was used to evaluate projects according to the performance measures. Weights were assigned to reflect the importance of policy priorities. For example, the goal related to the efficient movement of people and goods was given more weight than the quality-of-life goal. Ultimately, the prioritization system was only applied to highway construction projects. More than 1,000 highway projects were evaluated using the goals-achievement matrix. Each performance measure had a specific scale associated with it, and points were given to projects that benefited multiple modes. Projects were sorted into tiers. Based on their scores, Tier 1 projects were identified as immediate needs and were suggested for qualitative review. The qualitative information was provided to decision makers for use in making programming decisions. Additional elements were also included in the evaluation. Examples of these elements were HOV usage, truck counts, and bicycle and pedestrian access.

The review of the practices in different states identified some common trends. First, almost all states include multiple measures in the long-range transportation planning process. Second, most states use criteria for selecting projects for a specific program or mode. Most states allocate funds within specific programs, however, and prioritize projects within these programs. Many MPOs flex funds between programs, and a few states prioritize across modes.

This review highlights that multimodal trade-off analyses can be conducted using complex methodologies or simplified nonquantitative approaches. Some states are using these approaches. Decision making for project selection is becoming more closely linked to the planning process, regardless of the exact analysis technique used. Consideration of multiple modes is being incorporated into the planning process. The planning process is also being more closely linked to the overarching goals contained in the long-range plan. And, as we all know, political considerations will continue to play an important role in programming decisions.

*Randall Halvorson, Cambridge Systematics, Inc., moderated this session, and Josias Zietsman, Texas Transportation Institute, served as rapporteur.*

## PLENARY SESSION 5

# Performance-Based Contracting and Measuring Project Delivery

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Paresh Tailor, *Highways Agency, United Kingdom*

Amado Rubio Athie, *Secretariat of Communication and Transport, Mexico*

Stephen C. Beatty, *KPMG LLP*

Sidney Scott III, *Trauner Consulting Services, Inc.*

This plenary session identified and discussed techniques used in the contracting process to convert existing project standards into a performance-based framework for improving road quality and operating conditions. With an emphasis on public–private partnerships used both in the United States and abroad, the following methods were detailed: design, build, finance, operate (DBFO); concession agreements; provision of service; and asset utilization and bonus incentives to promote better highway planning and traffic operations. Research needs from the corresponding breakout sessions are identified on pages 98–108 and in Appendix A, pages 148–149.

## PERFORMANCE-BASED CONTRACTING IN THE UNITED KINGDOM

*Paresh Tailor*

My presentation focuses on performance-based contracting in the United Kingdom, including the use of the DBFO concept. DBFO represents the United Kingdom’s form of private finance initiative (PFI) contracts for roadways. We have a long history of using PFI contracts in the United Kingdom. Early PFI projects included the Queen Elizabeth II Bridge, the Second Severn Crossing, and the Birmingham North Relief Road.

DBFO is part of the government’s public–private partnership (PPP) initiative. This initiative focuses on having the private sector take over traditionally public-sector roles to provide better value for the money. As the name indicates, this approach includes having the private sector

design, build, finance, and operate a roadway, bridge, or other transportation facility. The DBFO concept was presented in a 1993 green paper titled “Paying for Better Motorways.”

The 1993 green paper identified several objectives for DBFO. These objectives included to ensure that the road is designed, maintained, and operated safely; to transfer the appropriate level of risk to the private sector; to promote innovation, both technical and financial; to foster the development of a private-sector road-operating industry in the United Kingdom; and to minimize financial contributions from the public sector. These objectives are still relevant to DBFO projects today.

There have been two phases of DBFO projects awarded. The first phase, split into two groups, consisted of eight projects, all awarded in 1996. The projects varied in size and cost from approximately \$19 million for small new works to \$428 million for significant new motorways. The projects were financed using a payment based on shadow tolls. The initial DBFO contracts were seen as a precursor to real tolls; therefore, shadow tolls were selected. The government at the time anticipated a “pay-as-you-go” or pricing system at some point in the future. This transition has not occurred.

In 1997, there was a change of government in the United Kingdom. The new government initiated a review of the roads program, including the DBFO projects, and all but one of the anticipated DBFO projects were stopped. In 2000, after the review, a revised program of 80 possible future projects was announced. Since 2000, this program has increased to include up to 113 possible projects. The projects include a mix of

motorway widening, trunk road widening, junction improvements, and bypasses. Approximately 47 of these projects have been completed to date. The total value of the remaining projects is approximately \$24 billion.

In 2000, the government also approved a second phase of three DBFO projects. The three projects were all high value and involved a variety of payment mechanisms. Two projects used a congestion pricing mechanism, and one used a lane availability pricing mechanism. The risk sharing in DBFO contracts is also important. The general basis of the contracts is for the public sector to transfer as much risk as possible to the private sector. The one risk retained by the government is the acquisition of land for the projects. The government ensures that the right-of-way is available so that the projects can move forward.

To date, 11 DBFO contracts have been awarded by the Highways Agency. Three PFI contracts have also been awarded. These contracts are the M6 Northern Relief Road (M6 Toll), which is the first and only toll road in England; the National Traffic Control Center, which is part of the agency's improvement in services as it moves toward being the network operator; and the National Roads Telecommunication Center, which is updating and improving the telecommunication networks adjacent to the Highways Agency network. These three contracts have a capital value of just less than \$4 billion. The next DBFO, which is currently being developed, is on the M25. It is anticipated to be awarded in 2008.

The typical DBFO structure involves numerous public- and private-sector groups. All the contracts include some type of performance mechanism that must be monitored. The Highways Agency has overall management responsibility for the DBFO contract. The lead DBFO company typically includes contractors from the design, construction, operation, maintenance, and financial sectors.

The core service delivery requirements for DBFO companies are defined in each contract. These requirements include providing a safe highway, including reducing casualties and maintaining a safe and serviceable network. Other requirements focus on minimizing disruptions and delays from incidents and maintenance, as well as keeping travelers informed, including maintaining the necessary technology.

Several benefits may be realized using DBFO contracts. Potential benefits include fostering development of a private-sector road-operating industry and improved cost certainty. Other possible benefits include making more reliable and accurate expenditure forecasts, transferring appropriate levels of risk to the private sector, and improving partnerships between the public and private sectors. Still other potential benefits include promoting innovation in all areas, including finance, and providing a better value for the money. An independent audit indicated a 15% savings using DBFO contracts, compared with the traditional public-sector approach.

The DBFO process provides benefits to the public sector, the private sector, and customers. The public sector obtains a better value for the money. The private sector benefits from a secure revenue stream. Customers benefit from safe and more reliable roadways and other transportation facilities and services.

Finally, let me provide a little information about the latest DBFO project. The M25 London Orbital roadway is the next DBFO project, which is scheduled to be awarded in 2008. It will be the largest DBFO project awarded by the agency. The overall project, including construction, operation, and maintenance is valued at approximately \$10 billion. The M25 is the largest ring road in the United Kingdom and is currently very congested. With the impending 2012 Summer Olympic Games being hosted in London, one of the main requirements of the contract will be that no construction can be scheduled during the Olympic period. This makes the contract a little more difficult. We are also looking at how to maximize management of the new lanes. The five main performance criteria for the contract will focus on lane availability, route performance, condition, safety performance, and proactive management.

## PERFORMANCE-BASED CONTRACTING AND MEASURING PROJECT DELIVERY: MEXICO

*Amado Rubio Athie*

We all share a common problem of obtaining adequate funding for transportation projects. Innovative approaches are needed to address transportation financing requirements.

Mexico needs significant investments in the highway sector. On an annual basis, Mexico's road construction and maintenance needs require an average of approximately \$5 billion. Available public funds allow the federal government to invest less than half the required amount. To close this gap, Mexico has developed three public-private partnership (PPP) models that seek to attract private capital to highway investments. The three models are highway concessions, PPPs or projects for the provision of service (PPS), and asset utilization. Highway concessions use toll income, PPSs use service payments, and asset utilization maximizes existing toll road income flows.

These models have been applied in the health, education, and transportation sectors. Six performance-based contracts have been awarded in transportation. The first service contract, to modernize the Irapuato-La Piedad federal road, was successfully awarded in August 2005 and will be finished in the middle of 2008. These approaches are helping increase the roadway inventory in Mexico.

The PPP model has several objectives. These objectives include allowing an earlier development of Mexico's free roads, although the model has also been used with new toll roads. Other objectives include increasing the amount of road investments with private participation, adding value to the services offered to users, and increasing the efficiency and productivity of public services. Still other objectives are to create new opportunities for the private sector and to better distribute and manage highway project risks.

The PPP model has a number of characteristics. A concession is awarded through a public bidding process, which also grants the concessionaire the exclusive right to sign the service contract. The duration of the service contract is fixed, from 15 to 30 years. The contract is fixed in time and amount. The contract establishes an association between the ministry and a private firm to design, finance, build, maintain, and operate a highway. The private firm provides services in exchange for periodic payments. The periodic payments are based on the availability of the road and traffic levels.

Each bidder requests a periodic payment determined as a function of construction, maintenance, and operating costs; the rate of return on equity, including financial costs; estimated annual traffic; and duration of the contract. The net present value of the periodic payments is the decision criterion used to award the concession, if the winner complies with technical, legal, and financial requirements. The government always maintains the property of the road. At the end of the concession period, the road is returned to the government. When the model is applied to a toll road, the periodic payment is made with a combination of toll revenues and budgetary funds.

The risks in PPP projects are divided between the government and the private sector. The government retains and manages the risks associated with planning and permitting, regulatory changes, and demand. The risk associated with design, construction, productivity, obsolescence and hidden faults, operation, and financing are transferred to the private sector. The risks related to force majeure, archeological findings, and inflation are handled and managed by the government and the private sector.

The legal structure begins with the bidding process. The bids are evaluated, and an award is made to the selected private group. The title of concession includes the purpose and duration, general conditions, obligations, and an early termination clause. The contract includes the scope of services, the concessionaire obligations, the payment mechanism, inspection procedures, penalties, and guidance for transferring the road to the government at the end of the concession period.

The Queretaro-Irapuato Road provides an example of the typical approach. The private service contract for improving this federal toll-free road includes widening

48 km of roads to four lanes, maintaining the 93-km road for 20 years, building seven interchanges, building four overpasses, providing emergency assistance for users, and building a 4.4 km boulevard. To adequately specify the expected services, the road is divided in 16 subsections. The activities to be performed in each section include building additional lanes; widening shoulders; and providing maintenance, traffic signs, mechanical assistance, incident attention, and communications and lightening in suburban areas. Technical standards are set, and inspection, supervision, and control procedures are defined.

Payments to the service provider are based on performance. The payment mechanism considers the availability of the road to users, traffic levels, the shadow toll requested by the service provider, and deductions when the road is not available for use. Payments are scheduled on a quarterly basis and are applied for each subsection of the road.

The performance of the service provider is also measured. The service provider will have to design, improve, maintain, and operate the road according to government requirements related to the physical road characteristics, specification of the operation activities, maintenance requirements, other services on the road, and road characteristics at the end of the contract. The government designates a representative who is responsible for ensuring that the requirements are met throughout the duration of the contract.

These models are used primarily to improve the characteristics and services of toll-free roads. The main criteria that are applied to select road sections to be improved include the number of users who will benefit, the value for money through risk transfer to the private sector, and the importance of the road at the regional and state levels. Other criteria include the ability to complete key transport corridors, the availability of alternative sources of funds, and the potential to support economic development in specific regions, such as in southeastern Mexico.

In its first stage, contracts have been awarded on six roadway modernization and improvement projects using these approaches. The bidding process will be initiated soon on two additional projects.

### PERFORMANCE-BASED CONTRACTING AND MEASURING PROJECT DELIVERY: CONCESSION AGREEMENTS

*Stephen C. Beatty*

My comments focus on the use of concession agreements and possible management, reporting, and measurement issues. It is important that control points are identified throughout the entire project when developing a conces-

sion agreement. One of the potential benefits of PPPs is the freedom for concessionaires to be creative. It is important that this freedom occur within the parameters established by the transportation agency, however. It is important to know what you are asking for and to clearly ask for what you want.

Key elements to consider in developing a concession contract include design and construction, operations, tolling, maintenance, expansion, rehabilitation, and handback. Jurisdictions that have been successful in the use of concession agreements have tied the measurement and management requirements back to the project objectives. The ability to direct and control must be set out in concession contracts.

The concession agreement is the control mechanism for the implementation of a PPP. We favor two types of requirements—specific and general—for use in a concession agreement. The first type of requirement is very specific about a certain action or activity. An example of a specific requirement would be specifying the width of the travel lanes or the depth of the pavement. The second type of requirement provides general direction. An example of a more general requirement would be to operate the facility in a safe manner.

A significant issue to address in design and construction is who designs the facility and to what standard. To maximize the potential creativity of the private sector, performance standards may be used in design and construction. One of the most difficult tasks that public agencies face is converting their specifications, needs, and measures into performance requirements. In Texas, it took 1 year to accomplish this task, with more than 100 people involved in the process. Elements to include in a concession agreement on design and construction are identifying who will certify the project design and who will assume the liability for the design. Independent engineers are frequently used in PPPs to address potential liability concerns.

We have found that the International Organization for Standardization methodology is beneficial in checking construction standards. On the finance side, the lender's engineer will be focusing on construction standards. Public agencies may also use a quality auditor or quality oversight approach. Other issues to consider are substantial completion and total completion. In a toll road or payment situation, you want to tie the ability to charge tolls to substantial completion, but you also want to ensure total completion. In terms of operation, you want to create an incentive for the concessionaire to do the right thing. You want the developer to act as the public agency would. Elements to consider include incident response, snow and hazard clearing, spills, utilities and other rights holders, safety, and customer service. The use of shadow tolls, availability payments, and concessions may also be addressed.

Recent advances in technology have improved accuracy and verification in tolling. Enforcement and collection have significant implications for the concession agreement. There may be issues with respect to equity among users: those who pay and those who do not pay. Setting toll rates probably gets the most media and public attention. The concession agreement should define who has the authority to set tolls and the guidelines or criteria that will be used to increase or decrease toll rates.

The expansion of a facility is often overlooked in concession agreements. This issue is important in long-term concessions and should be addressed in the agreement. You want the concessionaire to have the economic incentive to expand the facility when demand warrants. Expansion triggers are one method to accommodate these needs. The concession agreement should also include how additional interchanges or access points will be accommodated.

A concession agreement should also address rehabilitation needs. Dealing with rehabilitation has become easier with the widespread acceptance of the independent examination concept. Contractual provisions should address the timing of rehabilitation, including late-in-the-term rehabilitation.

Handback represents the final major element of concession agreements. The public sector should expect a well-maintained, 50-year old road in 50 years, rather than a brand new road in 50 years. Requiring inspection of a facility 5 to 10 years from the handback date and the development of a work list for needed repairs is a good approach. The concession agreement should identify how disputes will be resolved. Requiring a performance security, such as a letter of credit, is a good approach.

Other issues may emerge during PPPs. It may be necessary to address defects in existing sections of a facility. Public agencies may have strong desires for control, which often need to be tempered with the concessionaire's need to run a business. Both groups should focus on their appropriate roles and responsibilities.

## PERFORMANCE-BASED CONTRACTING: A VIABLE CONTRACT OPTION?

*Sidney Scott III*

My comments focus on performance contracting from a broad context. I am currently working on a Strategic Highway Research Program 2 (SHRP 2) project examining performance specifications. This project is exploring techniques to convert existing standard specifications into a performance-based framework.

It is important to start by examining the traditional way of doing business, which tends to be "Just tell me what to do; I want to build it and move on." The tradi-

tional method is price driven, with the burden of risk on the owner to design, specify, and control the work. There are exceptions to this traditional approach, however. For example, warranties have been used since the late 1800s. Therefore, some of the concepts we are considering today are not really new. We are rediscovering approaches, as well as developing new techniques.

We use methods and materials or specifications that describe the methods or process requirements and the materials or products to be used. In a general sense, performance contracting can be described as a goal- or results-oriented process. It is best-value driven in that price and other factors are considered. It does not dictate how to do something, except essential needs or minimum functions and standards. Performance contracting rewards innovation and rewards “better-than-the-minimum” outcomes. Innovation often comes from the private sector’s providing new ideas. We need to interject more innovative ideas in our business models in the transportation sector. At the same time, performance contracting ensures that public agencies, acting as stewards of public funds, obtain the maximum value of available resources.

In this country, we have focused on prescriptive requirements in highway contracting. This approach focuses on the result. We are moving more toward the use of performance contracting, however. In addition to PPPs, other models include performance warranties, performance-based maintenance or asset management contracts, and design-build. “Highways for Life” is an FHWA-sponsored performance contracting program to develop a framework within the traditional system.

We are seeing a number of performance-based contracting initiatives in the United States today. Many of these initiatives are modeled after the techniques being used in Europe and other parts of the world. The SHRP 2 project, Performance Specifications for Rapid Highway Renewal, is developing a performance framework and guide or standard specifications to capture the essential benefits. We started by examining the following questions that were identified in a 2004 FHWA Strategic Roadmap. What do we want? How do we order it? How do we measure what we ordered? How do we know we got what we ordered? What do we do if we do not get what we ordered? These are some of the basic questions that should be asked in the development of a performance framework.

The first question relates to defining what a public agency wants in a project. As other speakers have noted, a good place to start is with the goals identified by the agency in the planning process or the project development process. Typically, there are both high-level goals and project-specific goals. High-level goals may relate to safety, congestion reduction, innovation, and long-term performance. Examples of project goals include time sav-

ings, cost reduction, and product quality. Other project goals might focus on traffic management, work zone safety, and the environment.

I think innovation is an important goal. Allowing the contractor to use innovative approaches, within minimum requirements, can provide numerous benefits. Innovation is a common thread throughout many of the new contracting approaches. It is through innovation that value is added to these new contracting methods.

The second question focuses on the actual procurement method. There are many ways to buy services. The European model tends to be qualifications based. Characteristics of this approach include a prequalification process and negotiated contracts. Public agencies in the United States have historically focused on price consideration. This approach uses open bidding and fixed-price contracts. PPPs reflect characteristics of the European approach, especially providing flexibility for innovation and involving the contractor early in the process.

Several items need to be considered in performance-based contracts. First, it is important to determine whether the work can be described in terms of end result performance. For example, pavement may be described in terms of smoothness, strength, durability, aesthetic features, life, and safety. Second, does the contract provide for multiple means and methods or alternatives for achieving intended results, or does it specify one approach? Third, it is important to consider whether the specified alternatives are practical and economical. Fourth, if multiple factors contribute to the desired result, determining the relative importance of their contribution will be necessary. Finally, it is important to use factors that are measurable and testable.

There are several ways to measure what public agencies ordered. Traffic management can be measured by the travel time through work zones. Worker safety can be measured by incident rates. Pavement quality can be measured by smoothness. Pavement safety can be measured by skid resistance. Schedule adherence can be measured by the percentage ahead of schedule. Surveys can be used to measure user satisfaction. In addition to trust, public agencies can use a variety of tests to ensure the final product meets the specifications. Tests need to be rapid and reliable, repeatable, and achievable and economical.

The final question addresses what public agencies can do if the project does not meet the requirements or specifications. There are many approaches that can be used if this situation occurs. Incentive-disincentive strategies in a contract can be used to promote better-than-the-minimum performance, as well as addressing specific performance criteria. Pay adjustment systems can be linked to incentive-disincentive strategies, with payment based on value received. Shared risk contingency represents another approach that establishes a contingency fund. This technique provides incentives to the contrac-

tor to exceed targets, because it receives a share of the dollars in the contingency fund at the end of the project.

In summary, performance contracting represents a new way of doing business in the United States. We are incorporating ideas from approaches used in countries throughout the world. Performance contracting does represent a cultural shift for public transportation agencies and for contractors. We tend to have numerous smaller contracting firms in the United States, whereas other countries have larger, integrated contracting firms. It is also important to remember that performance contracting is not appropriate for all projects. Performance

contracting requires evaluating risk and the potential for risk–reward sharing. It requires a framework and specifications. Numerous benefits can be realized from performance contracting, including innovation, better value for the public investment, and improved service to the public.

*Anthony Kane, American Association of State Highway and Transportation Officials, moderated this session, and Josias Zietsman, Texas Transportation Institute, served as rapporteur.*



# **BREAKOUT SESSIONS**



## BREAKOUT SESSIONS 1

# Performance Measures as an Organizational Management Tool to Establish Accountability

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Gloria Shepherd, *Federal Highway Administration*  
Ross Chittenden, *California Department of Transportation*  
Sandra Straehl, *Montana Department of Transportation*  
Leonard R. Evans, *Ohio Department of Transportation*  
Archie Robertson, *Highways Agency, United Kingdom*  
John Gray, *Union Pacific Railroad*  
Greg Owen, *Ability/Tri-Modal Transportation Services, Inc.*  
Thomas Jeffrey Price, *Virginia Department of Transportation*  
Jaro Potucek, *Swedish Road Administration*

## USING PERFORMANCE MEASURES IN PLANNING, PROGRAMMING, AND BUDGETING

### The Federal Perspective

*Gloria Shepherd*

A federal perspective on performance measures in transportation planning, programming, and budgeting was provided in this presentation. A summary was given of the transportation planning and programming process; elements in the Safe, Accountable, Flexible and Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) and FHWA performance measures initiatives; and the application of performance measures. The following points were covered:

- Transportation planning as a profession has considerable expertise in developing long-range forecasts of travel demand. State departments of transportation, metropolitan planning organizations (MPOs), and public transit agencies have a long history of programming and budgeting transportation improvement programs. By their nature planning, programming, and budgeting are future-oriented activities. Thus, it is important to consider performance measurement in the context of transportation planning as a profession and the statewide and

metropolitan planning processes authorized under SAFETEA-LU.

- The transportation planning and programming process is a cyclical process. It begins with the current transportation system. Establishing a vision for the future transportation system and the goals to achieve that vision represents the next step. Future needs are then identified, and potential solutions are analyzed. The development of a long-range transportation plan brings all these elements together. The long-range plan focuses on a 20-year horizon. The State Transportation Improvement Program (STIP) and the MPO Transportation Improvement Program (TIP) include specific projects for the next 3 years. As projects in the STIP and TIP are completed, the process continues with a review of the goals and the identification of future projects.

- Performance measurement enhances the transportation planning, programming, and budgeting process. Good planning and effective programming are necessary, but not sufficient in themselves. Policy makers and the public expect more. They want to know what transportation agencies have done and are doing to address mobility, reliability, and safety issues.

- Performance measurement provides data and analysis that validate the accuracy of transportation planning forecasts and affirms that programming decisions are leading to promised results. Performance measures can also be used in a dynamic environment to

reconcile budgets for materials and labor. Performance measures provide an important mechanism to communicate planning and programming results to decision makers and the public.

- The adoption and use of performance measures by transportation agencies can foster understanding, accountability, trust, support, and collaboration with decision makers and the public. Although FHWA does not mandate the use of performance measures by states and MPOs, the agency supports the application of performance measures. FHWA has a number of initiatives under way to promote and advance the application of performance measurement in transportation planning, programming, and budgeting. Some of these initiatives relate to provisions in SAFETEA-LU. Initiatives are under way in the areas of planning and system performance, asset management, mobility and congestion, transportation safety planning, and project delivery.

- SAFETEA-LU increased the emphasis on transportation system and program performance measurement. For example, planning provisions include applying measures to optimize the use of the existing transportation network. Other provisions address performance measurement for improving and expediting planning and the environmental review process. Research and pilot programs, including the Surface Transportation Environment and Planning Cooperative Research Program, Highways for LIFE, and tolling pilot programs, have performance measurement and reporting requirements.

- Performance measures help make the decision-making process transparent and contribute to accountability within and among organizations, as well as between organizations and elected officials and the public. The FHWA Office of Planning and the FHWA Resource Center Planning Technical Service Team developed a 1-day workshop on performance measurement in transportation planning. The Transportation Planning Capacity Building Program has sponsored peer exchanges on performance measurement. Further, FHWA has supported national conferences, such as this conference, and workshops through TRB to advance the use of performance measurement.

- In addition to the standard performance measures used by many agencies, FHWA encourages consideration of nontraditional performance measures. Nontraditional measures can capture additional aspects of performance that address broad public policies. Combined measures can be helpful in equity analysis by contrasting available access to transportation by different income or demographic groups.

- Performance measures allow agencies to identify how well various operational strategies are working. These performance measures address mobility and congestion. The National Highway Institute (NHI) course, Transportation Systems Management and Operations: A

Regional Perspective, provides support for the department's congestion initiative. FHWA is developing guidebooks on the congestion mitigation program and congestion management and operations. Interim versions of these guidebooks are expected in October 2007. FHWA is supporting AASHTO and the Association of Metropolitan Planning Organizations Congestion Management Process workshops on the development and implementation of the congestion mitigation program. FHWA has supported national conferences and workshops through TRB that advance the industry's measurement of system performance, including discussion of the data collection, management, and analysis needed to support performance measurement in this area.

- President Bush signed Executive Order 13274, Environmental Stewardship and Transportation Infrastructure Project Reviews, on September 18, 2002. The executive order reemphasized the need to track performance in project delivery. Working with the Gallup organization, FHWA examined the relationships between counterpart transportation and resource permitting agencies. One finding from the focus groups was that environmental streamlining has focused attention on the need for better cooperation and communication between agencies. The Timeframe Wizard (the Wizard) is a software program designed to help state departments of transportation and resources agencies negotiate time frames for completing environmental reviews of proposed transportation projects. The Wizard allows agencies to set project-specific time frames for completing requirements, track the progress of meeting those time frames, and maintain a record of events.

- Asset management is a business process and a decision-making framework that covers an extended time horizon. It draws from economics, as well as engineering, and considers a broad range of assets. The asset management approach incorporates the economic assessment of trade-offs among alternative investment options and uses that information to help make cost-effective investment decisions. Performance measures set the standard for asset condition, which determines the necessary level of investment. The FHWA Planning and Asset Management Offices have developed brochures and other technical assistance materials on asset management. The FHWA Office of Planning works closely with the Office of Asset Management to develop and provide needed technical assistance and to support recent peer exchanges on asset management. The Office of Planning has also participated in international and domestic scan tours.

- The Office of Planning has been working in partnership with the Office of Safety to provide guidance, training, and technical assistance on the importance of integrating safety into the transportation planning process. The Transportation Safety Planning Workgroup

(TSPWG), which comprises representatives from federal agencies, is focusing on identifying strategies to integrate safety into the long-range transportation planning process to help reduce the number and severity of crashes on the nation's roadways. TSPWG has also promoted the development and implementation of Strategic Highway Safety Plans. The *Transportation Planner's Safety Desk Reference* includes information on the design and application of safety performance measures in transportation planning. FHWA also supports peer learning and training such as the NHI Transportation Safety Planning Course, transportation safety planning quarterly newsletters, and a transportation safety planning website hosted by TRB. Peer learning and workshops include discussion on data collection, management, and analysis needed to support performance measurement in this area.

### California's Proposition 1B: Programming for Performance Outcomes

*Ross Chittenden*

Proposition 1B, a \$19.9 billion bond initiative, was approved by California voters in 2006. This presentation described the multiple transportation needs and multiple outcomes targeted in the proposition. The following points were covered.

- In January 2006, Governor Schwarzenegger proposed the California Strategic Growth Plan, a \$222 billion 10-year infrastructure program. The plan includes \$107 billion in funding dedicated to transportation.

These funds are targeted for projects and programs to reduce congestion, improve connectivity, improve safety, and reduce air pollution.

- The Strategic Growth Plan is performance driven and outcome oriented. It is based on the mobility pyramid, which is shown in Figure 5. The mobility pyramid is used to highlight the need for a strong foundation and supporting components, not just system completion and expansion projects, which typically receive the major focus.

- System monitoring and evaluation provide the base of the pyramid. Maintenance and preservation of the existing system represent the next level. Smart land use, demand management, and value pricing components make up the third level of the pyramid. Elements in the fourth level include intelligent transportation systems, traveler information, traffic control, and incident management. Operational improvements are included in the next level. Finally, system expansion projects represent the top of the pyramid.

- Proposition 1B, or the Highway Safety, Traffic Reduction, Air Quality, and Port Security Fund of 2006, is a \$19.9 billion voter-approved bond initiative. Proposition 1B includes a number of elements, such as freeway upgrades to reduce congestion, safety improvements, local street and road repair, and seismic retrofit of local bridges. Also included are expansion of public transit, air pollution reduction measures, and port antiterrorism security improvements.

- There are 16 different Proposition 1B bond accounts for the various programs. The Corridor Mobility Improvement Account focuses on highly congested travel corridors. Congestion in California is projected to increase by 35% during the next decade. A total of \$8.5

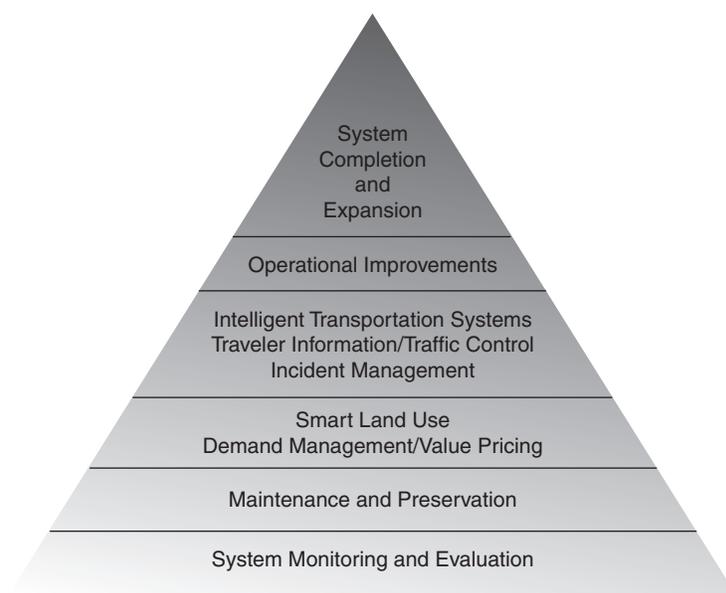


FIGURE 5 Mobility pyramid.

billion has been targeted toward performance improvements in highly congested travel corridors. These projects will also improve interregional connectivity between developing rural areas and urban centers. In addition, safety improvements will be made in some corridors.

- Funding is also focused on port infrastructure, security, and air quality. The Trade Corridors Improvement Fund includes \$2 billion to improve goods movement at California's ports—sea, land, and air—as well as major truck corridors. The Trade Corridor Emissions Reduction Account includes \$1 billion to reduce emissions and to improve air quality in and around ports. The Port, Harbor, and Ferry Terminal Security Account includes \$100 million in project funding.

- Proposition 1B funding is also targeted toward improving public transportation. The Public Transportation Modernization, Safety, and Security Account includes \$4 billion in funding. Projects in this area focus on rehabilitation, safety or modernization, capital service enhancement or expansion, new capital projects, bus rapid transit improvements, and rolling stock procurement, rehabilitation, and replacement. An additional \$1 billion in the Transit System Safety, Security, and Disaster Response Account is targeted toward capital projects that provide increased protection against security and safety threats.

- The Local Street and Roads, Congestion Relief, and Traffic Safety Account provides \$2 billion to cities and counties for projects. The account is a likely source for local road rehabilitation projects. A minimum of \$400,000 is provided to each city in the state.

- The State Highway Operations and Protection Program Account includes \$750 million in funding. Of this amount, \$400 million is targeted toward pavement rehabilitation and \$100 million is provided for operational elements. In addition, \$250 million is targeted for traffic light synchronization and other technologies to improve safety, operations, or capacity of local streets and roads.

- Other accounts focus on local bridge retrofitting, seismic retrofitting, school bus retrofitting, and highway–railroad crossing improvements. A total of \$125 million will provide an 11.5% required match to retrofit 497 local bridges. The account to retrofit school buses to reduce air pollution and exposure to diesel exhaust is funded at \$200 million. There is \$250 million in funding for the completion of high-priority grade separations and railroad crossing safety improvements.

- Proposition 1B contains specific accountability requirements. A governor's executive order requires each department to establish and document a three-part accountability structure for the bond proceeds. The accountability structure will include front-end, in-progress, and follow-up accountability steps and processes that are available to the public in a transparent and timely manner.

- Elements of front-end accountability include program guidelines, program adoption, program agreements, and project agreements. Program guidelines set project eligibility criteria. Program adoption identifies projects to be funded. Project agreements are signed by regional agencies, Caltrans, and the California Transportation Commission for on-system projects. Project agreements identify the project and set the scope, cost, schedule, and performance benefits that are to be accomplished.

- In-progress accountability involves managing project budgets, schedules, and expectations more effectively. It focuses on staying true to the intent of the project and the original scope, cost, and schedule, while achieving the stated benefits. There are no bond reserves to cover cost increases.

- Follow-up accountability involves compliance and financial audits and a closeout or completion report that documents the outcomes of the project and compares them with anticipated results. These audits will examine whether the project accomplished its goals on schedule and within budget. The audits will also consider whether the performance benefits described in the original project application were achieved. The audits will document the lessons learned and the way they might be applied to future projects.

- Transparency is an important element of Proposition 1B accountability. An Internet reporting tool will document the original project scope, cost, schedule, and performance benefit baselines. Expenditures and progress will be reported at preestablished time intervals, which will be at least quarterly. Information on the website will be broken down by project phase, including environmental, design, right-of-way acquisition, construction, schedules, and costs.

## Performance Measurement to Drive Investment Decisions

*Sandra Straehl*

The Performance Programming Process at Montana DOT was discussed in this presentation; and the development and purpose of the Performance Programming Process, the changes in Montana DOT culture as a result of the process, and the use of performance programming with customers and policy makers were summarized. The following points were covered:

- Implemented in 1995, the Performance Programming Process has been supported by three different Montana DOT directors. The intent of the process is to develop an optimal funding allocation and investment plan based on strategic highway system performance

goals and the continual measurement of progress toward those goals.

- The development of the Performance Programming Process was initiated in the late 1990s and grew out of the development of the first statewide transportation plan. The process is based on asset management principles. Capital and maintenance programs are driven by the approach.

- The Performance Programming Process is linked to Montana DOT's strategic highway goals. The allocation of funds through this process is tied to performance goals that are supported by Montana's statewide policy plan. The first statewide policy plan in 1995 included a goal of linking the programming and project nomination process to the policy goals of preserving the system and using the management systems to make optimal decisions. The process provides an annual forum to assess future funding. A major focus is on preservation and addressing congestion as needed. The analysis provides policy makers with information needed to make program selection decisions.

- Specific performance measures continue to evolve. Pavement performance measures include average ride and the percentage of roadway miles below the target in the average, superior, and desirable categories. The initial performance measures for bridges focused on the number of structurally deficient bridges. A new performance measure was added recently addressing the condition of bridge deck surfaces. The use of this performance measure has allowed the state to obtain funding from a new federal funding source. The initial safety performance measure examined the number of hazard elimination locations addressed. The current safety performance measure of reducing fatalities to 1 death per 100 million vehicle miles by 2015, is driven by the Comprehensive Highway Safety Plan.

- The Performance Programming Process focuses on the Interstate, National Highways, State Primary, and Bridge programs. These programs account for approximately 70% of the federal funds received by the department. The Secondary, Urban, Congestion Mitigation and Air Quality, Enhancement, and Safety programs are not included in the process.

- The process begins annually with the estimation of funding levels. Budgets are allocated to the management systems, and combinations of funding for the districts, systems, and projects are examined. Montana DOT has performance goals for pavements, bridges, and congestion. The ideal solution is to find a combination that keeps each system in each district in a desirable range of performance. The goal is to maintain the various districts' pavements, bridges, and other elements in good condition. Elements in one district should not be in the superior category if that means elements in other districts will fall into the undesirable category.

- Each management system begins with a budget, and funding is allocated to future work. Multiyear scenarios are then developed. Funding by districts, systems, and work types can be altered as needed. The condition of roadways and bridges is monitored regularly. Data are used to develop degradation curves that predict how long a particular type of work will last, as well as assess the right fix to extend the life of the asset. These predictions are considered and converted into an ideal funding allocation. The Planning Division then uses this allocation to load the program with work. Projects that are inconsistent with the adopted Performance Programming Process funding plan are not programmed.

- The use of the Performance Programming Process provides the opportunity to assess policy options and refine the direction of the program. The process has resulted in placing more emphasis in the program on resurfacing and rehabilitation. The analysis also resulted in an increase in federal bridge investment over federal apportionment levels to address bridge deck conditions. As a result of the process, Montana DOT also initiated a comprehensive safety approach before the federal planning requirement.

- Realized apportionment is a new approach to setting the tentative construction program to ensure that the Performance Programming Process planning values are realized over time. Realized apportionment attempts to address the issue of the cumulative total of how much apportionment is allocated to a system, a district, or a type of work versus the ideal performance-based planning value. Because project costs have increased each year, the major reconstruction projects require more funding. Realized apportionment helps Montana DOT stay on track.

- Numerous challenges with funding transportation needs still exist in Montana and other states. These challenges include questions on long-term funding from the federal and the state level, hyperinflation in the construction industry, and overdependence on bonding. Other challenges include parochialism in the decision-making processes and continuity in the approach used in the state.

## Research Needs

The following research needs were identified by participants in this session:

- Examine transportation agencies that have been successful in using performance measures to develop support from the legislature and other groups for additional funding. Identify and analyze case study examples in which the use of performance measures by state departments of transportation, public transit agencies,

and other agencies has resulted in broad support for new and ongoing initiatives and projects, including increased funding levels. Elements to be examined in the case studies include performance measures, communication techniques, and new or sustained funding levels.

- Conduct an assessment of the analytical models and visualization techniques available for use with performance measures. The analysis should examine models that are appropriate for various transportation modes, as well as those that can be used for multimodal performance measures and trade-off analyses. The study should explore the use of different visualization techniques and tools to present performance measure results. The assessment should include best practice case study examples.

- Examine potential performance measures for air quality, the environment, sustainability, economic impact of transportation projects, and bicycle, pedestrian, and transit use. Much of the experience to date with performance measures focuses on traditional applications associated with roadways and bridges. Other, more recent measures associated with traffic congestion, travel time, and trip-time reliability are becoming widely used. There is less experience with performance measures related to environmental factors, non-highway travel modes, and the economic impact of transportation. Research exploring performance measures, benchmarks, and targets associated with these topics would be beneficial. Case studies highlighting examples of measures currently in use should be included. The study should also examine the data needed to support these performance measures and identify data collection and analysis techniques.

- Examine techniques to identify the best approaches to optimize use of the existing transportation system and possible projects. Assess approaches to analyze how to maximize the benefits of projects to all users of the transportation system.

- Examine partnerships between state departments of transportation, other transportation agencies, and other public- and private-sector groups to develop, implement, and monitor performance measures. Addressing many issues, including air quality, goods movement, safety, and sustainability, involves numerous diverse groups. Research on methods that have been used effectively to bring various groups together to address common concerns through the use of performance measures would be of benefit to all organizations. The research should include best practice case studies.

*Woody Stanley, Federal Highway Administration, moderated this breakout session, and Katherine F. Turnbull, Texas Transportation Institute, served as rapporteur.*

## USING PERFORMANCE MANAGEMENT TO MAKE THE CASE FOR MORE FUNDING

### Obtaining Legislative Support in Ohio

*Leonard R. Evans*

Performance measures used in the Ohio DOT were discussed in this presentation, and the use of these measures to obtain legislative support for transportation funding increases in the state were described. The following points were covered:

- Performance management can provide a number of benefits. It helps establish a common understanding and conveys expectations and achievements. Performance management also can be used to identify obstacles or unmet needs and can signify the magnitude or impact of projects or programs.

- The Ohio DOT Business Plan links the strategic plan to the biennial transportation budget. Performance trends and forecasts are linked to funding levels in the business plan. Performance measures help to demonstrate successful internal resource management. They serve to establish a track record for effective management. Achieving a steady and predictable level of condition for existing assets simplifies the budgeting process. It also defines a performance expectation. This performance management approach was a key element in the legislature increasing funding for transportation in the state by \$5 billion during a 10-year period.

- At Ohio DOT, forecasting funding and program needs are tightly coupled to performance objectives and goals. Performance measurement establishes a basis for identifying how addressing additional concerns will affect core programs. Performance goals have resulted in significant improvements for pavement and bridge conditions in the state. Providing information on performance measures to stakeholders and the public has built support for the department's projects and services.

- Performance measurement helps establish a solid plan. It has provided a basis for ongoing discussions with the legislature concerning ongoing funding. It also allows the department to highlight its performance on projects and initiatives. Performance management helps to respond to the unpredicted. It establishes an understandable foundation for discussing unmet needs. For example, Ohio DOT has been better able to respond to significant increases in construction costs and to document these increases to policy makers.

## Using Performance Measurement to Make a Case for More Funding

*Archie Robertson*

Transportation funding in the United Kingdom and the use of performance measures at the Highways Agency were discussed in this presentation. The roles of different governmental departments and agencies, results of a recent study examining the use and funding of the transportation system, trends in the use of the system, and possible future directions were described. The following points were covered:

- The Treasury has overall responsibility for the allocation of funds from taxation. The Treasury sets performance levels to be achieved. The Department for Transport distributes funds between various transport modes depending on strategic priorities and targets to be achieved. The Highways Agency is responsible for operating and managing the strategic road network.
- The Transport Innovation Fund was recently introduced by the national government. The Transport Innovation Fund provides additional financial resources to government agencies that can deliver good ideas quickly. The Highways Agency, counties, and local authorities are all eligible to compete for these funds. The Highways Agency anticipates requesting funding for active traffic management strategies and other related projects.
- To explore future funding options, Parliament asked Sir Rod Eddington to lead a study examining transportation needs and funding after 2016. Results of this study are far-reaching with some controversial suggestions. The study found that the Strategic Road in the U.K. network is one of the most congested in Europe and the world. Approximately 61 billion journeys are made annually. The average resident makes more than 1,000 trips each year traveling more than 7,000 mi. The movement of people and goods on the transportation systems supports the U.K. gross domestic product (GDP). If capacity on the system becomes insufficient, the GDP will be constrained. For example, a 5% reduction in delay for business and freight equates to a £2.5 billion benefit, which represents 0.2% of the GDP. Congestion is costing the United Kingdom some £8 billion of GDP. If left unchecked, that will increase to £22 billion by 2025.
- The Eddington study has resulted in a major focus on the needs of the transportation system and transportation funding in the United Kingdom. The study suggests that even though passenger rail is part of the country's heritage, it is not the favored travel mode for most people. Thus, it suggests that significant investments should not be made in passenger rail. The report

also highlights the need to manage demand, including the use of pricing strategies.

- The roadway system and the passenger rail system in the United Kingdom can be compared. The network length of the roadway system in Great Britain in 2005–2006 was 388,008 km, compared with 14,356 km for the passenger rail network. In regard to passenger kilometers traveled in 2005, the roadway system carried some 735 billion passengers, accounting for 92% of all travel in Great Britain. The rail system carried 43 billion passengers, accounting for 5% of all Great Britain travel. In regard to freight, in 2005 the roadway system carried 163 billion tons, accounting for about 63% of the total. Approximately 22 billion tons was carried by rail, accounting for 9% of the total.
- Traffic on motorways and trunk roadways has been increasing at approximately 1% per year. The use of light vans has increased at a rate of 6% to 8% per year, however. This trend appears to be the result of the increase in shopping via the Internet and the delivery of goods to individuals. This type of delivery system places additional demands on the roadway system. The trend represents a change in the traditional form of goods distribution and has a significant impact on the transportation system.

## Research Needs

The following research needs were identified by participants in this session:

- Examine the use of performance measures to increase transportation funding. The research will examine case studies on the use of performance measures to build support among policy makers at the local, regional, state, and federal levels for increasing or maintaining funding for transportation. International case studies will also be explored and documented. The lessons learned from the successful programs and initiatives will be summarized.
- Conduct a research study examining the role of public–private partnerships (PPPs) in providing additional transportation funding. The study will explore U.S. and international examples of PPPs increasing the total amount of funding for transportation. Case study examples will be presented to highlight the methods and techniques used to obtain support from policy makers and the public for these new approaches.
- Conduct a study examining methods to use technology more effectively to communicate performance measures and transportation funding needs to policy makers, stakeholders, and the public. The use of technology by public agencies and the private sector will be

examined. The potential to use techniques and approaches commonly applied by businesses and private-sector groups will be explored.

- Examine appropriate performance measures to assess the economic impact of the transportation system and the impact of economic development on transportation. The study will identify performance measures currently being used by transportation agencies and will develop new performance measures for potential use by state departments of transportation, transit agencies, metropolitan planning organizations, and other groups.

- Conduct a study examining measurement techniques to assess transportation funding needs and the consequences of alternative funding scenarios. The study will consider modal funding needs and methods to conduct cross-modal funding assessments. It will also identify methods to determine the monetary value of the transportation system.

- Examine the use of public opinion surveys to effectively select appropriate performance measures and to prioritize policy choices. The study will examine case studies of transportation agencies using public opinion surveys as part of the performance measurement process and the benefits and limitations of using public opinion surveys. Guidelines will be developed on the use of public opinion surveys as part of a comprehensive performance measures process.

- Examine the use of trip-time reliability as a transportation performance measure. The study will explore the current use of trip-time reliability measures, how data are collected and analyzed to measure performance, and the importance of trip-time reliability to travelers and shippers. The study will provide guidance for transportation agencies using trip-time reliability as a performance measure.

*Lance A. Neumann, Cambridge Systematics, Inc., served as facilitator of this breakout session, and Randy Halvorson, Cambridge Systematics, Inc., served as rapporteur.*

## LESSONS FROM THE PRIVATE SECTOR

### Union Pacific Railroad's Experience

*John Gray*

The use of performance measures at Union Pacific Railroad (UP) was discussed in this presentation. Comments from the opening session related to performance measurement in the freight industry were expanded. The following points were covered:

- The U.S. freight industry is a combination of public and private components. Rail is the only component in which the line haul infrastructure, terminal infrastructure, and equipment and operations are all in the private sector. Trucking uses the public roadways, with the terminals, equipment, and operation in private ownership. Shipping using the inland waterways, blue water, and air includes public ownership or no ownership of the line haul infrastructure, a mix of public- and private-supported terminals, and private ownership of equipment and operations.

- Performance at UP is focused on measures that will drive capital investment and the efficient management of network operations. Performance measures reflect the need to understand the efficiency of private capital use and the need for capital creation to sustain the network.

- Measurement objectives at UP describe network fluidity and network efficiency. They describe service expectations for customers. Reliability and price are the two most important service expectations. Some customers are more time sensitive than others.

- UP uses a number of network-based performance measures. Examples of measures include 7-day vehicle loading rates, the network vehicle inventory, network velocity, terminal dwell times, terminal throughput versus terminal assets, and vehicle or package movement performance versus plan. Vehicle productivity, network assets unavailable for use, network mileage under constrained use limitations, vehicle delay time, and assets required to meet demand represent other measures. Many of these measures are examined for network components and the total network.

- Some issues may need to be considered with the use of performance measures. For example, staff will manage their activities according to the measures by which they are evaluated. As a result, it is important to identify and measure what is important to a company or agency. It is also important to ensure that the underlying causal issues are managed, not the measurements. Most freight measurements are usable over time only to measure performance of a single carrier, network, terminal, or operation. They cannot be used to compare carriers or modal performance. They also cannot be used to compare performance between networks.

- A number of additional measurement issues may need to be explored. It is important to measure what people can control and manage. It is also important that the measures focus on the level of management responsibility. Measuring the few critical issues may be more beneficial than trying to address too many diverse issues. For large companies or agencies, designing measurement structures that reflect system, or network, objectives not just local issues is also important. These measures must still be manageable at the local level, but

this approach helps control silo thinking. It is also important to reward performance that reflects measurement objectives, which usually requires some financial component. Approximately 10% of the personnel at UP are compensated by performance measures. Finally, it is important to remember that network management is dynamic. Measurements should be changed to reflect changing conditions.

## Challenges Facing the Trucking Industry

*Greg Owen*

Some of the challenges facing the trucking industry were discussed in this presentation. The negative consequences of traffic congestion on the movement of trucks, the importance of trip-time reliability, and the importance of managing people were noted. The following points were covered:

- Traffic congestion, especially on roadways and freeways around ports, is a concern for the trucking industry. Investments in operations and in new or expanded capacity should be made in areas in which the need is greatest. There are operational improvements that could have a positive impact on the trucking and freight industry. Improvements to intermodal facilities would also be of benefit. Support from the private sector and the public sector is needed to advance projects.

- Managing people is important in the trucking industry. For example, time can be lost in the morning if drivers take too long leaving the terminal. Linking incentives to performance provides one approach for encouraging employees to perform at high levels. It is also important to give people the opportunity to perform. An operations-based management system works better than an accounting-based management system in the trucking industry.

- The freight industry is interested in maximizing operational efficiency and productivity. The use of public-sector performance measures that focus on improving the operations of the roadway system benefits truckers and shippers.

## Research Needs

The following research needs were identified by participants in this session:

- Examine the application of performance measures to effectively manage the environmental process associated with new and expanded capacity projects. Conduct

a review to identify examples of transportation agencies using performance measures to proactively manage the environmental process.

- Examine approaches to coordinate performance measures related to freight and goods movement used in the public and private sectors. The research should first identify freight and goods movement performance measures used by public transportation agencies, shippers, railroads, trucking firms, businesses, and other groups. The next step would be to compare these performance measures to identify compatible measures, as well as those that may conflict. The results of this assessment would be used to develop coordinated and compatible public- and private-sector performance measures focusing on a shared vision for the freight system.

- Examine the costs and benefits of transportation projects that focus on the movement of freight. This assessment should consider the costs and benefits to the public and the private sectors.

- Explore the use of performance measures focusing on operational improvements that would benefit the trucking and freight industries. The study would include a review of performance measures currently used by state departments of transportation to monitor how operations affect the freight industry, identify potential measures, and discuss how to apply these measures in practice to improve system operations that will benefit freight movement.

*Anthony Kane, American Association of State Highway and Transportation Officials, served as facilitator of this breakout session, and Crystal Jones, Federal Highway Administration, served as rapporteur.*

## IMPROVING INTERNAL OPERATIONS WITH PERFORMANCE MANAGEMENT

### Virginia DOT's Approach

*Thomas Jeffrey Price*

Virginia DOT's use of performance measures to improve internal operations was discussed in this presentation. Examples of applying performance measures with procurement and internal financial controls, human resources, safety analysis, and asset management were given. The following points were covered:

- Performance measures are used throughout Virginia DOT to improve internal operations. Examples of internal operations include planning, program delivery, safety analysis, and asset management. Other internal operations include equipment management, property

management, procurement and internal financial controls, human resources, and information technology.

- The approach to internal operations performance management at Virginia DOT is to first understand the business framework. Defining the business framework includes identifying the purpose or function of the operation, the group and personnel responsible for the operation, and the processes used to execute the operation. The key deliverables or outputs are defined, along with the systems, data requirements, and data sources.

- A number of factors need to be considered in the development of performance measures. First, it is important to consider the purpose and desirable outcomes, including how the operation contributes to broader, higher-level goals. Second, the deliverables and how they are generated should be considered. Third, consideration should be given to who is responsible for the various tasks, including whether multiple groups or external sources are involved. Fourth, consideration should be given to how the measure might affect behavior, both positively and negatively. Finally, assessing what factors might influence changes in performance, including those that the agency has control over and those it does not, is important. In addition, how the operation contributes to higher-level agency and state goals is considered.

- The first example addresses procurement and internal financial controls. The purpose of the procurement and internal financial controls operation is to support and ensure accuracy and accountability in the department's financial system by providing services and internal controls in the management of purchasing, accounting, receivables, payables, payroll, and financial reporting. The fiscal division and fiscal staff in each organizational unit are responsible for this operation.

- Virginia DOT has a well-defined and open procurement process that follows state and federal guidelines. The fiscal division is responsible for key functions, including preparing the agency financial statements and the executive financial summary report. The division is also responsible for employee payments, vendor payments, agency billing and collections, financial reports for Virginia DOT operations, and tax reporting. The division uses Financial Management System II (PeopleSoft) to support these functions.

- Procurement and internal financial controls include the Virginia DOT performance measures related to the prompt pay compliance rate; the percentage of agency procurements made through eVA, a web-based purchasing system used by agencies in Virginia; the percentage of small, women, and minority goals met; and the occurrence and frequency of audit findings. Related higher-level measures include on-budget project delivery, planned versus actual expenditures, late payment fees

and legal costs, and the agency bond rating. As an example, the prompt pay performance is tracked by district.

- A second example is the human resources (HR) operation. The purpose of the HR operation is to provide statewide leadership for recruitment, selection, classification, compensation, performance management, employee relations, and rewards and recognition. HR also partners with clients to recruit, develop, and retain a highly committed, highly competent, results-oriented workforce. The Human Resources Division and district HR specialists are responsible for this operation.

- HR is responsible for a number of functions, including the development of staffing plans and strength reporting and the effective recruitment and relocation of employees. HR is also responsible for compensation and benefits administration, strategic workforce planning, and management reports on employment actions. Still other responsibilities include policies and procedures, management counseling, and dispute and conflict resolution.

- Examples of HR performance measures include the number of days open positions remain vacant after being posted and the percentage of employee assessments completed on time. Other performance measures are the number of employees who have received appropriate training and have the necessary skills to do the job, the percentage of employees receiving safety training, and the Healthy Virginians program participation rate. Related higher-level measures include the turnover rate, labor productivity, labor cost, and insurance losses.

- The third example is safety analysis operation. The purpose of this operation is to maximize traffic efficiency and safety while minimizing inconvenience and congestion on the highway network. The Traffic Engineering Division and district traffic engineering sections are responsible for that operation. The performance-based safety improvement process is used in this operation.

- Key deliverables and outputs of the safety analysis operation include the annual summary of crash data, Virginia DOT safety action plan, strategic highway safety plan, Virginia highway safety corridors, and designated safe routes to school. Examples of safety analysis measures include the number of hazardous location assessments conducted and before and after crash rates at Highway Safety Improvement Program locations. Other measures are the time to complete safety studies, the percentage of the Virginia DOT Safety Action Plan implemented, and the number of school districts with Safe Routes to School plans. Related higher-level measures include the number of traffic fatalities and the number of traffic injuries. Safety-related performance measures are tracked on the department's external dashboard.

- The fourth example focuses on the asset management operation. The purpose of this operation is to

ensure that Virginia DOT manages its infrastructure, equipment, and property assets in a manner that preserves their value, maximizes the Commonwealth's return on transportation investment, and ensures the safe and efficient movement of people and goods. District maintenance sections, the Asset Management Division, and the Operations Planning Division are responsible for this operation.

- The asset management process includes estimating statewide maintenance needs by districts, systems, and assets. Developing, maintaining, and monitoring maintenance budgets are also part of the process. Other elements include developing, programming, scheduling, and managing maintenance and property management contracts. Developing and delivering asset management training and maintaining equipment fleets, monitoring utilization, setting rental rates, and selling used and procuring new equipment are also part of the process.

- Examples of asset management performance measures include on-time maintenance projects, on-budget maintenance projects, equipment utilization rates, and the availability of rest areas. Related higher-level measures include the percentage of pavements rated deficient, ride quality, the percentage of bridges rated structurally deficient, and customer satisfaction with rest areas and fatigue-related crashes. Some of the asset management performance measures are provided on the external dashboard; others are listed only on the internal dashboard.

- A number of lessons can be learned from the experience using performance measures at Virginia DOT. First, measuring performance does lead to changes in the behavior of agency personnel. These changes can be positive and negative. From a positive standpoint, performance measures start employees thinking and behaving in new ways. First, personnel think more about process details, bottlenecks, inefficiencies, and assignment of responsibilities. Second, employees consider the method or technology being used. Third, staff think more about the connections to and dependencies on higher-level measures and outcomes. From a negative standpoint, performance measures may result in staff managing the measure and finding less desirable ways of making performance look good.

- Another lesson learned from the Virginia DOT experience is that performance management is a process that takes time. It is important to learn from mistakes and to make appropriate changes. Performance measures also result in competition between staff members, which can be a strong motivator. Performance measures can be used in a positive manner to build a broader understanding of how the agency works and to develop pride in accomplishments. Finally, the process helps keep a perspective on higher goals and measures.

## Swedish Road Administration's Approach

*Jaro Potucek*

Performance management at the Swedish Road Administration (SRA) was described in this presentation. The organization and responsibilities of SRA, the use of internal and external effectiveness measures, and techniques for communicating with policy makers were discussed. The following points were covered:

- Sweden has a population of approximately 9 million. The country covers approximately 2,000 km north to south. SRA is responsible for the road transportation sector, including managing the state roads. There are some 100,000 km of state roads, 40,000 km of communal roads, and 300,000 km of private roads. Approximately one-fourth of the private roads receive state subsidies.

- The Swedish Parliament and the government provide guidance to SRA through transport-policy goals and the 2004–2015 Long-Term Plan. Annual directives address funding and reporting requirements. SRA has approximately 2,600 employees. Similar to state departments of transportation, SRA has a headquarters or central office and seven regional offices. The SRA staff focuses on road management. Road work and consulting services are contracted.

- Although the phrase “what gets measured gets done” is often used in discussing performance measures, a more appropriate phrase may be “what doesn't get measured doesn't get done.” Monitoring performance measures is important to determine whether agency goals are being accomplished. Monitoring performance meets numerous objectives. First, monitoring goals is needed to assess current positions and decide future activities. Monitoring goals is also key to showing stakeholders that the agency is delivering promised projects and services and that they are getting value for their money. It also shows stakeholders that SRA is a reliable partner. Monitoring the effectiveness of individual units and contractors is important for benchmarking.

- SRA road network management is divided into three functions: operations, maintenance, and development. These three functions require different management methods and measurement methods. The road operations objective is to deliver suitable road conditions to present road users. The road maintenance objective is to deliver suitable road conditions to present and future road users. The objective of road network development is to provide permanent functional improvements to the network in the way of new roads or functionally improved roads.

- External effectiveness means the delivery of the optimal mixture of different customer goals. Internal effectiveness means the lowest long-term cost for the delivery of the product or service. SRA has different goals, as do various stakeholders. Some of these goals may conflict. The optimal balance between the goals of different stakeholders is a political issue. Because priorities change, these goals are assessed on an ongoing basis.

- The change in maintenance backlog during the year related to the maintenance cost is used as an internal measure of effectiveness. The cost is adjusted for the estimated influence of a number of factors, including inflation, weather, new environmental demands, new road components, and traffic growth.

- The operations condition related to the operations cost during the year is used as an internal measure of effectiveness relating to road network operations. An adjustment for the influence of a number of factors is made. There is also an adjustment for differences in achieved operations condition.

- Two terms—maintenance standard and backlog—are used in the analysis process. Condition means the actual state of the road network or a component. Standard means the promised, aimed, or prescribed condition. Normally, the standard is expressed as a set of trigger values for a number of condition variables. Exceeding a trigger value indicates that road work should be performed. The standard is specified using condition variables. Each standard has a corresponding annual cost. The standard should be balanced, representing SRA's idea about the best balance among the transportation policy goals or the best resource allocation and user groups.

- Backlog is the cost of optimal work required in relationship to the maintenance standard. It is an indicator of the level of compliance to the maintenance standard and estimates the relative road capital value. If a trigger value of the standard is surpassed and no work is performed, then a backlog occurs. When a significant backlog occurs, multiple measures are often delayed as trigger values are surpassed.

- The internal effectiveness of road maintenance is defined as internal efficiency (IE)/road maintenance = condition improvement due to maintenance/operations costs – cost-influencing factors. A high IE value means high internal efficiency. An IE equal to one (100%) corresponds to the IE used during estimation of the last long-term plan. Additional formulas are used to define winter operations and other measures.

- Cost may be influenced by a number of factors. New or eliminated road network components increase or decrease the maintained road network. Traffic growth increases the deterioration rate. The synergy effects of

road improvements result in better road conditions without maintenance work. A change in the maintenance standard determines the amount of road work needed. Weather variations have a significant influence on deterioration rates and road work. Changed environmental demands for road work increase the road work, as does changed traffic safety demands. The market situation has a significant influence on contract prices.

- SRA's long-term goal is to allocate the lowest long-term costs to achieve the specified maintenance standard. Internal effectiveness measures are important for a number of reasons. All organizations focus on effectiveness. The long-term plan for 2004 to 2015 includes improvement of at least 1% per year. Improved effectiveness is necessary to balance the costs of new demands and new roads. Measures of effectiveness that are comparable in time and comparable geographically are needed.

- Internal effectiveness measures are used for reporting to stakeholders, performing budget allocations, and assessing the goals for SRA's regions. The measures are also used for benchmarking between SRA's regions, analyzing results of research and development, and analyzing the results of reorganizations.

- Although the transportation policy goals in Sweden are stable, the interpretations do change. Similar to other countries, Sweden is experiencing increasing demands on the road system in a time of decreasing budgets and questioned credibility. There are demands for regular reports on road-condition effectiveness. SRA has demonstrated accountability based on asset management and other operations.

## Research Need

The following research need was identified by participants in this session:

- Complete a synthesis on the current use of performance measures for internal operations at transportation agencies. The synthesis will document the current state of the practice and provide case study examples of the use of internal performance measures at state departments of transportation, transit agencies, and other public-sector transportation organizations. The different measures and benchmarks used by various agencies will be highlighted. The synthesis will also identify areas for further research to help advance the application of performance measures to improve internal operations at transportation agencies.

*Pete K. Rahn, Missouri Department of Transportation, served as facilitator of this breakout session, and Hugh Louch, Cambridge Systematics, Inc., served as rapporteur.*

## BREAKOUT SESSIONS 2

# Communicating Performance Results Effectively to Your Customers

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Steven E. Polzin, *University of South Florida*

Kristine Leiphart, *Federal Transit Administration*

John Giorgis, *Federal Transit Administration*

Catherine Rice, *Maryland State Highway Administration*

Dan Jiji, *Port Authority of New York and New Jersey, I-95 Corridor Coalition*

John Wolf, *California Department of Transportation*

Jill Reeder, *Pennsylvania Department of Transportation*

John Webber, *Illinois Department of Transportation*

Michael Bridges, *Louisiana Department of Transportation and Development*

Julie Lorenz, *Kansas Department of Transportation*

Mara Campbell, *Missouri Department of Transportation*

Leonard R. Evans, *Ohio Department of Transportation*

Nick Mandel, *New Mexico Department of Transportation*

## WHAT PERFORMANCE INDICATORS ARE IMPORTANT AND COMPREHENSIBLE TO YOUR CUSTOMERS?

### Some Observations on Performance Measurement

*Steven E. Polzin*

Some of the challenges associated with using performance measurement were discussed in this presentation. Examples of performance measures used with public transportation services were provided, and successful techniques for communicating with policy makers were highlighted. The following points were covered:

- The challenge of measuring performance is a function of the complexity of the system being evaluated. A simple focus is on connectivity, cost, and safety. A holistic focus covers the full spectrum of impacts, which may include the economy, energy use, capacity, the environment, land use, and mobility.
- Holistic planning includes consideration of social, political, and technical issues. For example, transportation represents about 12% of the gross national product

(GNP) and approximately 18% of household expenditures. Considering these factors adds complexity to the performance measurement process. Measures whose causal linkages to actions are less well understood may be included, such as transportation investments and social justice, community cohesiveness, civic participation, and obesity. Other elements that may add complexity include using weighting factors and producing an aggregate performance metric. These approaches may deter consensus by enabling users to polarize on very different factors. Multimodal, multijurisdictional, and multisector involvement make programmatic and systematic performance measurement for transportation difficult.

- Problems with data availability and the scheduling of data collection, analysis, and reporting may be issues in some areas. Basic metrics on vehicle miles traveled and transit ridership may be delayed and often come with numerous caveats or explanations. The private sector seems to do a much better job of obtaining critical data. For example, Wal-Mart produces global weekly sales totals every Sunday evening.
- The transit industry has more than 30 years of experience using performance measurement. An extensive body of literature addressing performance measure-

ment in public transit exists. There are also standard data sources, including the National Transit Database and the Federal Transit Information System. Public transportation also has extensive experience with peer and trend evaluations and management audits. Transit performance measurement includes self-administered performance measures, with a goal of agency improvement, and performance measures administered by an agency with custodial responsibilities.

- An ongoing issue is the use of performance measures to make comparisons between public transit agencies. A frequently voiced concern is that transit systems cannot be compared because of differences in weather, politics, demographic profiles, urban form, historic ridership habits, topography, mode mix, governance structure, jurisdictional organization, and the public and private mix of operations. There may also be issues associated with data availability, data quality, and data comparability. Different transit systems may collect data in different ways.

- Many transit representatives are sensitive to the fact that highway and roadway projects do not receive the same scrutiny or performance evaluation as public transportation. Good multi- or cross-modal performance metrics are lacking, making comparisons across modes difficult.

- Even with those concerns, regular public transportation performance evaluations are conducted for internal and external purposes. The Florida Department of Transportation (DOT) requires that basic metrics for transportation systems in the state be published annually. Performance metrics are included in many transit executive directors' bonus evaluations. There is also strong media interest in rating and ranking strategies. Many oversight bodies require recurring or incidental performance evaluations. Performance metrics are also part of many grant programs or eligibility requirements.

- In communicating information on performance measures to decision makers, it is important to keep the measures simple, but to not apologize for complex information. An agency with complex goals is likely to have a complex performance measurement process. The appropriate use of language and graphical materials can make a major difference in how well identical information is communicated. Data can also be confusing.

- One approach to communicating with decision makers is to begin with the theoretical or logical hypothesis. Multiple data sources and multiple data analysis methods can be used to provide credible data to support a point. Anecdotal stories can also be used to exemplify the point.

- Topics for more discussion include considering performance measurement more like criminal law, which tests against the standard of removing all reasonable doubt, or more like civil law, in which all that is required

is a preponderance of evidence. It might also be suggested that it does not matter whether you see the glass as half full or half empty. What matters is how the information gets translated into action.

### Communicating Performance Reporting to Your Customers

*Kristine Leiphart and John Giorgis*

The use of performance measures at FTA was discussed. The agency's performance measures were summarized by Kristine Leiphart, and a case study example addressing transit ridership performance measures was described by John Giorgis. The following points were covered in their presentations:

- President Bush has stressed the importance of performance measures for federal agencies. He has said, "What matters most are performance and results. This administration is dedicated to ensuring that the resources entrusted to [us] are well managed and wisely used. We owe that to the American people."

- It is important to focus on performance measures that are comprehensible to your customers. Measures might address how much was accomplished, how well it was completed, and the benefits. It is also important to use a disciplined approach in developing and applying performance measures. An open communication process is important, as is moving quickly from talk to action.

- It is also important to let your customers know the relationship between strategic and performance planning. Strategic planning establishes the long-range goals. In program planning, the long-range goals are tied to the agency's goals. Annual performance plans are developed. Fiscal year goals and targets are tied to long-range program and strategic goals. Performance budgets are developed to identify the resources needed to fund long-range plans and short-term plans. Evaluations include quarterly performance reporting, performance and accountability reports, and feedback on the previous year's operations.

- FTA is conveying a number of messages to its customers with its performance measures. These messages focus on assessing efficiency and effectiveness, showing progress, and evaluating and holding managers accountable for results. The performance measures establish enduring outcome goals that target continual improvement as FTA's first priority.

- The Fiscal Year 2007 U.S. Department of Transportation (USDOT) Strategic Plan and the FTA Annual Performance Plan focus on safety, reduced congestion, global connectivity, environmental stewardship, organizational excellence, and security, preparedness, and

response. Goals in the FTA Annual Performance Plan address those areas. Goal 3, increased transit ridership, focuses on the USDOT Strategic Plan reference to reduced congestion. As part of Goal 3, FTA promotes transit ridership through investments, initiatives, and sharing information and best practices with transit agencies. Specific FTA management personnel are held accountable for meeting performance measures associated with the goals. The executive performance appraised record links the FTA goals to performance targets.

- A number of deliverables are associated with Goal 3. One deliverable is to conduct ridership reviews at two of the top 150 transit agencies and issue reports on recommendations for cost-effective methods of increasing ridership. A second deliverable is to recognize successful initiatives by FTA grantees to produce significant increases in ridership by presenting ridership awards. Developing a training course in partnership with the National Transit Institute to conduct ridership reviews is a third deliverable. As part of the United We Ride initiative, FTA will implement collaborative actions with other federal partners as part of Deliverable 4. These collaborative actions may include joint grantee training, conference calls, and other coordinated activities. A fifth deliverable is to continue investment in transit infrastructure and to rehabilitate or replace existing fleets to support increased ridership.

- The case study on transit ridership performance measures is an example of an approach that appeared good in theory, but did not work well in practice. An early approach to developing performance measures for transit ridership at FTA examined the desired end outcome of FTA's programs. Two outcomes of the program were increased mobility and reduced congestion. Increased transit ridership was identified as the way to measure those outcomes. Techniques to link the outcomes to FTA's performance were then examined. One approach was to remove the impact of external factors from the measure. Employment is an important external factor reflecting population changes and the fact that some 50% of transit trips are for commuting to and from work. It was decided to adjust transit ridership, using unlinked passenger trips, for employment changes in an urbanized area. It was felt that this approach would neutralize possible increases in transit ridership due to growth in employment, as well as declines in ridership due to declines in employment.

- There were a number of flaws with that approach. First, the increased complexity of the required analysis resulted in slower reporting by transit agencies. The analysis could not be completed without the urbanized-area-specific employment data, which lagged behind transit ridership data. Second, employment-adjusted ridership has no grounding in reality. It is difficult to interpret microdata at the regional level. Although the

percentage change in ridership has meaning as a performance measure, it has limited utility for other purposes.

- As a result of those flaws, the use of employment-adjusted ridership was discontinued. Actual ridership numbers are being used instead. Changes in the performance report numbers, such as increases or decreases in ridership, are directly connected with on-the-ground realities. This approach lets the data speak for themselves in regard to external factors.

- Work is ongoing on three of FTA's future goals for ridership performance reporting. The first goal is to further linkages between FTA programs, strategic planning, and performance measurement. The second goal is to baseline ridership targets against external factors. The third goal is to increase the frequency and availability of performance reporting and analysis to allow responsive decision making.

### Using Performance Measures That Are Meaningful to Your Customers

*Catherine Rice*

Customer service-related performance measures used at the Maryland State Highway Administration (SHA) were discussed in this presentation. The techniques used to gather input from customers, information obtained from these methods, and customer-based performance measures were described. The following points were covered:

- Personnel at state transportation agencies and the public often view situations differently. For example, agency personnel may characterize roadside debris as litter, animal carcasses, or other specific items, whereas the public sees it as junk. Transportation staff see incidents, accidents, and lane reductions due to reconstruction and maintenance activities, and the public sees a traffic jam. Agency personnel see night paving operations, road widening projects, and guardrail replacements, and the public sees never-ending construction. Staff work on traffic signal study requests, scoping studies, cost estimates, budgeting, and hiring contractors. The public sees no response to the major traffic problems. Agencies are using toll-free numbers, immediate e-mail responses, and friendly voicemail messages to deal with customers. Members of the public often ask if there is anyone they can actually talk with to get help.

- SHA is one of the modal administrations within the Maryland DOT. It owns, maintains, and operates some 5,200 mi of roadway and 2,500 bridges. The administration has approximately 3,200 employees, representing a mix of professional and blue-collar staff. SHA has an annual budget of approximately \$1.7 billion.

- SHA's vision for customer communication, satisfaction, and service is that the agency listens to and communicates with its customers to determine needs and expectations and to deliver excellent services and projects. SHA evaluates customer satisfaction through open communication and formal measurement to improve continually. The administration's key external customer groups include system users, neighbors, and shippers and businesses. Users of the system include personal vehicle drivers and passengers, truck drivers, bus riders, bicyclists, and pedestrians. The administration's neighbors include key transportation partners, such as other state agencies, industry groups, and local jurisdictions.

- There are three important steps in developing and implementing successful customer satisfaction performance measures. These steps are identifying customer viewpoints, applying customer input, and communicating agency performance. It is important to identify customer viewpoints. Customers know a problem when they see it, and they know when a problem has been addressed.

- A number of approaches and techniques can be used to identify customer viewpoints. Approaches in use by SHA include focus groups, context-sensitive solutions, customer telephone surveys, and postconstruction surveys. The Consolidated Transportation Program Tour, which involves the administrator visiting every county in the state, is another technique. Stakeholder advisory groups are also used to gain additional input from representatives of special groups.

- In addressing bridge safety, SHA uses a message that may contain too much jargon. The message from SHA addresses the percentage of bridges along the National Highway System that will allow all legally loaded vehicles to safely traverse and the percentage of SHA bridges identified as weight restricted and/or structurally deficient, so that there is no adverse effect on their safe use by emergency vehicles, school buses, and vehicles servicing the economy of an area. Simplifying this message and eliminating the use of technical terms represent a more customer-oriented approach.

- SHA includes questions on congestion in customer surveys. The results indicate that approximately one-third of Maryland residents do not mind congestion if they can predict how long it will take to make their trip. SHA monitors delays due to incidents, the average incident duration, the percentage of time that dynamic message signs and highway advisory radio are operational, the number of patrol hours logged, and the percent of lane miles with average annual volumes at or above congested levels. Providing information to travelers on travel times and trip-time reliability helps address the survey responses.

- Customers provide feedback on road safety characteristics during focus group meetings. SHA used the Strategic Highway Safety Plan as a means to build inter-

agency momentum to address safety concerns. A performance measure is the number of fatalities on all roads. Fatality rates, rather than total fatalities, are used in some states.

- Performance measures addressing snow removal include the number of hours required to regain bare pavement after a winter storm, the pounds of salt used per lane mile per inch of snow, and the total dollars expended per lane mile per inch of snowfall during the winter. Customers focus on how quickly roads are plowed after a storm.

- SHA uses numerous techniques to discern customer viewpoints. Customer focus groups are conducted in each district. Customers in recent focus groups identified key SHA functions, including maintaining roads, building roads, planning and designing new roads, constructing highways, providing for road safety, clearing snow, managing congestion, and providing emergency response.

- Focus group participants were asked questions relating to roadside and median mowing. Many responses focused on elements that are difficult to measure. Participants indicated that natural appearances are good and identified concerns about clear line of sight, clear shoulders for emergencies, and wildlife crossing roads.

- Focus group participants were asked to identify their expectations on the time it should take the agency to respond to questions and inquiries. Participants indicated that responses to telephone calls and e-mails should take 2 to 5 days and responses to letters should be received within 30 days. Information on satisfaction levels with response times for pavement repairs, litter removal, snow removal, and traffic signal outages was also obtained.

- A biennial statewide telephone survey provides additional detailed information on 22 key functions and specific areas of interest. For example, more detailed questions focus on factors that interfere most with safe travel and the SHA website. Survey responses identified the highest rated SHA responsibility. Snow removal was the highest rated responsibility, followed by providing roadway features, installing road signs, setting speed limits, and clearing accidents. Other responsibilities rated among the 10 most important included traffic management, roadside maintenance, bridge maintenance, travel information, and environmental protection.

- In a related question, survey respondents were asked to identify the importance of different SHA responsibilities. A total of 98% of respondents indicated that clearing accidents was important or very important. Maintaining roadways, removing snow, managing traffic, and providing roadway features were identified as important to very important by 95% to 97% of respondents. Maintaining bridges, 94%, and installing road signs, 92%, were the next highest ratings. Removing debris, providing emergency assistance, and setting speed

limits were rated as important to very important by 85% to 88% of respondents.

- SHA developed a satisfaction index that considers how important a service or project is to customers and how well the agency is doing in meeting customer expectations. Satisfaction is examined by customer segments. The agency continues to pursue a comprehensive customer service system that increases the linkage of customer input to strategic and tactical operation funding decisions.

- Pavement and maintenance index measures are used to address the overall quality of roads in the state. Measures include the percentage of pavement in acceptable condition, the percentage of the Maryland state highway network in overall preferred condition, and annual expenditures for maintenance activities. The timeliness of pothole repair was eliminated as a measure. Linkages between outcomes and operations are also being explored, and the asset management approach is being examined.

- In applying customer input, it is important to remember that government agencies exist to serve the public. The public expects and deserves good customer service. Private companies set the standard for providing customer service. The public expects courteous, personal service, with results in a timely manner and performed correctly the first time. Public agencies can learn from the private sector. Changes and improvements are needed for the agency to become customer oriented.

- Examples of customer satisfaction strategies at SHA include implementing a litter control action plan, adding completion dates to roadway signs for large and high-visibility construction projects, and implementing a 511 roadway information system and a 311 customer call center. In communicating agency performance to the public it is important to select the right measures and use an appropriate presentation method. Focusing on basic measures and eliminating technical terms are important. It is critical to use consistent, clear, and accurate data. The measures should be used to tell the story. Examples of presentation methods include the Internet dashboard, SHA annual report, and Maryland DOT attainment report.

- Focus group results show that SHA's customers care about clean, clear, smooth roads; avoidance of traffic jams, especially those due to accidents and road construction; timely responses to their inquiries and requests; and a personal touch. Using customer service performance measures ensures that focus.

## Research Needs

The following research needs were identified by participants in this session:

- Prepare a synthesis on the use of employee-focused performance measures at federal, state, and local transportation agencies. The experience with performance-based payments, bonuses, and financial incentives in public agencies will be explored. The programs at FTA and Missouri DOT will be highlighted, along with other examples. Necessary changes in legislation and policies to implement these types of programs will be discussed, along with keys to developing and implementing successful programs.

- Complete a synthesis on the use of customer service performance measures. The synthesis will identify the performance measures currently in use at state departments of transportation, transit agencies, and other organizations. The techniques used to develop the performance measures, to obtain input from customers, and to monitor performance will be included. Best practice case studies will be presented.

- Conduct a research study exploring the use of customer service performance measures in the private sector. The project will examine how performance measures related to customer service are developed, monitored, and used by companies and businesses. Approaches and techniques that may be appropriate for transportation agencies will be identified. Strategies on how the experience in the private sector can be transferred to transportation agencies will be described.

*Ronald Fisher, Federal Transit Administration, served as facilitator of this breakout session, and Katherine F. Turnbull, Texas Transportation Institute, served as rapporteur.*

## PARTNERSHIPS AND PERFORMANCE REPORTING: WHAT DOES THAT MEAN AND WHY SHOULD YOU CARE?

### Partnerships and Performance Measurement

*Dan Jiji*

The development and use of performance measures at the I-95 Corridor Coalition were discussed in this presentation. An overview of the coalition was provided, and the use of performance measures by the coalition and member agencies was described. The following points were covered:

- The I-95 Corridor Coalition is a partnership of transportation agencies along the East Coast. Formed in the early 1990s, the coalition represents a successful model for interagency cooperation and coordination.

- The region covered by the I-95 Corridor Coalition encompasses some 565 million long-distance trips, 5.3 billion tons of freight, and a \$3.95 trillion gross domestic

product. The region represents the third largest economy in the world.

- The transportation system in the corridor includes 1,919 mi of I-95 and 40,000 mi of National Highway System facilities. It also includes 22,000 mi of Class I railroads, 46 major seaports, and 103 commercial airports.

- The I-95 Corridor Coalition has a multimodal and multijurisdictional program. There is an emphasis on the needs associated with long-distance transportation across state jurisdictional boundaries. Major transportation issues in the corridor include traffic congestion, long-distance travel, and mobility in rural areas. The movement of freight, as well as emergency response and security, represents other issues in the corridor.

- The I-95 corridor is double the length of the state of California. Although it is one major transportation corridor, there are numerous stakeholders. Membership in the I-95 Corridor Coalition reflects these diverse stakeholders. Members of the coalition include the state transportation agencies for 16 states and the District of Columbia, 14 transportation authorities, five federal modal transportation administrations, and 29 related organizations.

- Performance measures are an important part of programs and projects at the coalition. Performance measures are critical for effective multijurisdictional system planning and decision making. Multijurisdictional data are often required to assess the true performance of the transportation system. Partnering also provides the opportunity to leverage data collection efforts, which can be costly, complex, and time consuming. Performance measures facilitate the focus of decision makers on policy questions, rather than on day-to-day operations. Performance measures provide a tool to help determine whether an investment is producing the desired result.

- The I-95 Corridor Coalition Performance Measurement Task Force was formed in 2005. The task force is made up of coalition members and is charged with focusing on information exchange and the development of a framework for performance measures at the coalition. The task force prepared a white paper on performance measures, which formed the basis for an October 2006 information exchange webcast on best practices in performance measurement. A course on performance measures was also developed and posted on the coalition website.

- The performance measures framework of the I-95 Corridor Coalition maps the relationships between the coalition's vision, mission, and goals; the coalition's guiding principles; and its strategies, projects, and program tracks. In addition, the existing and potential output and outcome performance measures are presented.

- The vision of the coalition is that the transportation network in the region will be safe, efficient, seamless, and intermodal and will support economic growth in an environmentally responsive manner. The mission of the coalition is for the agencies to work together to improve multimodal transportation services in the region through information sharing and coordinated management and operations. Examples of goals include improving mobility for people and goods, enhancing safety for all travelers, and improving the economic vitality of the region. Strategies include sharing knowledge and information, managing information, and facilitating deployment across jurisdictions and modes.

- Numerous benefits may be realized using performance measures, including the periodic refinement of programs and services to better direct resources to programs with a high return on investment. Performance measures provide more informed decision making, improved internal management, and enhanced understanding of programs and services. Performance measures provide better accountability to senior management, the public, and elected officials and improved correlation between organization goals and the needs of members, users, and the public.

- The opportunity emerged at the coalition to apply the principles of performance measures to actual program activities to measure effectiveness. The traffic-monitoring project using probe vehicles provided the opportunity to enable the use of performance measures. The vehicle probe project is a multistate traffic-monitoring project being implemented in the corridor. It is based on vehicle probe technology, which includes Global Positioning System, cellular, and toll tags. The traffic monitoring function is being outsourced as part of the project. The project will produce measurements of travel time and trip reliability. It will provide coverage of large areas and different roadway types, not just freeways.

- It is anticipated that the probe data project will provide a number of benefits, including improved traveler information and reliable travel-time data. Another benefit is improved traffic management, including knowledge of alternate routes. Improved performance measurement and improved planning and engineering are other potential benefits. The project will also provide expanded inputs for the integrated corridor analysis tool (ICAT) and the Information System Network (ISN). In addition, it will help satisfy provisions of the Safe, Accountable, Flexible and Efficient Transportation Equity Act: A Legacy for Users.

- Implementing the corridorwide traffic monitoring system offers the opportunity to use performance measures on a corridor basis. The project focuses on using data from the vehicle probes to measure system performance. A concept of operations was prepared to identify all users of probe system data, to define their information

requirements, and to describe how the data will be disseminated. The concept of operations will define a set of measures derived from the probe-based data that are meaningful to the coalition membership and the motoring public. Potential measures include travel time, travel-time reliability, speed variance, and travel-time predictability.

- The project will also use different methods to present the collected data, including annual reports, maps, graphics, and websites. The project data may have internal applications as well as applications that are external to coalition members. Different applications may benefit different user groups. Traveler information would be of use to motorists, travelers, and fleet managers. ICAT would be of use to planners, engineers, and elected officials. Operations managers and incident managers would benefit from ISN.

- The vision for ICAT is a GIS-based network covering the 16-state region. It would provide roadway and traffic data linked to the network, allowing examination of transportation patterns across states and for the entire corridor. ICAT would be accessible to members and would provide the ability to analyze trends and to forecast future travel volumes. The initial applications will focus on bottlenecks analysis, freight planning, and emergency evacuation planning. Data from the probe system could be used to evaluate system reliability across the multistate transportation network.

- The I-95 Corridor Coalition is actively engaged in multijurisdictional performance measurement. The coalition is implementing applications for planning operations and decision making. It has initiated the vehicle probe project to capture data in support of performance measurement and is moving toward integration of performance measures throughout its programs.

### **Corridor Management: Managing for Performance**

*John Wolf*

The development of corridor management plans in California was discussed in this presentation. These plans are being developed in 26 corridors as part of Proposition 1B. The following points were covered in the presentation:

- The Corridor Mobility Improvement Account is one of the Proposition 1B bond accounts. The account includes \$4.5 billion in funding for improvements in 26 congested corridors in the state. The California Transportation Commission is requiring corridor system management plans as part of obtaining funding for projects through this program.

- A key element in the development of the corridor management plans will be involving all appropriate

agencies and groups. Performance measures help focus the discussion of diverse stakeholders. The plans will build on the traditional system planning process that has been used in the state for many years.

- The corridor management plans will contain a number of components. These components include a description of the corridor, a performance assessment of the corridor, an understanding of the key issues, and the identification of the package of projects to address the needs in the corridor. Performance measures will be a key part of the plans. The intent is to develop plans that provide guides to strategic investments in the corridors and to consider all modes, system management strategies, and demand management techniques.

- Key elements of the process include collaboration between agencies and groups, an ongoing commitment on the part of these groups to work together, sound technical analysis based on accurate data, evaluation of a range of options, identification of the most appropriate investments and strategies, and use of performance measures to monitor and report on progress. Collaboration will be key to the success of the planning, project development, implementation, and operations process.

### **Research Needs**

The following research needs were identified by participants in this session:

- Complete a synthesis on the use of performance measures at the corridor level. The synthesis will explore the use of measures to monitor and report on network corridor performance. Elements to be included in the synthesis are the agencies and organizations involved in developing and using the measures, actual performance measures and benchmarks, data collection methods and analysis techniques, reporting methods, and use of measures in management and operations decisions. The synthesis will include best practice case studies.

- Conduct a more detailed assessment of the multi-jurisdictional, multimodal performance measures program. This study will identify how current programs are organized and operated and describe how the information on network performance is used in decision making. It will also explore new data collection and method analysis methods and techniques that could enhance multimodal performance measures. New and improved methods for measuring network corridor performance will be identified. The various institutional arrangements used to support current multimodal corridor performance measures will be examined, and approaches to enhance multiagency coordination and cooperation will be described.

- Conduct a research study examining the involvement of resource agencies in the development and use of

transportation performance measures. The study will explore how resource agencies are currently involved in developing transportation performance measures and identifying approaches to enhance their involvement. Performance measures related to the environmental review process will be examined, and approaches to use the performance management process to assist with environmental streamlining will be explored.

- Conduct a research study on the role of the private sector in developing and using performance measures at transportation agencies. The study will examine current methods to involve the private sector and possible approaches to enhance its participation. Performance measures related to public-private partnerships will be examined along with techniques to measure the impact of transportation in the private sector.

*Nick Compin, California Department of Transportation, served as facilitator of this session, and Janice Benton, California Department of Transportation, served as rapporteur.*

## VISUALIZING RESULTS OF PERFORMANCE MEASUREMENT PROGRAMS

### GIS? So What!

#### Visualization of Performance Measures

*Jill Reeder*

The use of geographic information systems (GIS) and other visualization techniques with performance measures was discussed in this presentation. The benefits of GIS applications were described, and examples from the Pennsylvania Department of Transportation and South Dakota were presented. The following points were covered:

- The automation of performance measures in Pennsylvania included a number of stages. The initial proof-of-concept stage was called the Data Rich Information Poor initiative. An effort was also initiated to explore the use of GIS as a tool to display metrics. The targeted audience was senior and midlevel decision makers.
- Typically, dashboards and scorecards are used to display performance measures. These methods are often used to present information on the status of project delivery, ride quality, and safety issues. To fully understand the message behind the dashboard, however, requires drilling down to the underlying data.
- Using GIS with performance measures is a logical approach for many reasons. First, many of the data used by state departments of transportation are spatially oriented. Second, often the story, or the real message, is in

the geography. Third, the mind cannot organize the spatial aspects of a spreadsheet as readily as it can a map. Finally, multiple interactive measures can be mapped.

- Often multiple measures are needed; one number does not accurately tell the full story. Financial, operational, customer, and human resource information may be needed to provide a comprehensive assessment of a topic or issue. Time-series-related data may be needed to accurately present the full picture on previous, current, and future performance.
- Pennsylvania DOT uses a value chain approach to consider measures. Dashboard measures might focus on system condition and performance and outcomes, such as travel time, crashes, economic benefits, and social and environmental issues. Above these measure are factors that Pennsylvania DOT can control, including resources, organization capacity, planning, programs and budgets, management, and outputs.
- Pennsylvania DOT has developed prototypes to display information on the international roughness index (IRI). The prototype includes the ability to layer other factors to better determine factors influencing poor IRIs and to include programmed projects to address problem areas.
- The South DOT has begun a 3-year effort using GIS to present performance measures. The effort began with the use of storyboarding. Activity-based costing has also been used. The department is building the database and the applications.

### Visualizing Performance

*John Webber*

The development and use of a records management system at the Illinois DOT were discussed in this presentation. The internal communications system, Construction Dashboard, employee information elements, and website used for external communication were described. The following points were covered:

- *Inside IDOT* was implemented within SharePoint (Microsoft InfoPath). *Inside IDOT* provides information to agency employees. It is used to communicate agency policies, programs, Illinois DOT news, training opportunities, and a wide range of other information. It enhances information and performance management at the department.
- The Construction Dashboard is a web-based system that provides information on construction contracts throughout the state. It is used to keep the completion of roadway construction projects on schedule and on budget. Program and measurement areas include scope, schedule, budget, and timely closeout of projects. The

scope is the percent of change orders to total contracts. The program measurement for schedules is the percentage of contracts beyond the allocated schedule. The budget program measurement is the percent of contracts over budget. The program measurement for timely close-outs is the percentage of contracts closed within the specific time limit.

- Elements of the employee information portion of the system include automated time cards, an integrated timekeeping system, and self-generated employee reports. The employee information elements have numerous benefits. A smaller staff is needed to conduct these functions, the functions are completed faster, and employees are better able to track their records.

- Another element of the system is IT Express, a one-stop help system for Illinois DOT employees. This page contains links that will navigate users to the right person to assist with their requests. For example, if users have a problem with their printers, they click on the report-a-problem link under the printer section. An e-mail to the service desk is automatically generated. The e-mail also automatically populates the fields for users to fill in what the service desk requires to identify their printers. Another element of the system is the action request form. This online form is used for making requests related to obtaining access to different system elements, enhancements, or other items. The completed forms automatically notify the responsible staff by e-mail.

- SharePoint is also used to enhance employee collaboration. Staff members can set up their own *My Site* page to meet their own work needs. Examples of other parts of the system that enhance communication and collaboration are the Chief of Staff site, Executive Office site, Diversity Council site, Strategic Initiative site, Electronic Documents site, and Forms Master List site.

- The system is also used as an external communication tool. The website, *GettingAroundIllinois.com*, provides information on current traffic conditions, construction delays, and travel times on major routes. Users can search for specific locations by address, zip code, intersection, community, point of interest, and other information. The site also provides information on Illinois DOT projects and programs. The approach of integrating all systems and providing data access from every point of entry promotes team building, information sharing, and communication across silos.

## Visualizing Performance Results

### *Michael Bridges*

The Louisiana Department of Transportation and Development's (DOTD) use of a dashboard system to present

information on performance measures was discussed in this presentation. The development and use of performance measures at Louisiana DOTD were summarized, and the dashboard elements were explained. The following points were covered:

- The department's Change Management Program identified and reengineered processes that are critical and drive the focus of Louisiana DOTD. It created a change management organization to facilitate improvement. The program instituted goal setting, performance measurement, and accountability. Examples of implemented changes from the program include electronic bidding, a cradle-to-grave project management function, right-of-way legislation, and a structure to implement the intelligent transportation system. The Change Management Program was changed to the Quality and Continuous Improvement Program to better reflect the ongoing interaction of planning, action, and examining and adjusting.

- The Louisiana DOTD performance system includes a number of components. The 5-Year Strategic Plan includes 80 performance indicators in the legislatively approved operating budget. There are office-, division-, district-, and section-level goals and objectives, which are updated monthly on an executive scorecard. Finally, there are five dashboard measures, which are updated nightly through the data warehouse and are displayed on the department's Internet site.

- The guiding principles of the dashboard measures are to keep it simple, to focus on the department's primary mission, and not to make excuses. Other guiding principles are to focus on measures that are meaningful to Louisiana DOTD customers and to drive internal change.

- The first dashboard measure is bid when scheduled. It is a simple measure that reflects the performance of most of the department. It focuses on no excuses for why a project is delayed. This dashboard has multiple process owners, including the road and bridge design section, utilities relocation, right-of-way section, project finance, and other groups. The measure represents the percentage of projects that had bids opened on or before the scheduled bid opening date.

- The second dashboard measure is bid within 10% of the Louisiana DOTD engineer's estimate. This measure focuses attention on accurately estimating the cost of projects. Accountability is assigned to the new estimates group in the project management section. A cultural change away from scope and budget creep is encouraged. The performance measures track the number of low bids more than 110% of the engineer's estimate, the number of low bids within 10% of the estimate, and the number of low bids less than 90% of the engineer's estimate.

- The third dashboard measure focuses on projects completed on time. It is another simple measure that reflects the performance of most of the department. There are no excuses for why a project is delayed. This measure addresses the completion of projects when promised. The actual measure is the number of projects completed within the original time established in the contract.

- The fourth dashboard measure is projects completed within 10% of the bid amount. This measure has multiple process owners, including construction, designers, utility relocation, and right-of-way. It focuses attention on minimizing change orders. The dashboard displays the percentage of projects with final costs of less than 110% of the contractor's bid.

- The fifth dashboard addresses traffic fatalities. Although Louisiana DOTD does not have direct control over this measure, the department can influence it through indirect means including striping, guardrail repair, and selection of the right projects. This measure is tied to the department's mission. The dashboard measure is traffic fatalities on Louisiana public roads on a year-to-date basis. The dashboard also displays the year-to-date average based on the previous 5 years.

- The use of performance measures and dashboards provides a good way to focus the activities of a department and to assess progress toward meeting goals and objectives. The department's experience stresses the importance of keeping the measures and the presentation of results simple and focused on the department's primary mission. It is also important to use measures that are meaningful to customers. Performance measures can be used to drive internal change and provide a no-excuse environment.

## Research Needs

The following research needs were identified by participants in this session:

- Complete a synthesis on the use of visualization techniques with transportation performance measures. The synthesis will include case study examples highlighting the use of visualization techniques by state departments of transportation, transit agencies, and other organizations. The synthesis will include examples of visualization techniques for use internally and externally.

- Conduct a research study exploring new and innovative techniques and tools that could be used with transportation performance measures. The study will explore visualization techniques used in the private sector that may be appropriate for application by transportation

agencies. The most promising visualization techniques will be identified, and potential pilot projects will be presented.

*Rina Cutler, Pennsylvania Department of Transportation, served as facilitator of this breakout session, and Francine Shaw-Whitson, Federal Highway Administration, served as rapporteur.*

## BENCHMARKING AND TARGET SETTING: STATE PERSPECTIVES

### Performance Targets . . . Inclusive, Exclusive, Always Elusive

*Julie Lorenz*

The development of performance measures and targets at the Kansas DOT was discussed in this presentation. The context for the performance measurement process in the department was described, and the department's strategic performance focus areas were highlighted. The following points were covered:

- When Debra Miller was appointed Kansas DOT secretary, she initiated a top-to-bottom review of the agency. The review included a survey of 900 stakeholders. Survey results indicated a high regard for the performance of the highway system in the state. Lower ratings were given for the way the department conducted business and delivered the system, however. For example, the department was viewed by many survey respondents as too rigid and not interested in input from the public or other agencies. Through the Partnership Project (P2), Kansas DOT has made a concerted effort to become more of a collaborative agency. The phrase "responsive and responsible" is used to characterize this collaborative approach.

- Work was also initiated on performance measures to help institutionalize the P2 philosophy. The development and use of performance measures and targets at the department resulted from Secretary Miller's proactive review of the agency and the stakeholder surveys, as opposed to responding to a crisis. Some state departments of transportation have developed performance measures in response to a crisis situation. Promoting change and accountability in response to a crisis situation may be easier than doing so when everything is going well.

- Kansas DOT has established six strategic focus areas for performance measures. The focus areas are project and program delivery, preservation and maintenance, workforce development, economic impacts, safety, and modernization and congestion.

- Using performance measures in project and program delivery allows the department to focus on performance in new ways. Before the development of performance measures, each individual project was monitored. Project managers reported any problems to the program review committee. Decisions were made on individual projects, but the overall program view was never really addressed. The performance measures focus on aggregating data on all projects to determine whether the department is delivering the overall program on time and on budget. Specific targets are less important in this area because the department is gaining a better understanding of its business.

- Setting targets is important in the preservation and maintenance strategic focus area. The roadway system in the state is in good condition as the result of a strong ongoing investment in preservation and maintenance. Performance measures in this focus area, such as the percentage of Interstate pavement in the highest-rated condition, have been exceeded. A series of road rallies will be used to establish performance measures that are in line with customer expectations. The department is taking a harder look at measures to make sure they are meaningful.

- The department used a 15-question survey from the book *First Break All the Rules* to establish performance measures in the workforce development focus area. The questions gauge the climate within individual work units. The measures focus on supervisors creating positive energy and an open work environment, as measured by employee retention and employee productivity. Baseline data are being established for these performance measures, which have been challenging to develop because employees tend to focus on compensation issues.

- Similar to many state departments of transportation, Kansas DOT has struggled with developing relevant performance measures related to economic impacts. One measure being used is the average truck speeds in major travel corridors, such as I-70. Truck travel speeds on I-70 in Kansas are higher than speeds in other states. Although this performance measure provides an indication of travel time and trip-time reliability for commercial vehicles, it may not be the most appropriate measure of the economic impact of Kansas DOT products and services. As part of developing the long-range transportation plan, which includes engaging stakeholders throughout the state, additional performance measures related to economic impacts will be identified.

- Targets have been set for safety performance measures based on reasonable annual increases in safety belt use and decreases in fatality and injury rates. These measures are commonly used by transportation agencies.

The modernization and congestion focus area has been a little harder to define and to set targets for. Modernization addresses ensuring that highways meet current standards. Sufficient shoulder widths are used as the modernization performance measure. Targets were also set for the level of acceptable congestion in urban and rural areas.

- Road rallies will be used to link performance, customers, and budget considerations. Road rallies involve citizens driving on different roadways in the state under different conditions. Their satisfaction levels are correlated to actual road conditions. Participants also meet to discuss their experiences and potential modernization, capacity, and congestion performance measures and targets. The funding levels and trade-offs associated with meeting different targets are also discussed. This information will be used in developing the department's 2009 legislative package and budget request. The link to setting and meeting performance measure targets in a budgetary context is important.

### Benchmarking and Target-Setting: State Perspectives

*Mara Campbell*

Performance measures at the Missouri DOT were discussed in this presentation. The Tracker system and the use of benchmarking rather than setting specific targets were described. The following points were covered:

- Missouri DOT's performance measures are aligned with the department's mission and value statements. Key tangible results are identified. These results are what customers expect Missouri DOT to deliver. Examples of tangible results include uninterrupted travel and a safe transportation system. All the elements are aligned to performance.

- *Tracker* is a quarterly publication that is organized around 18 tangible results. Currently 132 individual measures are monitored. The number of measures is fluid, however. New measures are added and existing measures are deleted in response to changing demands and conditions. Measures are assigned to senior and midlevel managers who are responsible for identifying ways to improve the specific measure and to carry out the improvements. Specific targets are not set. Rather, individuals are responsible for continuing improvement. Senior and midlevel staff are held accountable for progress on the assigned measures. Quarterly meetings are held to review progress. Presentations are required to address performance and actions. The discussion of plans is not permitted.

- A cascading technique is used with the process. A supplement to Tracker breaks measures down for internal use. Districts and divisions have their own Trackers and are required to provide quarterly updates. The district and division Trackers, which contain more detailed measures and performance trends, provide data for daily business operations. The measures roll up to the department Tracker. This approach connects all employees to Tracker.

- Specific performance targets are not used at Missouri DOT. It is felt that performance targets limit results. Staff focus on meeting a target, rather than exceeding it and continuing to improve. Without specific targets, staff continue to strive for improvements and are more likely to be innovative and creative in their efforts. In addition, performance targets are time consuming to set. Performance targets frequently can compete with each other, and on occasion can conflict.

- For those reasons, Missouri DOT focuses on benchmarking to the best of the class and to industry leaders. Performance measures may be benchmarked to other state departments of transportation or private businesses. This approach allows the department to learn from the best in the public and private sectors.

## Benchmarking and Target Setting

*Leonard R. Evans*

Performance measures, benchmarking, and target setting at the Ohio DOT were discussed in this presentation. The way targets are established, monitored, and used was described. The following points were covered:

- A number of methods are used to set performance targets at Ohio DOT. The use of performance measures at the department started as a quality improvement initiative. The division of quality conducted mandatory total quality management training for all employees. Performance measures were identified as part of a reorganization of the department that focused on moving toward a process-driven organization. Part of the process focused on identifying the requirements of the department and determining whether the requirements were being met. Other elements used in setting targets were customer surveys, historical data, the strategic plan, funding levels, and benchmarking to other agencies.

- Customer surveys are used to identify what projects and services are important to the public, as well as obtaining their views on how the department is performing. Surveys were conducted in the development of the long-range transportation plan. They are also conducted annually to obtain feedback on how the department is

performing. For example, customer surveys have highlighted the importance the public places on the Freeway Patrol, which helps stranded motorists.

- Identifying key processes within the department was also an important element in setting performance measure targets. All parts of the organization were reviewed, and 65 measures were identified by management. These are collective measures. If a district is performing poorly on a measure, it is the responsibility of the central office to review funding levels, training, and processes and to intervene to address the problem.

- Historical performance was also reviewed, especially in the maintenance area. The process has resulted in a change from simply conducting maintenance activities to focusing on outputs. Ohio DOT personnel drive roadway segments and count guardrail deficiencies, shoulder deficiencies, litter, and other items. Targets were established through an analytical process that considered the overall performance, standard deviation, and expectations. Most districts were well below the targets when the process started 3 years ago. Significant progress has been made in all maintenance areas during a short period of time.

- The Ohio DOT performance measures are linked to the department's strategic plan. The department's business plan links the strategic plan to the biennial transportation budget. The business plan ties the strategic planning process with Ohio DOT's mission and goals. It highlights the department's strategic initiatives, which address gaps in performance. It also links to the 65 measures in the organizational performance index. Performance trends and forecasts are linked to funding levels. The budget process considers results, and resources are allocated to measures not meeting targeted levels.

- Achieving a steady and predictable condition level for existing assets simplifies the budgeting process. When performance measures were first implemented, 20% of pavement on the priority roadway system was deficient. Resources were allocated and improvement was quickly achieved. It was realized that this level of investment could not be sustained over the long term. This realization resulted in a change in the goals from zero deficiencies to a level that could be sustained in the long term, and the target changed to a manageable level of deficiencies or a steady state condition. The goal is to keep the system at a sustainable level perpetually.

- The use of performance goals has resulted in significant improvements for pavement and bridge conditions in the 12 Ohio DOT districts. Performance goals have set departmentwide expectations. Ohio DOT conducts internal benchmarking and external benchmarking. These efforts help in validating priorities, identifying best practices, and responding to change. External benchmarking considers other state transportation agen-

cies, businesses, and other sources, such as *Governing* magazine.

### Evolution of Performance Measures with Change from State Highway Department to Department of Transportation

*Nick Mandel*

Performance measures and setting targets at the New Mexico DOT were discussed in this presentation. The initial development of performance measures at the New Mexico Highway Department and the change in performance measures with the change to a department of transportation were described. The following points were covered:

- The development and use of performance measures started about 10 years ago at the highway department. At that time, the focus was on traditional highway performance measures, including smooth roads, pavement condition, number of highway signs, number of litter pickups, and project lettings. Rather than setting specific targets, the performance measures were oriented toward continuous improvements.
- There was some initial resistance among staff when the performance measures were first introduced in the department. Over time, however, the measures became an accepted, refined, and sophisticated system. There were 18 performance categories and some 90 specific measures as well as a well-developed data collection process to support assessing the various measures.
- When a new governor was elected, a new highway secretary was also appointed. At the same time, the highway department was expanded into the New Mexico DOT. The change influenced the department's performance measures, which had to address more than just highways. This change was a challenge because the culture at the department had been focused on highways. A change in thinking was required of many employees. Also required were the development and use of new performance measures on other modes and programs.
- The roadway system in the state continues to be a major focus of the performance measurement system. Approximately 92% of the department's budget supports the roadway network. New Mexico is still primarily a rural state. As a result, the roadway system is critical for the movement of people and goods.
- Additional performance measures were needed to address the department's new responsibilities. Performance measures for public transportation, park-and-ride facilities, traffic safety, and other elements were developed. Targets and benchmarks were established for the

transit and park-and-ride measures based on estimated demand. As targets were met, more challenging targets were set. The department implemented the Rail Runner commuter rail line in the Albuquerque area to help address traffic congestion and provide travel options. The line will be extended to Santa Fe during the next few years. Response to Rail Runner has been good, with ridership levels meeting projected demand.

- The highway system continues to be a major focus for New Mexico DOT. Providing projects and services on time and on budget are key performance measures that have been targeted for improvement. Agency leadership has set a target to be a Tier-1-level performer by 2011. The department has used the work of the AASHTO Standing Committee on Quality to learn more about methods used in other states to improve on-time and on-budget performance.
- Driving while intoxicated (DWI) is a major problem in the state. New Mexico has ranked Number 1 or Number 2 among states for fatalities related to DWI over the years. With the transition to a department of transportation, the agency leadership set a goal to reduce DWI-related fatalities so that New Mexico is not among the five worst states. This goal represented a significant improvement for the state. When this goal was met, a new target of further reducing DWI-related fatalities was set so that the state is not among the 10 worst states by 2010. When this target is met, a new target will be set to not be among the worst 25 states. Performance targets can be thought of as moving goal lines.
- Performance targets and benchmarks will vary by state. Targets need to reflect the conditions being addressed, the social and economic characteristics of the area, and other factors. Targets and benchmarks also reflect the challenges and the environment in an area. The measures, targets, and benchmarks changed when the agency became a department of transportation to reflect the agency's broader responsibilities. Adaptability is also important in setting targets and benchmarks as conditions change. As organizations change, benchmarks and targets will also change.

### Research Needs

The following research needs were identified by participants in this session:

- Conduct a study examining the performance measures being used by state departments of transportation throughout the country. The study will identify common or generic performance measures, as well as measures that are unique to different state departments of transportation. The benchmarks and targets used with differ-

ent performance measures will also be identified. The intent of the research is to share information on the measures and approaches being used in different states, not to compare how various states rank on different measures. The study will also examine different combinations of measures and explore the benefits and limitations of various mixtures of measures.

- To set performance measures and benchmarks, conduct a research study examining the use of stated-preference surveys to assist in determining customer expectations related to different aspects of the transportation system. Some states have used stated-preference surveys of motorists, shippers, and other stakeholders and customers to obtain input on establishing targets. Other transportation agencies can benefit from using that approach. The study will document the use of stated-preference surveys and their advantages and limitations and provide guidance on the use of these

surveys. Case study examples will be presented to highlight the application of stated-preference surveys to set performance measure targets and to monitor progress toward meeting those targets.

- Conduct a research study to examine the real cost of setting and meeting performance measure targets. Meeting a target may mean that another target was not met. The study will explore the use of trade-off analyses and other methods to better identify the costs associated with meeting targets and the impact on other targets or objectives that are not met as a result. The study will also examine techniques to assess the costs and benefits of alternative solutions and the viability of those solutions.

*Joe Crossett, TransTech, served as facilitator of this breakout session, and Vicki White, California Department of Transportation, served as rapporteur.*

## BREAKOUT SESSIONS 3

# Data and Tools

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R. Greg Albright, *California Department of Transportation*

Tarek Hatata, *System Metrics*

Michael Pack, *Center for Advanced Transportation Technology, University of Maryland*

Jim Benson, *Greghill Solutions*

Thomas Jeffrey Price, *Virginia Department of Transportation*

Michael Halladay, *Federal Highway Administration*

Tadashi Okutani, *National Institute for Lands and Infrastructure Management, Japan*

Ramkumar Venkatanarayana, *University of Virginia, Center for Transportation Studies*

Crystal Jones, *Federal Highway Administration*

Shawn Turner, *Texas Transportation Institute*

Chandra R. Bhat, *University of Texas at Austin*

Peter Möhl, *PTV Traffic Mobility Logistics*

## VISUALIZATION

### I-880 Corridor System Management Plan

*R. Greg Albright and Tarek Hatata*

Greg Albright highlighted elements of the corridor management plans. He stated the importance of a change of culture to bring operations and planning together and described the need to empower traffic operations personnel to become drivers of planning, focusing on short- and medium-term solutions. Tarek Hatata discussed the I-880 corridor system management planning process, including the use of microsimulation techniques. The following are key points of their presentations:

- The corridor management planning process involves all appropriate agencies and jurisdictions. The plans include consideration of all modes. Major components of the planning process and the plans include the use of a multiagency corridor team, description of the corridor, assessment of the corridor performance, and assessment of alternatives. An improvement proposal is developed based on this information. The process is ongoing as projects are monitored after implementation.

A change in agency culture is important to bring operations and planning together. Empowering traffic operations personnel to become the drivers of planning, focusing on short- and medium-term solutions, is also an important part of the process.

- Proposition 1B includes the Corridor Mobility Improvement Account. The California Transportation Commission is requiring the development of corridor system management plans in the 26 corridors. The I-880 corridor system management plan was completed before Proposition 1B, but it represents a model for the Proposition 1B corridor system management plans. The planning effort examines a number of operational, intelligent transportation system (ITS), transportation demand management, and traffic control strategies, as well as system expansion alternatives in the corridor. Performance measures should identify how the system is performing, identify why it is performing the way it is, and with the use of other techniques, evaluate alternative strategies.

- The portion of the I-880 corridor in the study is approximately 35 mi long. There is a good traffic detection system in the corridor, which provides data on the operation of the system. The approach focused on detailed performance assessments and microsimulation based on

what-if analysis. A base performance assessment was conducted first, followed by the identification of bottlenecks. Microsimulation is being conducted to test different improvement scenarios. The scenario performance evaluation will be used to develop recommendations and performance improvement estimates. Microsimulation does take time and resources, so it is important to allocate extra time if this technique is being used.

- The study began with an examination of weekday delay on the freeway. Detection data in the northbound direction were used to compute weekday delay on the freeway from January 2003 to December 2005. The results indicated that there is no typical day because there is great variability in the daily delay. Weekday averages by month and the average delay by time-of-day were computed to obtain a better perspective on the most congested time periods. The averages by year were also examined. These data pointed out the increases in midday delay in 2005, compared with 2003 and 2004. The ramp meter system is not in operation during the midday period. Overall, total daily delay is between 10,600 and 11,600 h.

- Travel times and trends were also computed for the entire corridor. Trends similar to those noted with delay were identified. Travel-time reliability was also computed. There are a number of methods to examine trip-time reliability. The average travel time was analyzed. The 70th, 85th, 95th, and 99th percentiles were also examined.

- The detection data were also used to calculate productivity losses by segment. These data were aggregated for the study corridor in regard to lost lane miles for different time periods. Mobility productivity loss was defined as loss of throughput measured by vehicles per hour per lane. A typical productivity loss can result in a reduction of the normal 2,000 vehicles to 750 vehicles per lane per hour. The lost equivalent lane miles for a day, a month, or a year can be calculated. The cost of adding one lane mile of freeway in California is approximately \$100 million, so the loss of 3.6 equivalent lane miles due to congested conditions is approximately \$360 million.

- Crash data were also examined. The California Department of Transportation (Caltrans) collision database indicates that during a 4-year period, generally between five and 15 collisions occur daily. Further, collision-free days are rare. The monthly averages do show a slight recent downtrend in collisions, however. The California Highway Patrol reports more than 100 incidents on the corridor every day of the week.

- The corridor bottlenecks identification and analysis used speed contours to identify the specific bottleneck locations and the extent of the bottlenecks. Results of this analysis indicated that the severity of the bottlenecks changes from day to day. When the speed contours for the northbound direction for October 2005 were

reviewed, it appeared that there were three major bottlenecks, with two in the same location. A more detailed review showed that one of the bottleneck locations was actually two separate bottlenecks. Aerial photographs and field observations were used to identify the causes of the bottlenecks, their extent, additional contributing factors, and possible strategies to address those issues.

- The base-year microsimulation model has been calibrated to reasonably replicate the performance and bottlenecks in the corridors. Caltrans has addressed one of the bottlenecks through improved ramp metering. The next steps in the project will focus on testing the scenarios developed specifically to address the bottlenecks identified and to develop a phased implementation plan.

### D.C. Area Regional Integrated Transportation Information System with Real-Time and Archived Performance Monitoring

*Michael Pack*

The concept and prototype development of an area regional integrated transportation information system (RITIS) in the Washington, D.C., region were discussed in this presentation, and the visualization capabilities of the system prototype were illustrated. The following points were covered:

- There are currently multiple incident management systems in the Washington, D.C., metropolitan area, including those operated by Virginia Department of Transportation (DOT), Maryland State Highway Administration, District of Columbia DOT, transit agencies, and selected counties and cities. Coordination and cooperation among these systems is somewhat ad hoc, however.

- The vision for RITIS is an automated system that compiles real-time traffic and transit data from the incident management systems above, processes the data into a common format, and shares them with agencies, the media, and the public. A prototype of RITIS has been developed. The prototype includes many of the functions envisioned for the complete system.

- The complete RITIS will include numerous functions and components. These functions include acquisition of data on incidents, events, construction, and related information. Real-time dissemination of traveler information and information concerning incidents and traffic management is also a key function. Archived data for research and development, planning, and performance measures represent other functions.

- The RITIS prototype provides real-time performance monitoring information. It provides information on current traffic conditions, incidents, and crashes in a visual map-based format. Video from closed-circuit tele-

vision (CCTV) cameras located in different corridors can also be viewed.

- Incident data can be examined using the RITIS timeline tool. This tool allows incident data to be visually displayed on one screen. It provides a method to manage, display, and comprehend complex data sets. This tool is also very interactive. Information on the location, time, and characteristics of an incident can be displayed. The traffic operators' notes and information on the responding agencies and the status of traffic lane closings, traffic conditions, and variable message signs can also be displayed and analyzed.

- A three-dimensional performance monitoring program is under development. This system will provide a bird's eye view of the area. A demonstration was provided on the current capabilities of this element.

- The archived data in RITIS can be used in the performance measurement process. Incident data can be examined by the type of incident, the number and types of disabled vehicles, the location, and the time of the incident. The duration of an incident, response time, and time to clear the vehicles can all be examined. The archived data can also be used in planning and operations. Incident data can be used to identify high crash locations and locations to deploy safety patrols.

### **Omnipotence Now! Wisely Using Existing Information, or Jubilation Through Information Integration**

*Jim Benson*

Communication, performance measures, and data presentations were discussed, and a hypothetical story of how information available on the Internet could be used to evacuate a small community in eastern Washington was provided. The following points were covered in the presentation:

- Agency and agency personnel are wasting potential by not using available data effectively, not communicating to colleagues and the public effectively, and not using performance measures effectively. It is important to involve people in the process.

- Key elements of using performance measures and data presentation integration include integration, the context, management, person-to-person communication, research, and performance measures.

- Data integration, management, research, communication, and performance measures are contingent on the context people are dealing with. This context is continually changing. Approaches to data management and data visualization that can respond to these changes in context are needed.

- Data integration is vital for effective management. Agency personnel often “overthink” the problem when simple and flexible solutions may be appropriate. Building a culture about data sharing within an agency is important to avoid data stovepipes. It is important to avoid systems that dictate content. In addition, full knowledge of data should never be assumed.

- Person-to-person communication is time consuming. It is also resource consuming and can be the source of bottlenecks. Person-to-person communication is probably not appropriate for status requests, but it is appropriate for decisions, creative solutions, and dire messages.

- Performance measures should be based on available data and tracked in real time. They can be used to better understand fluctuations in performance. It is also important to make and track adjustments in performance measures as needed.

- Research can help support examining results in a common language. Comparing real-time data is also important. Promoting the value of existing data can build support within an agency and with other agencies and groups. Data save money and time.

### **Research Needs**

The following research needs were identified by participants in this session:

- Conduct a research study that includes a synthesis of current applications of visualization techniques with performance measures and an examination of emerging visualization technologies. The initial phase of the study will identify current visualization tools and techniques used by state departments of transportation, transit agencies, and other public-sector groups to display performance measure results. Best practice case studies will be presented. This phase of the study will also identify methods to promote the use of visualization at public agencies. The second phase of the study will explore the potential application of emerging visualization techniques. Technologies and techniques that appear most feasible will be identified, and possible pilot projects will be described.

- Staff with skills and expertise in visualization techniques are needed. A multiple-pronged approach is suggested to address that need. Elements to be developed include a training course in the use of visualization techniques with performance measures, to be offered on a regular basis. The course would be targeted to staff at state departments of transportation, transit agencies, metropolitan planning organizations, and other organizations. A second element will reach out to universities and technical colleges to provide internships and

employment to students in visualization programs. This effort will be aimed at establishing links for ongoing attempts to attract students in visualization to jobs in the transportation sector.

- Conduct a study to explore strategies for establishing closer working relationships between human factors research and transportation agencies seeking methods to address safety, sustainability, congestion, and environmental issues. Addressing issues in those areas often requires changes in behavior. Human factors research can be used to help transportation agencies address those concerns.

*Michael Manore, Bentley Visualization Center, served as facilitator of this breakout session, and Joe Zietsman, Texas Transportation Institute, served as rapporteur.*

## DATA AS AN ASSET

### State Perspective

*Thomas Jeffrey Price*

The importance of data as an asset for state departments of transportation was discussed. How data fit into the business architecture, activities under way at Virginia DOT, and examples of benefits derived from the use of data were described. The following points were covered:

- Information has value. It enables an agency to do things faster, better, and at a lower cost. Information is used to identify the factors that influence changes in performance. Data enable predictive modeling and performance management. Decisions related to how much we spend to collect, manage, interpret, and disseminate data and information are influenced by the use and benefits derived from the data.

- Data are part of a business's architecture. Elements of a business's architecture include the organization, business process, information, applications, technology, and strategy. Important questions relate to what data are collected, who collects the data, how they are stored, and where they are stored. It is also important to define what the data represent, what their limitations are, and who is responsible for their accuracy, completeness, currency, and security. Defining who has access, who controls access, and how the data can be accessed is also important. Identifying how data flow from the source to end users, how the data are used, and the data products that are generated represents other components of the business architecture.

- The value of the data collected by transportation agencies can be increased. First, it is important to

develop and implement a data business plan that formalizes the link to agency goals and the internal organization, defines responsibilities and data flows, and clarifies the purpose and value of data. It is also important to collect only data that are needed and that will be used. Cataloging and managing the data that are collected and developing standards for data and systems are key. Integrating and sharing data across all parts of the agency is efficient and builds support among diverse groups. Finally, it is important to design and implement data warehouses supported by technology that facilitate broad access to and analysis of data.

- The Virginia DOT dashboard demonstrates the value of data. The dashboard pulls information from several different enterprise systems and aggregates it in a single web-based application. A number of activities are under way at Virginia DOT to enhance the collection and use of data. A business architecture review board for system operations was established to coordinate data and technology initiatives from a business perspective. A system operations data business plan is being developed, and all systems and data in the system operations are being reviewed. The mapping of data flows is an ongoing process. The staff is experimenting with artificial intelligence to find methods to extend the value of the data collected at Virginia DOT. The department is also collaborating with data providers and users to improve the understanding of data issues, to identify problems, and to find solutions.

- The system operations data business plan contains a number of components. These include a summary of Virginia DOT's strategic vision and goals and the alignment of key business functions with the goals. The data products generated by business functions are identified, as are the roles and responsibilities for data and functions. The data, system, and technology requirements are defined. A gap analysis may be included, along with strategies and plans. Data flow maps can be developed for different elements.

- The way data are used determines their value. The data systems at Virginia DOT are used to provide key information to decision makers and agency staff. In 2002 the Virginia DOT commissioner asked the question, "How many projects are delivered on time or on budget?" Numerous responses were provided. Now the dashboard is the official source of that information. Before FY 2005, budgeting for maintenance and operations was based on the previous year's allocation. Maintenance and operations budgeting is now based on information from the asset management system. Better inventory and condition data enabled better estimates of needed work, and more compelling justifications can be made for funding. This approach led to increased allocation in FY 2006 and FY 2007.

## Highway Safety Data Essential to Program Success

*Michael Halladay*

Safety-related programs at FHWA were discussed in this presentation. Key elements of various programs were described, and the importance of accurate safety data was highlighted. The following points were covered:

- Roadway safety is at a plateau. The number of highway fatalities in 2005 was the highest since 1990. Although the figures for 2006 were somewhat lower, safety is still a major concern. There are behavioral, vehicle, and environmental factors that may influence safety, crashes, and fatalities. The question is how to approach all these challenges in a comprehensive and coordinated manner.

- A strategic approach to highway safety is essential. This approach brings all groups together. Safety-conscious planning makes safety an explicit priority in the transportation planning process. It gives safety equal weight, along with congestion relief and environmental protection, in the decision-making process at the project, corridor, and system levels. FHWA is working with states to develop strategic highway safety plans that include the four E's—engineering, enforcement, education, and emergency services. FHWA is also working with states and partners at NHTSA to gather data that can help identify problems and measure success. One-third of fatalities are related to speeding. FHWA is coordinating with NHTSA and the Federal Motor Carrier Safety Administration (FMCSA) on the U.S. Department of Transportation Speed Management Team. It is also important to consider older road users and the needs of older drivers in highway design, which will improve the system for all road users.

- Implementing the four E's represents a key program focus area. Education and enforcement are important, especially those efforts targeted at high-risk populations. Examples of high-risk populations include nonusers of safety belts, impaired or drunk drivers, teens and young adults, drivers of commercial vehicles, and nonusers of motorcycle helmets. Engineering and operations activities focus on run-off-road, speed-related, intersection, and pedestrian and bike crashes, as well as designing for special populations, such as older drivers.

- A number of key elements are associated with a state-based strategic approach. These elements include gaining a broad constituency, validating and documenting leadership commitment, and identifying and documenting state-specific safety opportunities. Gaining agreement on target areas with the best opportunities to make a difference, identifying strategies and counter-

measures, and establishing targets and time frames are also key elements. Leveraging resources across stakeholders and providing a continuing forum to improve highway safety are also important elements of a state-based strategic approach.

- There is a critical need for state safety information systems. Data system quality metrics can be defined. Data should be complete, accessible, timely, accurate, compatible, and integrated. Information analysis capability should include the ability to identify problems, develop effective countermeasures, and evaluate safety benefits over time related to saving lives.

- Traffic safety data should be comprehensive and connected. Uniform traffic safety data should be collected, edited, integrated, and transferred electronically to track a traffic safety event in a timely manner. Law enforcement and state government should have direct access to data collected during a traffic safety event. Crash-related data and the data related to licensing, registration, and enforcement should be integrated to provide law enforcement with access to complete data at the scene. Integrated data are also needed to evaluate the human, vehicle, and environmental factors that are involved before, during, and after a crash. Direct access to traffic safety data should be facilitated for all users at all levels to ensure the availability of timely data. Federal data should be complete to identify emerging issues in a timely manner. The federal databases and users of the federal data should have access to reliable and timely data.

- FHWA provides leadership and programs to reduce all types of crashes with an emphasis on reducing the types of crashes that claim the most lives. On the basis of 2006 data, roadway departures were a factor in 58% of fatalities, speeding was involved in 32%, intersection-related factors were involved in 21%, and a pedestrian was involved in 11%.

- Programs to address roadway departures focus on improved visibility, rumble strips, and roadside safety hardware. Strategies for improving visibility focus on increasing the brightness of pavement markings and signs. Rumble strips warn inattentive or fatigued drivers. One goal is to install shoulder rumble strips on all Interstates and install centerline rumble strips in areas with high head-on collision fatalities. Another goal is removing roadside hazards to provide a clear zone so that if a vehicle leaves the road, the driver will have time to recover. When a clear zone is not feasible, using the proper safety hardware, such as guardrails, breakaway poles, and crash cushions, is appropriate.

- The national intersection agenda provides guidance and direction for improved safety at intersections. The agenda was developed in coordination with partners, including AASHTO and ITE. FHWA is working with ITE to develop a toolbox of engineering counter-

measures to prevent red light running. FHWA is also working closely with partners at NHTSA on that issue. The *FHWA Informational Guide on Roundabouts* helps practitioners plan and design roundabouts.

- A number of programs focus on pedestrian safety. A Pedestrian Safety Outreach Campaign has been developed. The goals of this outreach effort are to sensitize drivers to the fact that pedestrians are legitimate road users and should always be expected on or near the roadway, to educate pedestrians about minimizing risks to their safety, and to develop program materials to explain or enhance the operation of pedestrian facilities, such as crosswalks and signals. The Safer Journey interactive CD takes the user through pedestrian safety scenarios encountered every day. This award-winning CD is intended to improve the level of pedestrian knowledge. Field operational tests to implement and evaluate advanced technology for pedestrian safety are under way in California, Florida, and Nevada as part of the engineering and ITS-based countermeasures program.

- Cross-cutting areas include speed management, safety belts, and older road users. Safety on rural roads is an important topic. There are 3.9 million miles of roads in America. Approximately 78%, or 3.1 million miles, are in rural areas. Further, some 661,000 mi, or 22% of total rural road miles, are owned by states. Rural roads carry 39% of travel, but 61% of fatalities occur on rural roads.

- It is important to understand the nature of specific safety issues in different areas. Having accurate data is a critical, fundamental requirement for a good safety program. Accurate data are needed to inform the public and political leadership and to obtain support for appropriate safety legislation, programs, and policies. They are also needed to engage partners as safety champions because highway safety is a public health crisis. Accurate data are critical to developing, implementing, and evaluating projects and programs that deliver the maximum return on investment.

- Accurate data are needed on the location of safety problems, along with the number of crashes occurring at various locations. Examining data by corridors and geographic area can help identify the possible interaction between safety problems. Assessing the causes of crashes, such as running red lights or railroad highway grade crossings, is important. In addition, examining crashes by mode is important. Data are needed to assess the potential effectiveness of planned safety strategies. Providing information to policy makers and the public helps build support for current and future activities.

- A number of collaborative activities are under way to improve the quality of safety-related data. Safety data programs at state departments of transportation are eligible for funding support. Many states host NHTSA-managed traffic records assessments panels, with

FHWA participation. Representatives from state departments of transportation, FHWA, and other agencies participate in the Annual Traffic Records Forum. Further, FHWA, NHTSA, FMCSA, and the Research and Innovative Technology Administration are collaborating on the National Traffic Records Coordinating Committees. There are extensive interest and efforts through TRB and other organizations focusing on improving safety-related data. Efforts are also focused on building and providing technical assistance. FHWA and other agencies are sharing best practices and recommendations. There have been international safety scans in Europe and Australia.

- The ultimate goal of data and information systems is a proactive roadway safety program. When highway safety information is collected and analyzed within a comprehensive safety framework, essential resources at the federal, state, regional, and local levels can be effectively directed to saving lives.

*Joseph Schofer, Northwestern University, served as facilitator of this breakout session, and Vicki Miller, Federal Highway Administration, served as rapporteur.*

## DATA COLLECTION TO SUPPORT PERFORMANCE MEASUREMENT

### Data Collection Systems to Support Performance Measurement

*Tadashi Okutani*

Performance indicators used by the Road Administration in Japan were discussed in this presentation. Different applications for obtaining, analyzing, and presenting traffic and travel-time data were described. The following points were covered:

- Japan's Road Administration uses 23 performance indicators, categorized into seven policy themes. The seven themes focus on strengthening international competitiveness, ensuring safety and security, significantly extending the lifespan of existing stock, executing road policies, reinforcing regional autonomy and competitiveness, creating environments for affluent living, and functionally reinforcing expressway networks. Traffic accidents are one of the indicators under the ensuring safety and security theme. Time loss due to congestion is one of the indicators in the reinforcing regional autonomy and competitiveness theme. Reliability of travel time is not used as an indicator at this time.

- An integrated traffic accident database was developed in 1988 to address the growing number of traffic fatalities in the country. Traffic accident statistical data

from the National Police Agency, the road traffic census data, and road administrators data are combined into an integrated traffic accident database. This database can be used to analyze the relationship between road structures, traffic data, and traffic accidents, enabling more effective identification of hazardous spots. Appropriate countermeasures can then be identified for these locations.

- The integrated traffic accident database is used to identify accident hot spots. Approximately 4,000 locations with high rates of accidents causing death or injury have been identified. These locations include roadway sections and intersections. Concentrated accident countermeasures are being implemented to cut accidents by 30% at these locations. This information is displayed on a digital map that is available on the Internet.

- Hazardous locations can be identified using the accident rate curve. Arterial roads are divided into some 890,000 sections. The ratio of accident, which is a ratio against the average accident rate, is calculated for each section. Each section is placed in order of the ratio of accident, to make the accident rate curve. The sections in which accidents occur twice as often as the average are identified, enabling concentrated measures to focus on high-priority sections. Near-miss crash locations are also mapped. These maps are being provided to the public on the website on a trial basis.

- Three-dimensional maps are used to provide a visual image of the time lost due to traffic congestion. These maps provide a powerful graphic image of the spatial locations of roadway congestion. A priority indication method is used for traffic congestion countermeasures. The first step is to arrange all sections in order of time lost due to congestion. The regional bureaus propose projects to address the problem sections.

- The vehicle information communication system is used along with vehicle detectors to provide real-time congestion information. Data are gathered through roadside devices, including light beacons, loop coils, and ultrasonic wave detectors. The real-time information is provided to car navigation systems, including character messages, simple figures, and maps.

- Mt. Tsukuba attracts a large number of visitors, especially during the autumn and spring tourist seasons. Severe traffic congestion often occurs on roads around the mountain's base. The August 2005 opening of a railway that allows passengers to travel from Tokyo to Tsukuba in as little as 45 min has further intensified congestion. A survey and an analysis using devices that automatically read license plates were conducted to ascertain fluctuations in travel time caused by congestion. The survey was conducted for 17 continuous days in November 2006 comparing travel times on the normal route and an alternate route. The standard route had larger fluctuations on weekdays, weekends, and holidays than did the alternate route. Fluctuations in travel time were espe-

cially great on weekends and holidays. The time reliability for the alternate route was stable throughout the day on weekdays and on weekends and holidays. Trip-time reliability surveys were also conducted on National Route 16 in the Tokyo area before and after improvements were made to other freeways. The survey results indicated a 5-min reduction in travel times and a 6-min reduction in the buffer time on National Route 16 after the improvements were made to other freeways.

- Different probe technologies and approaches have been used to collect travel-time data. There are different costs associated with the various technologies and approaches. Possible methods include probe vehicle surveys, probe person surveys using cellular telephones, bus location systems, probe taxi vehicles, drive recorders, and ITS-equipped vehicles. Implementing these approaches may involve collaboration with the private sector. An expressway bus-location system from the Yokohama Station to Haneda Airport has been used to provide information on real-time conditions and operating connections.

- A driving recorder captures information on vehicle use, including the forward image, acceleration, speed, breaking, and blinkers. This approach was recently introduced by a freight transport company. Driving recorders might be used for assessing traffic accidents and improving driver behavior.

- Road drivability maps incorporate three types of factors. These factors are the road structure design, driving speed, and driving safety elements. The road structure design factors consist of the number of lanes, radius of curves, sidewalk or shoulder widths, and other related factors. Congestion points are shown as a red circle icon on the map. The driving safety factor is a hazardous spot shown as a yellow star icon on the map.

- The drivability map includes roads forming a wide-area network, which are typically the higher-level roads. The total length of the roads on the map is about 200,000 km, which is 18% of all roads in Japan. Roads are divided into 500-m sections. Each section is categorized as suburban/mountain and urban according to roadside conditions. The sections are ranked by different criteria. A joint research project with private companies is incorporating the drivability map with in-vehicle navigation systems.

## Virginia's Statewide System Operations Performance Measurement

*Ramkumar Venkatanarayana*

The development and use of the Virginia DOT's statewide system operations performance measurement program were discussed in this presentation. The process for

developing the performance measures, the data sources, and the use of the measures by the department were described. The following points were covered:

- The Center for Transportation Studies at the University of Virginia assisted Virginia DOT with the development of the performance measures. A steering committee provided oversight to the work, assisted with obtaining access to the disparate data sets, and reviewed the various measures. The process began with a review of the currently available data. Although initially, complete automation was desired, as the project evolved it was realized that full automation might not be possible.

- In 2004 Virginia DOT created a business focus on system operations. The mission is to actively manage the transportation system to maximize safety, security, mobility, and return on investment to benefit customers. The four system operations goals address improving safety, improving highway operational performance, preserving the infrastructure, and improving security.

- The objectives of the research project were to develop a set of performance measures to support Virginia DOT's system operations program. Benefits of the research project included providing a comprehensive description of the development process in Virginia for use by other state departments of transportation and introducing new measures developed to meet Virginia DOT needs.

- The Virginia System Operations Performance Report is a monthly report used internally by Virginia DOT management. One section focuses on statewide measures, providing monthly details and 13-month trends. A second section focuses on regional measures that are examined on a monthly basis. An appendix provides the complete metadata.

- There are four performance measure categories. These categories focus on traffic, incidents, traveler information, and ITS technology reliability. The philosophy is to use existing data in innovative ways to create measures in each category. The performance measures focus on a speed index and throughput. The data available from continuous count stations are not ideal for these measures. Virginia DOT is investigating methods to obtain directly measured travel-time data. The incident performance measures address duration and types of incidents. The different sources of data illustrate the different operating philosophies used in various regions.

- The traveler information performance measures focus on changeable message signs (CMS), the 511 system, and the CCTV Internet system. The CMS logs are analyzed to track different types of messages. These message types are consolidated into a limited number of standardized categories. The CMS logs and the volume data from the detectors are examined.

- The Virginia DOT Information Technology Division is automating production of the monthly report. The use of travel-time data, which is key to developing more informative traffic measures, is being examined. The project highlights the benefits of using a steering committee to assist with consensus building and data access. It also points out the importance of beginning with available data. Procedures to assess, standardize, and archive the data can be developed. The project also supports the idea that data, measures, and reports evolve over time.

### Data Collection to Support Freight Performance Monitoring

*Crystal Jones*

Data collection activities supporting freight performance measures were discussed in this presentation. A project to collect real-time traffic information in freight-significant corridors was described. The project involves FHWA, the American Transportation Research Institute (ATRI), satellite technology vendors, and carriers. The following points were covered:

- One of the strategic objectives in the FHWA Strategic Plan addresses global connectivity. This objective is to facilitate a more efficient domestic and global transportation system that enables economic growth and development. The goals under this objective are to reduce travel time in key highway freight corridors and to reduce delays of commercial vehicles processed at National Highway System border crossings. The outcome measures are travel time and reliability on freight-significant highways and border crossing time.

- A public-private partnership has been established to support a freight performance measures data collection program. The partnership includes FHWA and ATRI, satellite technology vendors, and carriers. The methodology uses trucks equipped with automatic vehicle location systems as traffic probes. Data cleansing techniques allow the collection of data from most of the vendor carrier subscribers, which account for some 300,000 vehicles. ATRI manages the data.

- By using this system, data from 25 major Interstate freeways and five U.S.–Canada border crossings are being collected. Obtaining data from the U.S.–Mexico border crossings using the same methodology is under development. The program provides a quantifiable basis to engage public agencies and private-sector groups to investigate and explore possible causes of delay.

- There are a number of benefits from this public-private approach using trucks as probe vehicles to obtain freight data. There are also issues associated with

this method. Benefits include providing an accurate data collection process that directly measures traffic conditions for trucks and providing data on major travel corridors, not just urban and metropolitan areas. The main issues with this approach relate to privacy and data processing and management.

- Processing the data from the probe vehicles involves a number of steps. First, the raw vehicle location data are imported into a database. Second, data are linked to route references and outliers are removed. Third, trips are generated by sorting data using a unique truck identification and time stamp. Fourth, average speeds are calculated for each trip. The speed outliers are also removed. Finally, segmentation is performed based on specified or predefined segments.

- A phase data sharing agreement between freight performance measure data stakeholders was developed. These stakeholders include the trucking companies, technology vendors, FHWA, ATRI, and third-party technical assistance subcontractors. There are challenges for data sharing between industry, government, and third-party groups. Possible challenges include civil litigation impacts, competitive access to proprietary data, and government access for regulatory compliance.

- Government access of data is addressed in the Freedom of Information Act (FOIA) Protections. FOIA Exemption No. 4 states that trade secrets and confidential commercial information are protected from FOIA requests. The exemption further notes that data are better protected when given voluntarily and that data that are not possessed by government entities and are physically housed outside government are subject to fewer FOIA implications. The nondisclosure agreement between ATRI, trucking companies, vendors, and FHWA allows for internal distribution of analyses and aggregated data. Data cleansing and anonymity techniques are critical in this process. The method does not allow for commercial reselling of the data.

- Future short-term data distribution options are being examined. For example, known recipients could “check out” FHWA freight performance measures data. Another option is to manage the evaluation and feedback process to track freight performance measures, usage, utility, and shortfalls. Still another option is to implement a technical program to blend additional data sources. Longer-term data distribution options are also being considered. One option is for a third party to develop and manage FHWA’s freight performance measures database for a specific transportation set, such as the Interstate system, under a national contract. A third party could also catalog and document the National Highway System for state and local planners for a fee. Users would sign a data use agreement to provide a liability waiver, and the third party would still own the data.

## Data Collection to Support Performance Monitoring Programs

*Shawn Turner*

Five principles related to data collection methods and analysis techniques to support performance monitoring programs were discussed in this presentation. Factors associated with good data collection practices and some issues that may be encountered in data collection and analysis efforts were described. The following points were covered:

- A number of factors should be considered in collecting and analyzing data for use with performance measures. These factors include knowing the audience and building on commonly used approaches. It is important to acknowledge that perfect data do not exist and to use more than just traffic data. Knowing the details of the data collection and analysis methods and techniques is also important. A professor from the University of Washington has offered several cynical suggestions relating to data. These suggestions, known as Horwood’s Laws, include “good data is the data you already have,” “bad data drives out good data,” and the “data you have for the present crisis was collected to solve the previous crisis.”

- First, it is important to know the audience and understand how the audience will use the performance measures information. Knowing the audience helps in designing the message, formulating specific measures, writing reports, and developing the appropriate level of detail in reports and presentations.

- Second, building on the approaches and techniques used by other transportation agencies is appropriate. It is not necessary to be original. There are many good examples that can be used to develop appropriate performance measures and to present results to different internal and external stakeholders. Remember, imitation is the sincerest form of flattery.

- Third, it is important to remember that perfect data do not exist. Assess the quality of available data, and determine whether it is good enough for initial efforts. Use currently available data, noting any limitations or possible concerns, and develop a plan for future improvements.

- Fourth, typically, more than just traffic data will be needed. All elements that affect performance should be part of the performance monitoring process. Thus, data should be collected on traffic input, work zones, incidents, other events, and weather. The area covered by the data will need to be considered, as will data quality.

- Fifth, it is important to know the details of how data are collected and processed. Elements to understand include traffic sensors or field location units, controllers,

field devices, real-time processing before archiving, and calculations used in the various analyses.

- Two more of Horwood's Laws were presented. These items are that "the respectability of data grows with elapsed time and distance from the data source to the user" and "in complex systems, there is no relationship between data collected and the decision made."

## Research Needs

The following research needs were identified by participants in this session:

- Develop a synthesis on the evolution of performance measurement systems and the values associated with the measures. Include the experiences of agencies and researchers in the synthesis.
- Complete a synthesis examining the inherent challenges related to data collection, data archiving, performance measurement, and reporting. Include an assessment of data formats, institutional structures, and performance measure definitions. Identifying how different agencies, businesses, and groups are successfully addressing these challenges will be included.
- Conduct a research study examining techniques to improve current data collection methods and to explore future data collection strategies and techniques. The first part of this study focuses on accessing approaches to improve current methods to collect, archive, and analyze transportation data. Case studies of public-agency and private-sector groups that have been able to improve on current techniques will be highlighted. The second part of the study will explore future data collection techniques and strategies. The ability to use advanced and emerging technologies, as well as innovative strategies, will be examined. The most promising technologies and strategies will be identified, along with possible demonstration projects to advance their deployment.
- Conduct a research study assessing the advantages and limitations of different data collection strategies. The assessment will consider the costs associated with different strategies, alternative management approaches, techniques to build participation between multiple public agencies, and partnerships with businesses, shippers, and other groups. Best practice case studies will be developed.

*William Bachman, GeoStats, served as facilitator of this breakout session, and Kingston Chirwa, University of Southern California, served as rapporteur.*

## FORECASTING PERFORMANCE

### Activity-Based Travel Demand Modeling: Comprehensive Econometric Microsimulator for Daily Activity Patterns Performance Measurements and Validation

*Chandra R. Bhat*

Activity-based travel demand models were discussed in this presentation. The differences between the traditional trip-based four-step travel demand modeling process and activity-based models were summarized. The development, validation, and application of a comprehensive econometric microsimulator for daily activity patterns (CEMDAP) were described. The following points were covered:

- There are a number of differences between the traditional four-step trip-based and the activity-based approach travel models. Activity-based models address some limitations associated with the four-step models. The four-step model oversimplifies daily travel patterns, and it does not account for trip chaining. The four-step process is not well suited for analyzing policy actions, the application of ITS technologies and dynamic control, and air quality issues.
- The four-step travel demand process focuses on trips and not on the activities that motivate making the trips. The methodology is more statistical and less behavioral. It does not recognize the spatial, temporal, and modal linkages between the different trips a person makes. The duration and timing of trips are not considered explicitly. Time is represented simply as a "cost" of making a trip. The four-step process does not consider intrahousehold interdependencies.
- Activity-based travel demand modeling focuses on activity participation behavior. Travel is viewed as a derived demand. Explicit spatial and temporal interdependencies in activity and travel choices are addressed. Activity-based modeling includes detailed consideration of the timing and the duration of activity and travel. Travel is viewed in the context of overall daily time use. The emphasis is on household-level decision making and interactions between household members. Activity-based modeling is suitable for policy evaluations and for air quality modeling.
- Activity-based models can be used to address planning and policy issues, including congestion pricing and parking strategies. Congestion pricing strategies might include time-of-day-based tolls, area-specific tolls, individual lane or facility-specific toll, and vehicle-type-specific pricing. Parking strategies include parking capacity increases, downtown parking taxes, employer-

based parking schemes, individual-specific parking schemes, and duration-based parking charges.

- Other potential planning and policy issues that can be analyzed using activity-based models include transit projects, land use policies, and employer-based strategies. Transit projects and policies include fare structure policies, new services, park-and-ride facilities, and New Starts projects. Possible land use policies include transit-oriented development, mixed land use development, and walk- or bike-friendly neighborhoods. Still other land use policies address residential development patterns, new developments, and the relocation of jobs. Employer-based schemes include compressed workday, telecommuting options, and carpool and shared-ride arrangements. The impact of demographic changes can also be examined using activity-based models.

- The Texas DOT funded the development and testing of CEMDAP. CEMDAP is based on a system of econometric models, with each model corresponding to the determination of one or more activity–travel attributes. The models are applied in a systematic sequence to generate the daily activity and travel patterns of all members of each household in the study area.

- At a conceptual level, base year inputs include aggregate sociodemographics, activity–travel environment characteristics, policy actions, and model parameters. The synthetic population generator provides input to construct the detailed individual-level sociodemographics for the base year. The socioeconomic, land use, and transportation system characteristics simulator (CEMSELTS) provides the sociodemographics and activity environment. These characteristics link to the activity-travel simulator, CEMDAP, which generates individual travel patterns. These are loaded into a dynamic traffic assignment to develop link volumes and speeds. The link volumes and speeds are fed back into CEMSELTS.

- CEMDAP uses base year inputs that include aggregate zonal-level demographic characteristics, land use patterns, transportation network and level of service (LOS) measures, and any potential policy actions planned for a future year. The outputs for the forecast year include detailed activity–travel patterns. When the dynamic microassignment component is added, link volumes and speeds by time-of-day for the forecast year will be provided.

- CEMDAP can be used in any metropolitan area. It has been applied to the Dallas–Fort Worth (DFW) metropolitan area. The modeling framework characterizes the activity–travel patterns of all household members, including adults, children, workers, nonworkers, students, and nonstudents. It explicitly considers space–time interactions and constraints. It models the

allocation of maintenance activities, such as shopping, to household members and models parents' escorting children to and from school. It generates and links joint activities of parents and children. CEMDAP adopts an interleaved approach to the generation of activity–travel patterns of all household members. It models 11 out-of-home activity purposes for adults and three out-of-home activity purposes for children.

- The temporal resolution is a continuous time scale. The LOS data can be provided at any temporal resolution. Five time-of-day periods are being used in the DFW area application. The spatial resolution allows for any number of zones. The DFW application uses 4,874 zones. A standard Windows-based graphical user interface that allows users to modify model parameters is used with CEMDAP. A friendly diagrammatic interface, it helps the user understand the logic of the system and the underlying models.

- CEMDAP was applied to examine a 10% and a 25% increase in in-vehicle travel times, and a 10% and a 25% decrease in in-vehicle travel times in the DFW area. This analysis was conducted to assess the reasonableness of the predictions. The activity–travel patterns were predicted for the entire synthetic population of 3,452,751 from 1,754,674 households for the base case and each of the four changes in vehicle travel times. The impact that changes in in-vehicle travel time had on aggregate activity–travel patterns was examined for trip frequency, person miles of travel, vehicle miles of travel (VMT), and person hours of travel (PHT).

- The 10% increase in in-vehicle travel times reduced the total number of trips by 1%, and a 25% increase reduced the total number by about 2.4%. A 10% decrease in the in-vehicle travel time increased total trips by 1.1%, and a 25% decrease increased total trips by 3.1%. An increase in in-vehicle travel times decreases VMT; a decrease in in-vehicle travel times increases VMT. An increase in in-vehicle travel times increases the PHT for work and decreases the PHT for nonwork purposes, resulting in an overall increase in PHT. A decrease in in-vehicle travel times reduces the PHT for work and increases the PHT for nonwork purposes, resulting in an overall decrease in PHT.

- There is a distinction between assessment and validation issues. The validation process checks the accuracy of results from baseline runs and backcasts and makes comparisons with ground counts and screen-line volumes. It predicts the activity–travel patterns of a sample and compares the results with actual/observed patterns. The assessment process examines the intuitive reasonableness of model results, indications, coefficients, and equations. The sensitivity of model outputs to changes in inputs is examined, along with the ability of models to respond to system and policy variables.

- Four-step models are calibrated, adjusted, and validated to base-year ground counts and screen-line volumes. Activity-based models can also be validated to base-year conditions. A comparison may not be valid, however, given the fundamental and theoretical differences in the model basis. Activity-based and four-step models are not really competing.

- There is a motivation to adopt activity-based models only if they are better than or superior to traditional models. Two elements for judging model superiority are the ability to replicate base-year conditions with fewer or no model parameter adjustments/refinements and to replicate base-year conditions with a greater degree of accuracy. The model responsiveness to changes in inputs and the models' ability to analyze emerging policy issues and options represent two elements of the model capabilities and sensitivity.

- Before-and-after studies allow for obtaining observed before-to-after changes in a real-life transportation project. These studies assess the performance of predicted sensitivities from the alternative models to the observed real-life transportation system demand changes. The performance comparison is useful for evaluating the practical benefits and costs of activity-based models relative to trip-based models and identifying the key strengths and weaknesses of both models.

### Statewide Traffic Information for Bavaria, Germany

*Peter Möhl*

A traffic information system in Bavaria, Germany, was discussed in this presentation. The development and components of the system, use by the public, and future activities were described. The following points were covered:

- Bavaria is located in the southeast portion of Germany, in the heart of Europe. Bavaria is approximately 27,239 mi<sup>2</sup> in size, which is comparable to South Carolina or Maine. Bavaria's population is approximately 12,493,000, which is comparable to Illinois and Pennsylvania. Bavaria is known for many things. The headquarters of Adidas and Siemens are located in Bavaria. It is the birthplace of Pope Benedict XVI. It is also known for Oktoberfest.

- The public website, [www.bayerninfo.de](http://www.bayerninfo.de), was first implemented in 1995 and relaunched in 2006. It is an official website of the Bavarian DOT. It is available in English and includes traveler information, traffic conditions, and cycling information.

- The website uses maps to display a variety of information on traffic conditions. Maps are also used to dis-

play information on traffic forecasts, incidents, and road work. The incident reports highlight the roads and streets affected, the message being displayed, and the current status. The selection and settings control field includes the region, time, and content. There are also settings for color-blind individuals.

- The traveler information section includes all modes of transportation, including public transport, private automobiles, bicycles, taxis, and walking. The system provides route advice based on traffic conditions and forecasts. The information in the system is obtained from a number of sources, including transit operators.

- Different approaches are used for different time frames, including the current traffic state, short-term forecasts, midterm forecasts, and long-term forecasts. The services are fed by time-frame-dependent data. Data on the current traffic and the short-term forecasts come from Automatic Jam Recognition/Forecasting of Traffic Objects models. The National Transportation Planning model provides the inputs for the midterm and the long-term forecasts.

- The National Transportation Planning Model called VALIDATE, which is the nationwide model for Germany, includes 82 million residents. The model uses hourly volumes for major roads and public or commercial digital data sources. It is easy to update. Applications of the National Transportation Planning Model include regional and nationwide traffic forecasts, traffic volumes for billboard marketing, and travel-time estimation for navigation systems.

- The road network processing includes a number of steps. The initial NAVTEQ network for Germany consists of approximately 6 million links. The minor roads are removed. Generalization is by removing two-leg nodes. An automated, reversible, and repeatable process is used. The next step involves the mapping of the NAVTEQ attributes to assign relevant model attributes. The lower definition of the European final model network consists of 1.4 million links. Each traffic analysis zone (TAZ) contains approximately 10,000 residents, and there are five to 12 connectors per TAZ. There are currently 7,000 TAZs. Refinement is under way to develop 10,000 TAZs. Time-of-day traffic conditions are developed by combining time-of-day travel demand and time-of-day (pseudodynamic) assignment.

- VALIDATE for Bavaria is the statewide planning subarea model of VALIDATE Germany. VALIDATE for Bavaria is a base for services of [www.bayerninfo.de](http://www.bayerninfo.de). It is also used for midterm forecasts and for long-term forecasts. The long-term forecast is a one-time computation of assignments for 24 h per day and different daily patterns. It is forecast for 1 year and updated every 6 months. The sensitivity of services includes time delay in instances in which the scheduled impacts, such as road work, occur. The midterm forecast is an initial computa-

tion of assignments for 24 h per day and different daily patterns. It is forecast for 14 days, with daily updates. The sensitivity of services includes time delay in instances in which the scheduled impacts occur and the consideration of different routes. Short-term forecasts are based on time series. This approach considers measurement until the current point in time and chooses the best-fitting time series from a pool of representative time series.

- A number of additional steps are planned. These steps include using data from floating cars on a secondary network, developing a network of detectors in towns and villages to set up local approaches for traffic conditions and forecasts, and connecting to neighboring traffic management centers. Other activities include developing guided parking systems and adding events, weather, and public transport reports. These efforts require adaptation of existing models or integration and development of new methods.

- The development and operation of the system represent a public–private partnership. The public sector is responsible for the development of the system, financing of the infrastructure, and ownership of the infrastructure. The public sector is responsible for financial support of operations, data supply, and survey of quality and availability. The private sector is responsible for system setup and the operational concept. It is responsible for operation of the system, business development, and sales, services, and data.

- The system provides a very successful travel information portal because of the high-level services. These services are based on the reliable calculation of traffic conditions and forecasts. The model-based approaches are highly sophisticated. There is high potential for further services.

## Research Needs

The following research needs were identified by participants in this session:

- Conduct research to examine alternative methodologies to validate travel-forecasting models. Research exploring elements, such as individual travel dimensions, trip duration, trip purpose, mode share, spatial distributions, and other factors, is needed. The research will include reviewing before and after evaluations of forecasts to test validity. It will also present methodologies to conduct before and after evaluations to use with future projects. These methodologies can be used to conduct actual evaluations.

- Conduct a study assessing the strengths and limitations of different travel forecasting models and methods. The study results will be presented for technical staff and for policy-level staff. Information that is more detailed will be provided for technical staff, whereas the summary for policy-level personnel will focus more on a global level.

- Conduct a research study exploring techniques to enhance the linkages between travel demand forecasting, use of performance measures, and policy decisions. The study will examine current examples of these types of linkages, as well as potential approaches to enhance linkages.

- Conduct a research study examining techniques to forecast conditions in all modes and interrelations with land use and other characteristics, not just traffic volumes.

*Keith Killough, Southern California Association of Governments, served as facilitator of this breakout session, and Hugh Louch, Cambridge Systematics, Inc., served as rapporteur.*

## BREAKOUT SESSIONS 4

# Hot Topics

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Henrik Gudmundsson, *Danish Transport Research Institute*

Brian McCollom, *McCollom Management Consulting, Inc.*

Naveen Lamba, *IBM*

Janusz Supernak, *San Diego State University*

Paresh Tailor, *Highways Agency, United Kingdom*

Michael Halladay, *Federal Highway Administration*

Sandra Straehl, *Montana Department of Transportation*

Jim Gosnell, *Southern California Association of Governments*

Crystal Jones, *Federal Highway Administration*

## SUSTAINABILITY AND ECONOMICS

### Sustainable Transport and the Role of Performance Indicators

*Henrik Gudmundsson*

Henrik Gudmundsson discussed sustainable transportation and performance measures related to sustainability. He presented different definitions of sustainable transportation and described European research projects addressing performance indicators associated with sustainable transportation. Gudmundsson covered the following points in his presentation:

- There are different ways of examining sustainability. Sustainable transportation can be defined in different ways. A normative perspective on sustainability focuses on considering what is valued, where to go, and what comes first. An analytical perspective addresses what it will require and how the system works. A strategic focus explores how to make it happen and who cares about making it happen.
- One definition used by the World Commission of Environment and Development is as follows: “sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.” Sustainable development contains two key concepts: the concept of needs,

in particular the essential needs of the world’s poor, and the concept of limitations imposed by the state of technology and social organization on the environment’s ability to meet present and future needs.

- Four dimensions of sustainability have also been identified: environmental, social, economic, and institutional. These dimensions can be thought of as a hierarchy, as trade-offs, or as overlapping. These dimensions can also be defined for the present generation and current development or for the future generation and sustainability.
- Sustainable transportation is hard to define for several reasons. There are many aspects to the transportation system, including different modes, facilities, and services. In addition, transportation is only a partial contributor to sustainability. As a result, some researchers have suggested that sustainable transportation cannot be defined.
- The approach proposed in the IMplementation Paths for ACTION Towards Sustainable Mobility (IMPACT) project is to provide direction but not to define sustainable transportation. The direction provided in the IMPACT project is that a potential step toward sustainable transportation should contribute to reducing pressures on natural life support systems, including the climate system, that are overexploited with regard to their continued support of society’s needs or are at the risk of becoming overexploited. It should also contribute to increasing the overall well-being of the

present generation, avoiding, entirely, negative effects on people living in absolute poverty. The active participation of major affected stakeholder groups is important.

- Indicators for use with sustainable transportation serve many functions. Indicators serve communication, informative, diagnostic, and action functions. There are also different types of indicators, including normative or performance indicators, efficiency indicators, and comparative indicators.

- Different approaches have been suggested for measuring sustainability. One approach suggests that a sustainable development indicator is a statistical measure that provides an indication of the sustainability of social, environmental, and economic development. Another approach suggests quantitative measures of human well-being, economic activity, and natural processes and conditions, which are needed to sense the degree to which human activity may be continued or expanded in the future.

- A working definition of sustainable transport indicators has been proposed as part of the European Cooperation in the Field of Scientific and Technical Research 356 Action. This definition is “an indicator of environmentally sustainable transport is a variable, based on measurements, representing potential or actual critical impacts on the environment, or factors that may cause such impacts, due to transport systems, flows or policies, as accurately as possible and necessary in the particular context.” A number of elements are included in the environmental impact list. These elements include climate change, land use, hydraulic risk and hydrological changes, and the visual qualities of the landscape. Other elements include habitat fragmentation, air pollution, soil and water pollution, noise, and nonrenewable resource use. Still other elements are waste, perceived pollution, ecotoxicity, human health, and traffic safety.

- The European Environment Agency has issued annual reports since 2001. The purpose of these reports is to monitor strategies to integrate environmental concerns in transport policies in the European Union (EU). The report uses an indicator-based approach. The report focuses on seven Transport and Environment Reporting Mechanism (TERM) questions.

- Is the environmental performance of transport improving?
- Are we getting better at managing transport demand and modal split?
- Are spatial and transport planning becoming better coordinated to match transport demand to the need for access?
- Are we optimizing the use of existing transport infrastructure capacity and moving toward a better-balanced intermodal transport system?
- Are we moving toward a fairer and more efficient pricing system, which ensures that external costs are internalizing?

- How rapidly are cleaner technologies being implemented and how efficiently are vehicles being used?
- How effectively are environmental management and monitoring tools being used to support policy and decision making?

- A study of the use and influence of TERM was conducted. The study included a web search of references to TERM, an analysis of key documents, interviews with members of the EU and other stakeholders, and a survey of member state key personnel. The preliminary survey results indicate that the TERM framework and results are recognized at the highest policy levels. No examples of direct use in EU transport policy documents were identified, however. It appears that the TERM framework has had a mostly symbolic influence to date. Some use of TERM indicators in national reports and policies, such as the Commission for Integrated Transport, U.K., were identified. There has been extensive use of TERM fact sheets at the expert level, and TERM appears to have had a conceptual influence on national monitoring systems.

## Transit and Sustainability

*Brian McCollom*

Brian McCollom discussed public transportation and sustainability. He described preliminary information from the American Public Transportation Association on potential performance measures related to transit and sustainability, which are just beginning to be examined in many areas. He summarized traditional transit use measures, legislative benefit measures, and possible sustainability measures. McCollom covered the following points in his presentation:

- Public transit agencies and transit operators have been using performance measures for many years. Traditional measures focus on ridership levels, the use of public transit, service effectiveness, and cost-effectiveness. Passengers-per-vehicle revenue hour is a typical service effectiveness measure. Operating cost per passenger and the subsidy per passenger represent cost-effectiveness measures. The National Public Transportation Database contains ridership, cost, and performance data reported by public transit agencies.

- One of the limitations with the traditional public transportation performance measures is that they do not reflect the benefits that transit provides to individuals and to society as a whole. Providing information to policy makers on these types of benefits is important, especially in developing and maintaining funding support for transit. To respond to this issue, performance measures addressing basic mobility, congestion management, and livable communities are used in many areas.

- Transit provides basic mobility. It serves individuals without access to automobiles and meets the needs of transit-dependent individuals. Transit also provides congestion management benefits. It serves individuals who have access to automobiles, but who choose to use transit. These choice riders would use an automobile if transit service were not available. Investments in public transit benefit all transportation system users. Transit supports livable communities by serving nonwork travel, supporting existing infrastructure, and reducing automobile vehicle miles of travel.

- Transit organizations, agencies, and operators are beginning to explore transit and sustainability. Transit can contribute to sustainability in at least three areas. The first area is design and capital construction. Transit agencies can work to make facilities as green or environmentally friendly as possible. The second area is operations. Transit agencies can reduce hazardous waste and pollution and increase energy efficiency. The third area is service design. Land use and transit-oriented development can be encouraged and promoted to increase transit ridership.

- Potential transit operations measures related to sustainability focus on emissions and energy efficiency, both in terms of vehicles and facilities. TriMet in Portland, Oregon, tracks emission reductions for its transit fleet. Information on the reductions in oxides of nitrogen and particulate matter is presented graphically on the TriMet website. Although this measure provides a good indication of cleaner transit vehicles, multiple measures are needed to reflect other elements of sustainability. The measures per passenger trip or passenger mile may need to be normalized because increasing service levels and the addition of more buses would increase emissions levels.

- Transit service design and sustainability measures might focus on increasing ridership and the use of other alternative modes through compatible land uses. Transit-oriented development should increase walking and bicycling trips, as well as transit ridership. It may also result in shorter transit trips, as well as increased ridesharing.

- In developing performance measures for public transportation and sustainability, it is important to consider the perspectives of different agencies and groups. Transit agencies and transit operators will focus on what they can control. State departments of transportation, metropolitan planning organizations (MPOs), cities, or states will have broader perspectives. Transportation is a system, not just a collection of modes. Further, transportation is just one element of a sustainable community.

## Research Needs

The following research needs were identified by participants in this session:

- *Complete a synthesis on the current use of performance measures related to sustainability at state departments of transportation, public transit agencies, and other public-sector agencies.* The synthesis should include a literature review of the use of performance measures addressing sustainability. It should also include best practice case studies focusing on the development and use of sustainability performance measures by transportation agencies.

- *Conduct a comprehensive assessment of performance measures relating to transportation and sustainability.* This study will build on the synthesis described previously. Elements to be examined in the study include correlating existing performance measures with sustainability; identifying reference points and benchmarks on sustainability; and assessing trade-offs between various social, economic, and environmental factors. Examining future modal footprints, assessing the life of renewable and nondestructive resources, and analyzing the cost-benefit ratio and affordability of sustainable investments represent additional research activities. The study will consider best practices in sustainability through a transportation lens and explore the scale and scope of possible sustainable performance indicators at the global, national, state, regional, and local levels. The study will also examine measures related to different transportation modes, such as exploring the cost-effectiveness of transit services using sustainability as a consideration. It will also explore the involvement of resource agencies in the development and use of sustainable transportation performance measures.

*Josias Zietsman, Texas Transportation Institute, moderated this breakout session, and Howard Glassman, Florida Metropolitan Planning Organization Advisory Council, served as rapporteur.*

## PERFORMANCE MEASUREMENT AND EVALUATION OF TOLLING AND CONGESTION PRICING PROJECT SYSTEM BENEFITS

### Stockholm Congestion Charging Program: A Performance View

*Naveen Lamba*

Naveen Lamba discussed the congestion pricing trial project in Stockholm. He summarized the project background, objectives, and performance. He also described traffic conditions since the trial project ended in 2006. Lamba covered the following points in his presentation:

- After the general election in September 2002, the Social Democrat Government announced the Stockholm

Trial Project. Procurement of the technical system began in August 2003. The contract was signed in July 2004. The congestion tax trial period was from January 3, 2006, to July 31, 2006. After the general election and referendum in September 2006, the new conservative government announced the new policy of congestion charges. The congestion charges began as a permanent element on August 1, 2007.

- The Stockholm Trial Project included three complementary components: improved public transportation, new park-and-ride facilities, and congestion charges. The project involved the City of Stockholm; the Swedish Road Authority; SL, the public transport operator; and IBM. The City of Stockholm was responsible for procurement, general information, the evaluation program, and the park-and-ride facilities. The Swedish Road Administration was the owner of the congestion charging system and provided information on how to pay the toll. IBM was responsible for designing, building, and operating the system. SL operated the public transport service.

- The objectives of the road-pricing component focused on improving mobility and the environment. The objectives were to reduce congestion by reducing traffic volumes by 10% to 15% during the peak hour, to improve accessibility for buses and cars in the innercity, and to improve the environment. The trial established a cordon around Stockholm. A toll was charged for trips into and out of the cordon area. The congestion charges trial operated from January 2006 to July 2006. The revenue was returned to the Stockholm region for investments in the public transport system and infrastructure connected with the trial.

- The trial provides an example of using pricing to redistribute the traffic volumes over time. Key elements of the approach included charging in both directions of travel across the cordon and charging more during the peak periods. The maximum charge was \$9 a day. There were no charges in the evenings, Saturdays, Sundays, and holidays. A number of vehicle classifications were exempt from the charges. Exempt vehicles included taxis, environmental vehicles, buses heavier than 14 tons, vehicles with disability permits, foreign cars, emergency vehicles, and motorcycles. In addition, trips to and from Lidingö Island were exempt.

- IBM designed, built, implemented, integrated, and operated the trial congestion-charging system. There are a number of components to the system. The gateway along the roadway registers the vehicle, and a picture is taken of the vehicle's license plate. This information is matched with the registered vehicle. The vehicle owner has 5 days to pay the toll. Payment methods include transponder direct debit, license plate direct debit, Internet, contact center, and 7-11/Pressbyrån (a convenience store in Sweden). The system operates with no barriers,

no stops, and no roadside payments. The call center operations were also managed by IBM during the trial.

- On a daily basis during the trial, the system identified some 350,000 passages, managed some 850,000 photographs, managed some 110,000 payments, and responded to 2,000 to 10,000 calls. There were approximately 1 million user accounts and 430,000 distributed transponders. There were 81 charged lanes in the cordon. The system averaged 99.96% availability, and the number of failed charges was very low.

- Over the 7 months of operation during the trial, there were some 46.5 million passages at control points, of which 33.5 million were passages liable for the tax. The total number of tax decisions was 14.4 million. There were 13,000 appeals to the tax authorities. As of June 16, 2006, 5,200 appeals were granted. Of the appeals granted, 20% were for incorrect number plate interpretation, 9% were for the Lidingö rule exemption, 8% were for stolen license plates, 3% were for manipulated license plates, 2% were for foreign registered vehicles, 1% was for stolen vehicles, and 57% were for other reasons.

- The number of calls to the customer service center during the trial began at approximately 10,000 a day. By the second month, the number of daily calls had declined to 2,000. By the end of the trial, daily calls were averaging less than 2,000. The most common questions focused on payments and accounting, onboard units, company inquiries, general information, and balance statements.

- The trial was successful in reducing travel into and out of the cordon area. The number of passages was reduced by 90,000 to 115,000 per day compared with the previous year. These figures represent a reduction of approximately 20% to 25% over the prior year. Peak traffic was reduced. In terms of public opinion, the initial reaction was that the trial was not a good idea. After 3 months, however, public opinion changed, with more people favoring the trial. The referendum in the City of Stockholm concerning continuing a pricing scheme passed with 51.7% voting in favor of continued pricing.

- The outcome of the trial exceeded expectations. Benefits of the trial included a reduction in traffic volume by 25% and removing 100,000 peak hour vehicles. At the same time, an increase of 40,000 mass transit users per day was experienced and bus operations were improved. A 30% to 50% reduction in queue times was experienced. A decrease in emissions was realized, with a 14% decrease in emissions in the city and a 2.5% decrease in the county. Public opinion was increasingly positive. Media, individuals, and businesses all supported the trial. There were challenges with the trial. These challenges included the short delivery time of a complex solution in combination with a fixed launch date under significant public scrutiny, as well as integration of a large number of external partners.

- The technical components of the system performed very well. The technical system had 99.96% availability. It worked well in complex and simple locations, in good weather and in bad. All service-level agreements were met, and an error rate of less than 0.1% was experienced.

- The congestion charging scheme trial period ended July 31, 2006. By August 1, 2007, traffic volumes had increased by an average of 20%. A nonbinding public referendum was held on September 17, 2006. The results were mixed. City residents voted to continue the scheme, whereas other neighboring jurisdictions voted against the measure. The overall split was almost 50–50. The new government has decided to make the scheme permanent, with some policy changes that allow for using toll revenue for a broader set of transportation infrastructure improvements. The permanent system became effective August 1, 2007, as a camera-based tolling system. Transponders are not part of the system. There has been significant interest from around the world in the scheme design, implementation, and operation. There have been visits from several U.S. organizations, both public and private.

### San Diego's I-15 HOT Lanes: Performance Measures and Evaluation

*Janusz Supernak*

Janusz Supernak discussed the expansion of the high-occupancy vehicle (HOV) lanes on I-15 in San Diego to high-occupancy toll (HOT) lanes. He summarized the project components and the studies that have been conducted on the different project elements. Supernak covered the following points in his presentation:

- The I-15 FasTrak project is the first corridor-based dynamic congestion-pricing program in the world. The original federally funded, \$9.95 million, 3-year demonstration program has been extended indefinitely. FasTrak subscribers can use the HOV lanes on I-15 for an adjustable fee, which ranges from \$0.50 to \$8.00, based on the level-of-service (LOS). The project began in December 1996 as ExpressPass, which allowed a set number of individuals to purchase monthly permits for single-occupancy vehicle use of the HOV lanes. FasTrak began in March 1998.

- The HOT facility is 8 mi long and includes two lanes separated from the general-purpose freeway lanes by barriers. The HOT lanes operate southbound in the morning and northbound in the afternoon. There is one entrance and one exit to the HOT lanes. FasTrak toll signs located before the entrance display the current tolls for single-occupant vehicles. Carpools, which use the

facility free of charge, enter on special carpool-only lanes. Other entrance lanes are reserved for FasTrak users, who must have a valid FasTrak responder and account. California Highway Patrol (CHP) officers provide visual enforcement of the carpool occupancy requirements at the entrance.

- The initial ExpressPass demonstration included four project goals. The project goals were to maximize the use of the previously underused HOV lanes, to improve transit and HOV service along I-15, to help relieve congestion on I-15, and to test a new road toll system. The demonstration project was accepted by FHWA under the Intermodal Surface Transportation Efficiency Act (Congestion Pricing Pilot Program) in January 1995.

- State legislation was needed to implement the initial demonstration project. In October 1994, Assembly Bill 713 authorized the 3-year demonstration, allowing single-occupant vehicles to use the I-15 HOV lanes for a fee. The law requires LOS B, or the preexisting LOS C, to be maintained at all times. The state legislation also requires that revenue from the project be used for transit improvements in the corridor. The I-15 project revenue was used for a new express bus service, called the Inland Breeze.

- The initial demonstration project and the ongoing operation of the I-15 HOT lanes involved several agencies and private-sector groups. The San Diego Association of Governments (SANDAG) is responsible for coordination and project management. The project management team includes Caltrans, SANDAG, FHWA, Federal Transit Administration, and CHP. Wilber Smith & Associates assisted the local project partners. TransCore is the electronic toll collection (ETC) system operator. KT Analytics is a consultant to FHWA. San Diego State University is conducting the comprehensive monitoring and evaluation of ExpressPass and FasTrak phases of the project.

- ExpressPass, the first phase of the demonstration, operated from December 1996 to March 1998. A flat monthly fee, which began at \$50 and increased to \$70, was used for unlimited use of the HOV lanes by a limited number of single-occupant vehicles. A colored windshield decal was placed on the vehicles. Visual enforcement was provided by CHP.

- The second phase began in June 1997 when transponders replaced the monthly decals. FasTrak use began in March 1998. Variable per-trip pricing is used, with tolls typically ranging from \$0.50 to \$4.00 depending on the traffic flow in the HOV lanes and the time of day. In extreme cases when LOS C is exceeded, a maximum toll of \$8.00 can be charged.

- A comprehensive approach was taken with the evaluation, including the use of I-8 as a control corridor. Baseline data were collected on both I-15 and I-8. Multiple data sources were used. The primary focus was on

measurable effects, with careful statistical assessment of significance. The comparison of findings includes both macroscale and microscale analyses. A five-wave panel and other surveys were conducted. FHWA monitored the project reporting, which had high visibility.

- Several macroscopic studies were conducted as part of the evaluation. These macroscopic assessments included the traffic study, the transit study, the park-and-ride study, the cost-of-delay study, and the air quality study. An assessment of enforcement and violation levels was also conducted. Microscopic studies included the attitudinal panel study, the land-use study, and the business study.

- Several other studies also were completed as part of the evaluation. Studies were conducted concerning the media coverage, marketing efforts, and public response. This study included recording of all media reporting, news conferences, promotions, and letters received. Institutional issues, such as the role of a project champion and project partnerships, were examined. Safety issues were considered in the panel responses and focus groups. Community outreach, including the environmental justice requirement for public hearings, was explored. Acceptance of the project by the public was examined in focus groups and surveys. A technical assessment of the ETC system also was conducted.

- The results from the traffic study indicate that most of the primary objectives were successfully met. There was substantially better use of the HOV lane mainly because of the increasing number of program participants. Both ExpressPass and FasTrak have proven to be feasible pricing systems. Contrary to common expectations, neither system negatively affected carpool volumes. The FasTrak system was able to redistribute a portion of the Express Lane volume from the middle of the peak to the shoulders of the peak. The use of FasTrak decreased average travel times by only 4 to 6 min. Trip time reliability was no better in the HOT lanes than the general purpose freeway lanes. The project moderated emissions levels along I-15 as compared with I-8.

- The results from the bus study indicated that the Inland Breeze bus service had a steady increase in ridership, but ridership was less than expected. Ridership was primarily reverse commuting. Overall, the Inland Breeze service was moderately successful. The results from the park-and-ride study indicated that occupancy levels at park-and-ride lots along I-15 were approximately twice as high as facilities along I-8. No reduction in the use of park-and-ride lots on I-15 was recorded.

- The cost-of-delay study found higher delay on I-15 than on I-8. There was an initial reduction in delay on I-15 because of the project, but increases in delay on both I-15 and I-8 were recorded later. The results are inconclusive because of latent demand in both corridors and external factors, such as construction work on I-5.

- There was an expectation that the project would improve air quality in the corridor. Improved speeds and increased traffic volumes caused higher emissions, however. A moderating effect of the I-15 project on the emissions in the corridor was observed.

- There has been a substantial decrease in violation of the vehicle-occupancy requirement on the I-15 HOT lanes since the project began. The increased CHP enforcement levels appear to be a key factor in the decrease in violations. In addition, the program may have converted some previous single-occupant vehicle violators to participants. There has been a slight increase in violations between ExpressPass and FasTrak phases, with some concerns about the low efficiency in tracking violators.

- The land-use study found that the program was considered to be a secondary factor in housing choice. Factors such as good schools and the quality of neighborhoods were more important in housing choice. The business impact study found that ExpressPass appears to be favored over FasTrak by the local business community. Potential business interest in the program hinges on a company's dependence on the corridor where the program is installed. The program is a secondary factor for business performance.

- The media study found that media coverage was fair, timely, and generally objective. Most news reports were focused on providing information about the project. In late 1997, the media's focus began to shift from the project itself to an overall discussion of I-15 traffic problems. Overall, the study found that project leaders developed constructive media relations.

- The outreach efforts conducted by SANDAG to comply with environmental justice and other requirements did not attract substantial public attention or participation. It appears that the public in the corridor did not view the program as controversial during either phase.

- A five-wave longitudinal study was conducted to examine travel behavior, perceptions, and attitude changes. There were 1,500 participants included in the various waves. In general, FasTrak customers were affluent, educated, and primarily women who lived near the facility. Over the course of the evaluation, FasTrak use became increasingly selective. The results indicated that respondents did not leave carpools to become FasTrak users. Program participants believed they saved approximately 20 min per trip, and trips were predominantly work based. Up to 90% of participants paid the FasTrak fees themselves. Both FasTrak users and carpoolers perceived travel conditions on the HOT lanes as satisfactory. Both groups viewed the program as successful and felt the program was effective in reducing congestion. Individual participants liked pricing as a solution and preferred FasTrak over ExpressPass. Program participants highly valued the perceived safety in the HOV lanes as one of the key benefits of the program. Equity issues did not emerge.

- The results from the evaluation highlight a few broader findings. First, the project shows that HOV lanes on an urban freeway can be successfully expanded into HOT lanes. Implementation can bring measurable and significant positive effects, both for individual travelers and for systemwide operations. The main incentives to become a program participant are perceptions of increased trip time reliability, time savings, and safety. Dynamic, traffic-adjustable pricing leads to a more uniform use of the peak period, but the fixed price system may actually be counterproductive in that respect.

- In addition, the vision of the project was clear from the beginning. The idea to improve transit in the I-15 corridor was noncontroversial. An influential political champion, Mr. Jan Goldsmith, was able to make the idea a reality. The project was consistently presented as a win-win-win solution, with all parties gaining something directly or indirectly. Operational performance matched expectations.

- FasTrak users were steadily increasing, with some subscribers interested in a “safety net” type of tool to combat congestion when an important trip was at stake. FasTrak performance was very reliable, with free-flowing travel conditions delivered 99% of the time. The FasTrak per-trip pricing system appeared to be nonelitist, allowing virtually anyone to become a subscriber. The high image marketing of the project was very effective. The complexity of the project required collaboration among several stakeholders. The national visibility of the project was a catalyst to promote collaboration. The project was well managed by SANDAG. Media coverage was fair and nonsensational. The HOT lanes solution did not involve taking away any lanes. The expansion from HOV to HOT version appeared to be a logical improvement to the public and to policy makers.

## Central London Congestion Charging Scheme

### *Paresh Tailor*

Paresh Tailor discussed the congestion charging system in Central London. He summarized the background of the project and described the pricing components, the operation of the scheme, and performance of the system to date. Tailor covered the following points in his presentation:

- The 1999 Greater London Authority Act provided authority to the mayor of London, Ken Livingstone, to introduce congestion charging. The act also stated that all surplus revenues raised must be reinvested in the transport infrastructure. Livingstone opted to exercise these powers as promised in his manifesto. Livingstone’s transport priorities were to reduce congestion, to make radical improvements in bus services, to improve jour-

ney time reliability, and to make the distribution of goods and service more efficient. Congestion charging was introduced on February 17, 2003.

- Several factors influenced considering Central London for a road-pricing scheme. First, with a population of more than 7 million, Greater London is the largest urban area in Europe. Second, with some 1 million workers, Central London represents the heart of the United Kingdom’s business, government, media, and heritage activities. Central London has the worst traffic congestion in the country and among the worst in Europe. Drivers spend approximately 50% of their time in queues. Every weekday morning, the equivalent of 25 busy motorway lanes of traffic attempts to enter Central London. It is estimated that London loses between £2 to £4 million every week in terms of lost time caused by congestion. There was a general acceptance among the public and policy makers that something had to be done to address these issues.

- The system operates weekdays from 7:00 a.m. to 6:00 p.m. A charge of £8 per day is levied for private vehicles entering the zone. The charge for commercial vehicles is £7. A £10 late payment fee is levied the day after. Failure to pay the charge results in a fine of £100. This fine is reduced to £50 if it is paid within 14 days. Some vehicles are exempt from the pricing charge, including buses, taxis, and hybrid vehicles. Residents are eligible for a 90% discount.

- The performance and impact of the system has been monitored. Elements examined include traffic patterns, congestion levels, public transport ridership and accidents, business and economic impacts, operation and enforcement, and revenues.

- The pricing scheme resulted in an increase in bus ridership and improvements in bus reliability and journey times. There appears to be little or no change in the number of trips to the central area. Approximately 50% to 60% of trips moved to public transport, 20% to 30% diverted around the zone, and 15% to 25% made other adaptations. Although accidents continue to decrease, it appears that the road safety initiative is the major reason for this decrease rather than the congestion-pricing scheme.

- It is difficult to assess the effect of the pricing scheme on businesses and the economy of Central London because of other confounding factors. These factors include the closure of a London underground tube line because of a derailment, the Iraq war, the terrorist bombing, and the general economy. Overall, it appears the scheme had a generally neutral impact on the London-wide economy.

- The congestion-pricing scheme is operated and enforced by a third-party contractor. After some initial difficulties, service has improved. The overall satisfaction with operation has increased to 79% of users. The error free payment rate was 99.8%. There has been an increase in public information campaigns.

- Cameras at entry and exit points and at various points within the zone are used for enforcement. Approximately 90,000 penalty notices are issued per month. This figure continues to decrease over time, however. Foreign and diplomatic vehicles are required to pay the charge.

- The net revenues from the scheme are less than the originally projected £130 million a year. This difference appears to be the result of successful congestion reduction, higher-than-expected exempt and discounted vehicles, and higher-than-expected evasion levels. The approximate net revenue in 2006 and 2007 was £123 million. By law, all net revenue must be spent on transport strategies, including 82% allocated to the bus network, 11% allocated to roads and bridges, 4% allocated to road safety, and 2% allocated to walking and cycling.

- Lessons learned from the project include the importance of the political commitment of the mayor and the fact that the charging scheme was part of an overall strategy. Other lessons learned include monitoring the baseline before introduction of the project, early development of traffic management measures and programs, and extensive public consultation and stakeholder engagement. The use of proven technology, the inclusion of bus improvements as part of the project, and the importance of public information campaigns represent other lessons learned from the project.

## Research Needs

The following research needs were identified by participants in this session:

- Complete a synthesis on the use of performance measures with tolling and congestion pricing projects in the United States, Canada, Mexico, and Europe. The synthesis will explore performance measures currently used with HOT facilities, congestion pricing, and tolling projects. Best practice case studies will be included in the synthesis.

- Conduct a research study that builds on the synthesis and examines additional performance measures for application with tolling and congestion pricing projects. The research will explore performance measures appropriate with all elements related to developing, financing, and operating these types of projects and methods to communicate the results to policy makers, the public, users of the facility, and other groups.

*Daniela Bremmer, Washington State Department of Transportation, moderated this breakout session, and Tim Lomax, Texas Transportation Institute, served as rapporteur.*

## SAFETY

### Highway Safety: A Perspective on Performance-Driven Strategic Plans

*Michael Halladay*

Michael Halladay discussed safety programs at the U.S. Department of Transportation and FHWA. He described the Highway Safety Improvement Program, Strategic Highway Safety Plans (SHSP), and the status of national implementation. He also noted the importance of data in defining and addressing safety concerns. Halladay covered the following points in his presentation:

- Crashes on the roadway system are a significant problem. In 2005, some 6.1 million crashes were reported by police. Of these, 39,189 were fatal crashes, approximately 1.8 million were injury crashes, and approximately 4.3 million were property-damage-only crashes.

- Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) includes several key highway safety provisions. SAFETEA-LU elevated infrastructure-related safety funding at state departments of transportation to a new core program for the first time. Coupled with a doubling in the amount of funding dedicated to safety, this change established a very strong statement of policy and investment level to advance highway safety. The Safe Routes to Schools program is managed by the FHWA Office of Safety. This program has a broad set of objectives, which includes encouraging elementary and middle school students to walk and cycle to school, to improve safety, and to promote overall health and reduce obesity. The NHTSA program includes the Highway Safety Grants to States or the 402 program. It also includes incentive grants focusing on child safety and booster seats, motorcyclist safety, and other activities.

- The purpose of the Highway Safety Improvement Program (HSIP) is to achieve a significant reduction in traffic fatalities and serious injuries on public roads. The new core funding program included \$5.6 billion over the 4 years from Fiscal Year 2006 to Fiscal Year 2009. Set asides included \$220 million a year for railway highway grade crossings and \$90 million a year for high-risk rural roads.

- To obligate HSIP funds, states must develop and implement a state SHSP and produce a program of projects or strategies. States also must evaluate the plan on a regular basis and submit an annual report to the Secretary of Transportation. State departments of transportation must develop the SHSP after consultation with prescribed safety stakeholders. The plans must analyze and make effective the use of crash data and address the “four Es” (engineering, enforcement, education, and

emergency medical services) plus management and operations. The plans must consider safety needs of all public roads and describe a program of projects or strategies to reduce or eliminate safety hazards. The governor or the responsible state agency must approve the SHSP.

- The SHSP guidance identifies steps in developing an SHSP. These steps include gaining leadership support and initiative, identifying a champion, establishing a working group, and bringing safety partners together. Other steps involve gathering and analyzing data, adopting a strategic goal, and identifying key emphasis areas. Forming task groups, identifying key emphasis area performance-based goals, identifying strategies and countermeasures, and determining priorities for implementation represent other steps.

- There is a critical need for state safety information systems. These data systems should be complete, accessible, timely, accurate, compatible, and integrated. Information analysis capabilities are needed to identify problems, develop effective countermeasures, and evaluate safety benefits over time.

- The SHSP process requires consultation with numerous stakeholders, including the state, the governor's highway safety representative, regional transportation agencies, and metropolitan planning organizations MPOs. Representatives from the major modes of transportation, state and local traffic enforcement officials, and motor vehicle administration agencies also should be involved. The SHSP process also should be coordinated with Operation Lifesaver, state-level highway and grade-crossing safety programs, and various motor carrier safety programs. Other major safety stakeholders include tribal governments, state and local agencies, emergency response agencies, and the judiciary community. The medical community, motorcycle community, academia, safety advocates, and civic organizations represent other stakeholders. Representatives from the highway, railroad, trucking, insurance, and hospitality industries should also be involved.

- An SHSP should establish goals for identified critical emphasis areas. Targets and time frames should be established for specific strategies to reduce fatalities. To the degree possible, targets should be linked to a particular strategy or strategies so that reductions in crashes can be tracked to the successful completion of a strategy. For example, a target might be a 20% reduction for cross-median crashes. The resulting reduction of cross-median crashes can be correlated with a strategy such as the installation of a median barrier system. SHSPs are dynamic documents, and the targets listed may be adjusted along with countermeasures and strategies.

- Many of the SHSPs contain similar emphasis areas. A review of a sample of 28 SHSPs in February 2007 highlights these similarities. A total of 26 SHSPs include both roadway departure and occupant protection as emphasis

areas. Impaired driving was an emphasis area in 25 SHSPs. Other emphasis areas listed in 15 to 20 SHSPs included young drivers, intersections, pedestrian safety, and traffic records. Commercial vehicles, speed management, older drivers, motorcycle safety, and bicycle safety were listed in 12 to 15 SHSPs.

- Numerous benefits may be realized from a SHSP. These benefits include establishing common statewide safety goals and priorities through enhanced coordination, strengthening existing partnerships and building new safety coalitions, and using a collaborative process to draw on the strengths and resources of all safety partners. The plan allows the scheduling and implementation of safety improvement programs, comprehensive initiatives, and coordinated projects. It also incorporates both behavioral and infrastructure strategies and countermeasures into one process. Sharing data, knowledge, and resources and leveraging limited resources represent still other benefits.

- A state may use up to 10% of HSIP funds to conduct other safety projects identified in the SHSP. The state must certify that it has met its needs related to railway-highway crossings and that it has met its infrastructure safety needs related to highway safety improvement projects.

- The SHSP does not replace existing state plans or programs, but rather acts as a catalyst to bring diverse safety stakeholders together to set collective goals, agree on key priority emphasis areas, implement safety investments through current plans and programs, and monitor the results of these investments over time. It is anticipated that future cycles will help institutionalize the SHSP intent and process into the state safety culture.

- It is important to understand this new SHSP requirement and its link to the transportation planning and programming processes. Statewide transportation plans, metropolitan transportation plans, transportation improvement programs, statewide transportation improvement programs, as well as the HSIP, Motor Carrier Safety Assistance program, commercial vehicle safety plans, highway safety plans, and other state and local plans, are all critical to the success of an SHSP and vice versa, as is the developmental process involved in preparing them. The SHSP is a statewide safety plan that involves a collaborative and comprehensive approach that provides a framework for advancing all of the state's safety activities. The SHSP should be consistent with overall statewide long-range transportation plan goals. While the SHSP is initially being developed, safety partners should consider the safety goals identified in the statewide transportation plan and the metropolitan transportation plans.

- There are challenges and barriers with developing and implementing a SHSP. Examples of possible challenges include internal communications and collabora-

tion, external communication, and collaboration with other agencies and organizations. Data deficiencies, access to resources, management support, and political support represent other challenges. Conflicts among agencies, technical expertise, staff and consultant support, and time to coordinate and facilitate the partnerships represent still other challenges.

### Safety Planning and Performance: A Rural State's View

*Sandra Straehl*

Sandra Straehl discussed safety planning in Montana. She described the key transportation safety issues in the state and safety planning activities at the Montana Department of Transportation (MDT). Straehl covered the following points in her presentation:

- MDT has pursued a performance-driven program for the past 7 years. A performance goal for safety was initially included as a performance measure. The measure was the number of high hazard sites that were improved. This element was selected because it represents the only element over which the department has control.

- The six states with the highest percentage of vehicle miles outside of urban areas are Montana, Vermont, South Dakota, North Dakota, Wyoming, and Maine. Conversely, the four states with the most urban travel characteristics are Massachusetts, Rhode Island, New Jersey, and Connecticut. It is important to remember that the travel characteristics in a state and the demographics of the population directly affect the ability to address highway traffic safety issues.

- The recent Reason Foundation report authored by Dr. Hartgen from the University of North Carolina identified Montana as having the deadliest roads, whereas Massachusetts was identified as having the safest. The report did not point out, however, that Montana has the most rural travel characteristics, whereas Massachusetts has the most urban. This demographic detail is important. Some highway safety issues are unique to rural states. These issues include speed, distance from emergency services, and scarcity of officers patrolling vast areas. For example, 77% of Montana's travel is outside of urban boundaries. Rural travel speeds are much higher than congested urban travel speeds, and the consequences of higher speed crashes are often severe. The average distance to trauma centers in Montana for crashes occurring in rural areas is 1 h. In Massachusetts, the average is 15 min. In addition, the presence of law enforcement is scarce in states with vast rural areas. Massachusetts has roughly 12 times the number of offi-

cers, and these officers cover a state that is  $\frac{1}{8}$  the size of Montana. These comparisons point out that rural states have special challenges to overcome in making progress in reducing fatalities.

- Rural areas also face significant challenges because of the distances to transport victims to trauma centers. If someone is injured in a crash near Sand Springs, Montana, an ambulance has to travel 97 mi each way from the nearest trauma center in Circle to get the victim to treatment. That 194-mi round trip is longer than the 163-mi distance between Boston, Massachusetts, and Albany, New York.

- Data from the NHTSA 2004 Fatal Analysis Reporting System for speed-related fatalities indicate that states in the Rocky Mountain region have higher speed-related fatality rates than other regions in the country. Montana has the highest rate for speed-related highway fatalities in the region.

- From 2001 to 2006, 1,278 people died on Montana highways. Approximately 75% of the individuals who died in crashes were not wearing seatbelts. It is estimated that 470 individuals, or 50%, would have survived if they had been wearing seatbelts. Although Montana's seatbelt usage rate is greater than 80%, only 27% of those who died in highway crashes were wearing seatbelts. These figures indicate that the higher-risk drivers are dying in highway crashes at a greater rate than safe drivers.

- NHTSA data on the percentage of Native American alcohol-related fatalities in the Rocky Mountain states compared with the Native American population in each state also show some alarming trends. In Montana, 30% of the alcohol-related fatalities are Native Americans, whereas only approximately 6% of Montana's population is Native American. Native Americans are overrepresented in alcohol-related fatalities in every Rocky Mountain state except Utah. In Montana, Native Americans are overrepresented in highway fatalities.

- MDT is working toward solutions that can make a difference in these statistics in the rural west. In 2005, the Montana Highway Patrol was able to field only 30 officers for any shift. MDT maintains approximately 11,000 mi of centerline highway, of which all but approximately 500 mi are high-speed rural highways. MDT does not enforce speed laws, but works cooperatively with the Montana Highway Patrol to increase its staffing levels. In the 2005 legislative session, MDT worked with other agencies and interest groups to obtain legislative approval of an open container ban and graduated driver's licensing. The experience in 2005 points out the importance of multiagency cooperation, a consistent message, and accurate and consistent data.

- In the fall of 2006, MDT completed Montana's first comprehensive safety plan. The planning process brought stakeholders together from all the state, federal,

tribal, and local perspectives to identify strategies to reduce fatalities on Montana highways. Although SAFETEA-LU includes a requirement to develop a SHSP, MDT had already initiated the development of a comprehensive, multiagency, multijurisdictional plan.

- The last National Travel Survey showed that more than 90% of all Montana households travel at least once annually to destinations more than 100 mi away, versus 80% of households nationally. These households took an average of 9.4 trips that were more than 100 mi long, versus 6.9 trips nationally. It is not unusual in Montana to travel 90 or 100 mi to go to work. This “extreme commuting” is normally done in a pick-up truck, often on two-lane roads and at high speeds.

- Numerous federal, state, regional, and local agencies are participating in Montana’s CHSP. Participating agencies include the Highway Patrol, Human Services, Office of Court Administration, FHWA, MCSAP, emergency responders, Indian Health Service, MPOS, local law enforcement, the American Automobile Association, the governor’s office, NHTSA, the Bureau of Indian Affairs, the Office of Public Instruction, and driving under the influence task forces. Safe communities groups, tribal governments, safety groups, and motor carriers are also involved. Having the MDT director as both a cabinet-level champion and a department-level champion has been beneficial. Other state agencies welcomed the MDT’s involvement, and a continuous working relationship has emerged on numerous issues.

- There are seven steps to Montana’s CHSP. The first step is to build a mission and outreach to major partners. The second step is to understand the problem on the basis of key data. The third step is to define goals and objectives that are data driven. The fourth step is to discover and align existing strategies. The fifth step is to conduct a gap analysis and to identify new strategies. The sixth step is to allow champions to lead. The final step provides a loop back to the beginning of the process to ensure ongoing efforts.

- An initial set of objectives was agreed on for the CHSP. These objectives include bringing seatbelt use up to 90%, reducing alcohol and drug-impaired fatal and incapacitating injury crashes, reducing Native American fatal crashes, and reducing single-vehicle run-off-the-road fatal and incapacitating injury crashes. Other objectives include reducing crashes for young drivers and implementing an integrated transportation records and crash reporting system accessible to all stakeholders to manage and evaluate transportation safety. Reducing crashes, injury crashes, and fatal crashes along identified high-crash corridors and reducing crashes, injury crashes, and fatal crashes in identified high-crash locations represents another objective. Reducing crashes involving commercial trucks, developing an effective and integrated emergency medical service delivery system,

reducing older driver fatal and incapacitating injury crashes, reducing motorcycle fatal and incapacitating injury crashes, and reducing fatal and incapacitating injury accidents in urban areas represent additional objectives.

- The long-term element of the plan, which covers the next 3 to 5 years, includes goals, long-term data trends, and key issue areas. The annual element addresses progress on objectives and goals, new strategies to support objectives, and emerging trends. One goal related to business process streamlining was to combine NHTSA, FHWA, and MCSAP safety planning functions.

- Three of the most important goal areas in the plan address Native American fatalities, seatbelt use, and high-crash corridors. In Montana and other western states, Native Americans are overrepresented in highway fatalities. In 2004, 20% of all fatalities were Native American. Of these, 71% were related to alcohol, and only 7% of the individuals who died in these crashes were wearing seatbelts.

- MDT cannot address the alcohol-related fatality issues without the tribal governments being involved in the solution. Six of the seven counties with the highest alcohol-related fatalities are those in which the Flathead, Blackfeet, Crow, and Northern Cheyenne reservations are located. Issues that need to be addressed include the lack of tribal traffic codes, lack of cross-deputization in the majority of reservations, difficulty in obtaining traffic crash records from tribal authorities, and differential Bureau of Indian Affairs law enforcement.

- Montana was the only state in the country that used the \$25,000 stipend from FHWA for a “safety conscious planning forum” that focused on Native American issues. Representatives of six of the state’s seven reservations attended. The governor attended the forum to stress the importance of the issues. Issues identified at the forum included interjurisdictional challenges, lack of tribal traffic laws, lack of cross-deputization, and spotty data submission.

- In the spring of 2006, the governor invited representatives from the tribal governments and the federal government to participate in a day-long session to identify strategic issues that should become part of the state’s comprehensive safety plan and the strategies. The strategies in the CHSP that support reducing Native American fatalities include data gathering, cross-deputization, uniform traffic codes, tribal officer training, and encouraging each reservation to develop its own comprehensive safety plan.

- MDT implemented a community-based education and media campaign 4 years ago on four Native American reservations in Montana. The program, called Safe on All Roads or SOAR, is active on the Blackfeet, Rocky Boy’s, Fort Belknap, and Fort Peck reservations. Because the most effective messages and communications will

come from within the communities, rather than from outside agencies, MDT partners with local tribal colleges and local resident interns to develop and implement communications aimed at Native American audiences. Activities include partnership building with local groups and businesses, news releases, media placement, media relations, coordination with community agencies and organizations, coalition building with regional and community leaders, law enforcement liaison, and facilitation of displays and sponsorships for public events. The program's goals are to reduce traffic deaths and injuries on these reservations by increasing seatbelt use, supporting education regarding proper use of child safety seats, and reducing incidences of impaired driving.

- One of three major themes of the SOAR Native American campaign is "Buckle up because you love me." This theme builds on the love and respect that exist within Native American families. The second theme is that safe travel and protection is traditional in the Plains Indian culture. This theme is aimed specifically at correctly using child restraint devices. The third theme is that taking pride in Native American heritage requires sobriety behind the wheel.

- The total cost of the program has been approximately \$170,000. As part of the overall program of public education, local coordinators are building a SOAR Corps—a growing group of people on reservations who sign a personal contract to be a safe driver and to encourage others to be safe drivers and passengers. The personal contract states that an individual will commit to always wearing a seatbelt, will ask others to be properly buckled up, will not ride with a driver who has been drinking, and will not drive after consuming more than two drinks of alcohol.

- The concepts are tested in focus groups of Native Americans within the communities. The results indicate that the concepts that make the strongest impact are messages delivered by local individuals that provide an emotional appeal—in short, honest connections with traditional tribal values with an emphasis on respect for family. The concepts focused on the personal consequences of risk behavior do not appear to communicate well. Messages that score the lowest are those focused on law enforcement.

- The SOAR program has helped build trust between the state and the tribal governments, which has been useful in moving toward agreements for overtime patrols by tribal law enforcement and other efforts. Obtaining crash data on roads within reservation boundaries remains a challenge. MDT currently obtains data on fatalities from the highway patrol but has not been able to obtain other crash data. MDT has been working with the tribes, FHWA, and the Indian Health Services to obtain consistent crash data for nonfatalities, with mixed success. Concerns remain on confidentiality and sover-

eighty issues. At this time work is under way on crash reporting forms to ensure compliance.

- Of the 1,278 highway fatalities between 2001 and 2006, 74% of the individuals were not wearing seatbelts. Most of the fatalities occurred on high-speed, two-lane highways in rural areas. Studies indicate that more than 450 of these individuals would not have died if they had been wearing seatbelts. Seatbelt usage is perhaps the most important factor in reducing fatality rates on high-speed rural highways.

- A primary seatbelt law in Montana came close to being approved by the legislature in the previous session. Although the bill has not been approved yet, progress has been made over the past few years. Two sessions ago, the bill did not get out of the Senate. One session ago it passed the Senate and lost by 56 votes in the House. In the 2007 session, the primary seatbelt bill was defeated by only six votes in the House. MDT is committed to reducing deaths by increasing the use of seatbelts. Implementing a continuous information campaign and taking highway traffic safety information out into the communities are two of the major efforts.

- During the last 5 months of 2006, MDT began a postcard campaign to focus attention on the need for a primary seatbelt law. Postcards were sent to every legislator. The message on the postcards focused on different aspects of the issue. This simple approach proved effective. MDT will continue outreach efforts related to the seatbelt issue using a postcard campaign leading into the next legislative session to keep the safety message in front of state legislators. This summer, MDT has conducted a series of Community Highway Safety Forums around the state to help communicate the message.

- Travel corridors with high numbers of crashes have been identified. The MDT director and staff visited the communities close to these corridors this past summer to communicate the importance of residents taking responsibility for addressing these problems. MDT personnel stressed the importance of participation by law enforcement, community leaders, and users to make a change.

- One corridor with high crash rates is US-191 between the rapidly growing Bozeman area and Big Sky Resort. Contrary to what many people thought, the highest numbers of crashes in the corridor occur during the morning and afternoon weekday or peak periods when residents are traveling to and from work and school, rather than on weekends when recreational travel is highest. The data also indicate that the increase in crashes has not been caused by an increase in truck traffic. Truck traffic remained relatively constant between 1998 and 2006, whereas passenger vehicle traffic showed a steady and significant increase. The trends indicate that the corridor is becoming more of a commuter corridor. Changing the crash rate requires changing the behavior of individuals driving it every day. The

Community Highway Safety Forums will bring together driving under the influence task forces, local and state law enforcement groups, safe kids coalitions, and the highway users with goal-changing behavior to save lives.

- Examining the crash data points to some emerging trends. Over the past 5 years, both injury and fatal motorcycle crashes have increased more than 30%. Crashes resulting from inattentive driving have also increased. Motorcycle riders tend to be mostly middle-aged men. It is difficult to examine motorcycle crashes, however, because of one-time registration, which prevents a good estimate of the number of motorcycles on the road, and the limitation of traffic data collection equipment for collecting consistent motorcycle data. As a result, it is impossible to know whether the increase in fatalities and crashes is proportionate or disproportionate to use.

- Reducing highway crashes, injuries, and fatalities is an essential mission for MDT. Progress in this area is slow and incremental. It is important to remember that improvements require changes in individual behavior. In an overwhelmingly rural state, there is no single solution regarding highway traffic safety.

## Research Needs

The following research needs were identified by participants in this session:

- Develop and maintain a safety countermeasure effectiveness clearinghouse or warehouse.
- Develop a synthesis on currently available safety planning tools and techniques.
- Conduct research studies examining demographics and crashes, including fatal crashes. The studies will explore relationships between demographic characteristics and higher crash rates.
- Conduct research studies examining the effectiveness of safety strategies applied in rural and urban areas. The studies will include comparisons of the effectiveness of different techniques in urban and rural areas and identifying the strategies that appear most effective for different areas.
- Explore the potential to develop a national highway safety database. The project will include assessing the potential elements of a national safety database, the cost to develop and maintain, the uses, and the benefits. The potential roles and responsibilities of federal, state, and local agencies and groups in developing and maintaining the database will be examined.
- Conduct a study examining methods to integrate safety data and visualization to support comprehensive safety strategies. As an example, visualization techniques could be used to enhance identifying the locations and

times for law enforcement efforts to maximize safety benefits.

- Examine the benefits and costs of safety programs across all of the 4Es, including a cross-functional trade-off analysis.

- Explore methods and techniques to increase collaboration and partnering with the public health community to address traffic safety issues. A first step will be to develop a synthesis on current best practice examples and possible future methods to increase and enhance partnerships. The study will also consider ways to advance the development of low cost countermeasures for both states and communities and methods to disseminate this information to advance the state of the practice.

- Explore the development and use of bipartisan road safety committees within states and communities. Examine different institutional arrangements for the formation of these committees or coalitions and their use as a forum to promote safety-related policies, programs, and activities.

*Sandra Straehl, Montana Department of Transportation, moderated this breakout session, and Kingston Chirwa, University of Southern California, served as rapporteur.*

## FREIGHT PERFORMANCE MEASURES

### Performance Measures of Freight-Related Activity

*Jim Gosnell*

Jim Gosnell discussed freight performance measures. He described the importance of the efficient movement of goods in southern California and the freight performance measures used by the Southern California Association of Governments (SCAG). Gosnell covered the following points in his presentation:

- With two of the largest ports in the nation, California's southwest mega-region is closely tied to the logistics and goods movement industry. Infrastructure improvements are essential to keeping this gateway region competitive in the global marketplace and to improving the quality of life in the region.

- The Los Angeles–Long Beach Port complex is the largest in the United States and the fifth largest in the world. Several factors contribute to the success of these ports. First, the ports can accommodate 1,000 container Panamax ships. Second, the deep harbors and landside facilities make the ports the preferred destination for shippers. Third, the ports have state-of-the-art on-dock facilities. Fourth, both ports have intermodal transfer and distribution facilities.

- The ports and the logistics industry are important to the economy of southern California. These industries employ more than 500,000 southern Californians. The logistics industry provides jobs to 8% of southern Californians. Salaries for jobs in the logistics industry are relatively high paying.

- There are air quality concerns related to the ports and goods movement in southern California. If particulate matter 2.5 pollutants are not reduced to the national standard by 2014, the region will fail to meet the attainment requirements, and health concerns will continue.

- Developing and using freight performance measures at MPOs, state departments of transportation, and other public agencies can be challenging for several reasons. First, the logistics industry is fragmented, making it difficult to collect necessary data. Second, large corporations are often reluctant to share information, especially with public agencies and their competitors. Finally, the private sector may be skeptical of public interference.

- The Ports of Los Angeles and Long Beach handle approximately 40% of the nation's containerized imports. Truck and train trips serving the Ports of Los Angeles and Long Beach continue to increase. Daily truck trips represent an important part of the overall traffic on freeways in the area. The use of "just-in-time" delivery of products also continues to increase. The square footage of warehouse space near the ports is forecast to increase by approximately 315% by 2030.

- The freight-related performance measures in the Regional Transportation Plan focus on mobility, reliability, safety, cost-effectiveness, productivity, and the environment. The mobility performance measure relates to average daily speed and delay. Reliability is defined by the percentage variation in travel times. Accident rates represent the focus of the safety performance measure. The benefit-to-cost ratio defines the cost-effectiveness performance measure. Production is represented by the percentage of capacity in the peak period. The environmental measure focuses on the generation of emissions. Based on data limitations and the modeling process, SCAG is focusing on the mobility, the cost-effectiveness, and the environmental performance measures.

- Examining capacity projects is based on the premise that infrastructure improvements will reduce transit time for shippers and improve efficiency and reliability. Further, reliability has a real dollar value to shippers. Finally, the value of time savings will be significantly greater than the investment to achieve the time savings.

- The value of speed and reliability to shippers and users of the system can be calculated. An analysis of travel times in 2030 with and without truck lanes was conducted. The addition of truck lanes significantly reduced travel times between the ports and major commercial centers in the region. The monetary value of the time savings

to shippers and businesses was calculated. The analysis indicated that each dollar invested in truck lanes and other improvements provides a return of \$5 to \$11.

- A 2005 study examined an as-is scenario in which fees were imposed but not used to provide new regional congestion relief and a congestion relieve scenario in which fees or tolls were paid by users of newly constructed highway and rail systems that provide regional congestion relief. The private-sector investment in the congestion relief scenario provided more positive results with less traffic congestion, and the ports became more attractive to shippers, resulting in higher increases in the volume of shipments.

## Freight Data Collection and Performance Measures

### *Crystal Jones*

Crystal Jones discussed the development and use of freight performance measures. She described a public-private partnership being used to collect freight data on major Interstate freeways and five U.S.–Canada border crossings. Jones covered the following points in her presentation:

- It is important to put goods movement and international trade in the proper context. Approximately 25% of the U.S. Gross Domestic Product is related to international trade. This figure is predicted to grow to 35% in the next 20 years. From 1980 to 2002, truck travel on U.S. highways grew by 90% whereas lane-miles of public roads grew by only 5%. Between 2002 and 2035, the highways carrying 10,000 or more trucks are expected to increase from 10,000 mi to 34,000 mi.

- Traffic congestion is no longer just an urban issue. Congestion impedes timely and reliable freight movements and threatens business productivity. The travel growth rate has been even greater in rural areas than in urban areas. Freight volumes are expected to increase 92% by 2035 from the 2002 level. If left unaddressed, by 2035, congestion will be a significant problem on many major Interstate corridors.

- The FHWA Office of Freight Management and Operations has five objectives: (a) to understand the magnitude and geography of freight moving on the nation's transportation system, including international freight; (b) to develop strategies, analytical tools, institutional arrangements, and professional capacities for all levels of government to address freight movement; (c) to understand and promote the economic benefits of freight transportation; (d) to encourage innovative freight technology and operations; and (e) to enforce commercial vehicle size and weight requirements.

- The Government Performance and Results Act of 1993 established a requirement for federal agencies to identify goals and measurable outcomes to gauge performance in meeting program objectives. In response to this requirement and in seeking to advance its own performance, FHWA has developed a National Strategic Plan. To measure performance under the plan, FHWA has developed performance measures for productivity and efficiency improvements in relation to the highway system.

- There are five strategic goals in the plan. The productivity strategic goal is to continuously improve the economic efficiency of the nation's transportation system to enhance the United States' position in the global economy. The strategic objective on global connectivity is to facilitate a more efficient domestic and global transportation system that enables economic growth and development. The goals are to reduce travel time in key highway freight corridors and to reduce delays of commercial vehicles processed at National Highway System (NHS) border crossings. The outcome measures are travel time and reliability on freight significant highways and border crossing time.

- Freight performance indicators were developed through an evaluation process that balanced the value of an indicator as a measure of performance against the difficulty and cost of obtaining the necessary data. The freight performance indicators include point-to-point travel times on selected freight-significant highways, crossing times at international borders, and the condition of connectors between the NHS and intermodal terminals. Other performance indicators are the cost of highway freight per ton-mile, cargo insurance rates, customer satisfaction, and the hours of delay per 1,000 vehicle miles on selected freight-significant highways.

- These performance indicators reflect those ranked highest in terms of descriptive value and technical appropriateness. Although data availability and costs are important considerations, measures with relatively high data costs also may be used. Customer satisfaction, for example, would require considerable effort to design a survey, obtain the cooperation of private firms, and conduct the survey. It was included because of the high value of the information that can be obtained through surveys.

- A public-private partnership has been established to support a freight performance measures data collection program. The partnership includes FHWA and the American Transportation Research Institute (ATRI), satellite technology vendors, and carriers. The methodology uses trucks equipped with automatic vehicle location systems as traffic probes. Data cleansing techniques allow the collection of data from most of the vendor carrier subscribers, which accounts for some 300,000 vehicles. ATRI manages the data.

- Using this system, data from 25 major Interstate freeways and five U.S.–Canada border crossings are being collected. Obtaining data from the U.S.–Mexico border crossings using the same methodology is under development. The program provides a quantifiable basis to engage public agencies and private-sector groups to investigate and explore possible causes of delay.

- Data collection at the five U.S.–Canada border crossings began in July 2005. The program includes one border crossing each in Washington, North Dakota, and Michigan, and two in New York. Data from the transportation network supporting the crossings are also being collected. For example, data collection at the Ambassador Bridge in Detroit, Michigan, includes four approach routes on the U.S. side and three approach routes on the Canadian side.

- Two performance measures are used with both the freight-significant corridors and the border crossings. The two performance measures for freight-significant corridors are the average operating speeds for the entire corridor and travel time reliability using the buffer index. The performance measures for border crossings are the total crossing time and the crossing time reliability, using the buffer index.

- Travel time reliability is the consistency or dependability in freight travel times measured from day to day and across different times of day for an origin–destination pair. It is focused on unexpected delay rather than the typical delay related to capacity–demand. The buffer index is defined as the extra time, or the time cushion, that should be added to average travel time to ensure on-time arrival at a destination at a given level of confidence. The planning time index is defined as the total time a traveler should allow to ensure on-time arrival.

- Other travel time measures include average travel time in the peak period in major metropolitan areas, city-to-city travel time, and shipper point-to-point travel time. Other measures of delay include the hours of delay per 1,000 vehicle miles and the percentage of a corridor experiencing morning and afternoon peak period delay. Other reliability measures include the annual hours of incident-based delay, annual hours of work zone-based delay, and the annual hours of weather-based delay.

- The data obtained through the freight performance measures data collection program are being examined. Data from 2005 and 2006 indicate that trip time reliability is declining in many of the major freight corridors.

- The response from representatives at state departments of transportation concerning the data has been positive. Responses indicate there is confidence the data can be applied in decision making, project analysis and prioritization, and trend analysis. Other areas where the data may be used include transportation planning; analyzing the effects of varying operational conditions on

the network; and making investment decisions at the national, state, and local levels.

- The state representatives also identified areas for additional research. Examples of further research include collecting and analyzing data for more roadways, building freight performance measure tools and products based on user-defined requirements, and using freight performance measure data as an input to transportation models. Other research topics include collecting freight data for the other modes and improving visualization tools.

- Several activities are under way or planned for the future. These efforts include developing an Internet-based tool to disseminate data to state departments of transportation, MPOs, and other agencies. The data would be available by direction, time-of-day, and city pairs. Assessing the potential to expand the data collection beyond the Interstate system will be explored, as well as enhancing data by adding additional vendors and fleets. Potential partnerships with public agencies and universities to apply the results in trend analysis, demand modeling, forecasting models, cost-benefit analysis, and before-and-after assessments are also being pursued. Finally, expanding data collection to include the U.S. border with Mexico is under way.

## Research Needs

The following research needs were identified by participants in this session:

- Conduct a research study to develop a “just-in-time” index for trucks and freight movement. The index would provide an economic health index for freight, much like the Dow Jones Index has become a market indicator.

- Complete a synthesis on the use of freight-related performance measures by state departments of transportation, MPOs, and other transportation agencies. The synthesis will include best practice case study examples. To the extent possible, it will also document performance measures used by shippers, trucking firms, railroads, air services, and other private-sector businesses.

*Kermit Wies, Chicago Metropolitan Agency for Planning, moderated this breakout session, and Johanna Zmud, NuStats, served as rapporteur.*

BREAKOUT SESSIONS 5

# Performance-Based Contracting and Measuring Project Delivery

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Nick Harding, *Halcrow*

Amado Rubio Athie, *Ministry of Transport, Mexico*

Stephen C. Beatty, *KPMG LLP*

Thomas Jeffrey Price, *Virginia Department of Transportation*

Geoffrey Yarema, *Nossaman, Guthner, Knox, and Elliott, LLP*

Carl Clayton, *Stantec Consulting, Ltd.*

Karla Sutliff, *California Department of Transportation*

## **PUBLIC-PRIVATE PARTNERSHIPS: AN INTERNATIONAL PERSPECTIVE OF PUBLIC-PRIVATE PARTNERSHIPS USED AROUND THE WORLD**

### **Performance Measures in Public-Private Partnership Contracts**

*Nick Harding*

Nick Harding discussed the use of performance measures with private concessions in the United Kingdom. He summarized the use of concession agreements and described the national-level performance indicators applied with these approaches. He described the operational performance measures being used with new contracts. Harding covered the following points in his presentation:

- The use of the design, build, finance, and operate (DBFO) approach in the United Kingdom was initiated in 1994. There have been 12 signed DBFO road contracts to date, accounting for approximately \$2 billion in new construction. These contracts represent an average savings of 15% compared with the traditional approaches. A \$4 billion contract for the M25 project is in procurement.
- There are 14 national-level area performance indicators. These indicators include response to emergency incidents, response to Category 1 defects, customer satisfaction, and the environmental amenity index. Other indicators are site workplace safety, time predictability

of projects, cost predictability of projects, and the predictability of resource forecasting. Still other indicators address winter maintenance, defect-free work, road traffic accidents at roadworks, street lighting outages, network availability, and third-party claims.

- A new approach is being used with the M25 project. This approach represents a true partnership and the sharing of risk. The concessionaire will receive base payments with performance adjustments. The payment adjustments will be made based on a number of components. These components include lane availability, route performance, condition criteria, safety performance, and proactive management.
- The performance management framework is currently being developed. The framework will be a 5-year management plan that outlines the performance measures, agreed targets, and how the DBFO contractor intends to achieve the measures and targets. The DBFO contractor's management systems will be used to enable the achievement of the targets and will include continual monitoring of performance and benchmarking against national performance. The DBFO contractor will be expected to assist by working proactively and collaboratively in helping the Highways Agency achieve its aims and objectives, which will change over time. Measures are being developed to evaluate the performance of the DBFO contractor in this area. An annual report will be published that reviews the previous year's performance and information back into the next year's management plan.
- The lane availability component is intended to provide the DBFO with an incentive to conduct maintenance

at times and in a manner to minimize delays to the traveling public. It is similar in concept to lane closure and lane rental charges, but more flexible and simpler to apply. Payment deductions will be made if the normal flow of traffic is restricted for routine and planned maintenance and renewals. This component is anticipated to be the most significant element in monetary terms.

- The route performance component considers monthly adjustments that reflect the reliability of journey times and the effects of incidents. Bonus payments will be made if journey times show high reliability. Payment deductions will be made if journey times show significant variance from the norm. Excessive travel time is undesirable, and deductions based on delay points are accrued. Low variability of travel time is desirable, and additional payments based on reliability points are accrued. The DBFO contractor will be awarded net points equal to reliability points minus delay points. Net payment to the contractor equals net points multiplied by a pound value per point.

- The condition criteria component considers monthly adjustments reflecting the condition of the road and the technology equipment. There are payment deductions for failure of ride quality, rutting, and texture depth requirements based on traffic speed condition surveys. There are also payment deductions based on failure to deal with high-profile Category 1 defects within an allowable hazard mitigation period and losses of the technology systems.

- The safety performance category focuses on annual adjustments reflecting safety performance on the project road. The assessment is based on a 5-year rolling average of killed and seriously injured casualties for both the traveling public and the workforce. Bonus payments or deductions are made depending on performance compared with national trends.

- The proactive management category considers annual adjustments reflecting the extent to which the DBFO contractor is proactive in working with the Highways Agency as the agency's priorities change and key objectives develop. Potential bonus payments are available for proactive involvement. The assessment measures for the proactive management category are still being developed. Possible measures could include the DBFO contractor's awareness of key areas for improvement in operational performance on the project road, the understanding of Highways Agency priorities and constraints, and effectiveness in bringing forward ideas for improvement of operational performance.

- In summary, it is important that performance measures align with an agency's objectives. It is beneficial to look beyond standard condition indicators. In public-private partnerships, performance measures can be used as incentives to correct behavior and to align the interests of the contractor and the public agency.

## Comparative Results for Public-Private Partnerships

*Amado Rubio Athie*

Amado Rubio Athie discussed the use of public-private partnerships in Mexico to advance needed highway projects. He highlighted the background about the use of public-private partnerships, current activities, and measuring performance of contractors. He elaborated on his comments in the plenary session. Athie covered the following points in his presentation:

- Several factors have contributed to the use of public-private partnerships in the highway sector in Mexico. These factors include limited federal funding, the need for earlier development of toll and free roads, and the need to provide continuity in the road network. The approach also offers better service to users and expedites the integration of important transportation corridors.

- Three public-private partnership models are being used in Mexico. These models are highway concessions, projects for the provision of service (PPS), and asset utilization. Highway concessions use toll income, PPSs use service payments, and asset utilization maximizes existing toll road income.

- The revenue source for the highway concession model is users. Government support is provided through an initial contribution and a revenue guarantee. The traffic risk is transferred from the government to the concessionaire. The government provides the project design. The concession title is the legal document used with this model, and the concession duration is 30 years.

- There is no government funding support with the PPS model. The revenue source is periodic use payments. A small portion of the traffic risk is transferred to the concessionaire. The government provides the conceptual design and a list of requirements. The legal documents are the concessionaire title and the service contracts. The duration of a PPS is 15 to 30 years.

- The revenue source for the asset utilization model is highway income for 30 years. There is no government financial support, and the traffic risk is transferred to the concessionaire. The legal document is the concessionaire title, and the duration is 30 years.

- The PPS model can be used with several different projects. One example is a toll-free road modernization project with periodic payments consisting of 90% availability payments and 10% shadow tolls. Another example is toll-free road modernization and a new toll road concession project with periodic payments equal to the availability payment minus the toll income. Still another example is a new toll road concession with an initial high investment cost using periodic payments equal to availability payment minus real-toll income. Examples of the

assets utilization model include existing toll road income flow plus modernization of some sections and existing toll road income flow plus construction and modernization of some sections.

- The payment mechanism is based on the availability of the road and maintenance of performance standards. The private-sector operator can control the availability of the road. Revenues and expenditure streams can be modeled with some certainty, so concessionaires view this approach as relatively low risk. The road availability criteria and payment allocation can be spread across sections and time.

- The service provider designs, improves, maintains, and operates the road according to the government's requirements. These requirements refer to the physical road characteristics, specification of operational activities, maintenance requirements, other services on the road, and road characteristics at the end of the contract. The government designates a representative to ensure that the requirements are met throughout the contract's duration.

- Public-private partnerships are a key to increasing highway infrastructure investments in Mexico. Existing conditions are favorable for road development through public-private models in Mexico caused by a stable macroeconomic environment, models and projects that are attractive to the market, interest on the part of key national and international contractors, and existing highway assets that can support new project development. Consequently, there is a window of opportunity in Mexico that can be seized to increase competitiveness, promote employment, and contribute to regional development.

### International Perspective of Public-Private Partnerships Used Around the World

*Stephen C. Beatty*

Stephen Beatty discussed the use of public-private partnerships with transportation projects in Canada. He described the experience with different approaches on various projects. Beatty covered the following points in his presentation:

- Several factors should be considered with the use of public-private partnerships. First, it is important to remember that no two projects are alike. Elements that may influence the appropriate public-private partnership approach include (a) the type of project, especially congestion relief projects versus new capacity projects; (b) whether the project is in an urban or rural area; (c) the concession and cost recovery requirements; (d) the toll-setting requirements; and (e) provisions for modifications.

- The Confederation Bridge has been in operation for approximately a decade. A single-bid variable was used on the project, which was the minimum subsidy required. There was no opportunity for innovation, other than in design and construction to address ice and wind conditions related to the ocean environment.

- Highway 407 began as a concession project, but evolved into a design-build project. The provincial police required a safety review of the design, which added cost to the development of the facility. Toll-rate setting is based on congestion relief objectives. As long as the facility meets the congestion relief objectives, there are no constraints on tolling, but there are significant penalties if these objectives are not met. There were also initial requirements to measure congestion on other roadways. These requirements have been modified to monitor only the performance of Highway 407. The facility has been operated as a concession for approximately 7 years. Some sections have been expanded during this time, and some sections have been rehabilitated. There are also safety step-ins and performance specifications. The project does not include a noncompete provision.

- The Sea-to-Sky Highway was defined backward, with a predefined budget of \$600 million. The design-performance basis of competition for the project included safety, speed, and environmental impacts. The closure regime for construction was predefined. Safety bonuses, flow rate bonuses, and traffic volume bonuses were included. The handback provisions include a late-term review of the condition of the facility.

- The Golden Ears Bridge and Anthony Henday Drive project represents a more traditional European-style cost-recovery concession. It has been in operation for approximately 10 years. The innovation on this project focused on price. As the market has matured, the margins have become thinner.

- The Fredericton-Moncton Highway project provides an example of a public-private partnership project on a rural low-volume road. There were encounters with defects on a portion of the road, which caused problems between the contractor and the government. There was also an issue with the insurance market. At the time, liability insurance was not available for projects between \$50 million and \$500 million. As a result, the government stepped in as the insurer of last resort to share this risk.

- Noncompete clauses have received a great deal of attention on many projects. Although noncompete clauses are important to concessionaires early in the life of a project, they are less important over the long term. Noncompete clauses can be structured so that they fall away at some point. Innovative approaches to noncompete clauses can serve the needs of the private sector and protect the public interest.

- Effective concessions must have control points throughout all phases to control risks. Control points are needed in design and construction, operations, tolling, maintenance, expansion, rehabilitation, and handback. Most successful concessions tie all payments to measures linked to project objectives. Controls should be included in the concession contract. Using performance objectives rather than excessively specific design specifications unlocks the creativity of bidders and provides opportunities for new cost-effective solutions. Using independent engineers to conduct quality audits for concession contracts is a good approach for public agencies to consider.

Beatty concluded by remarking that most successful concessions tie all payments to measures tied to project objectives. All controls should be in the concession contract. Having performance objectives rather than excessively specific design specifications unlocks the creativity of bidders and the potential for cost-effective new types of solutions. He recommended using independent engineers to perform quality audits for concession contracts.

### Performance Measures and Public–Private Partnerships in Virginia

*Thomas Jeffrey Price*

Jeffrey Price discussed the use of public–private partnerships in Virginia. He described the legislation authorizing public–private partnerships, current and planned projects, and lessons learned to date. Price covered the following points in his presentation:

- The Virginia Department of Transportation (VDOT) is responsible for managing the third largest highway system in the country, with more than 70,000 mi of roadways. In 2004, a multimodal examination of capacity needs found a \$108 billion gap between available funding and needs over the next 20 years. Construction inflation has grown more than 40% since that time, increasing the funding gap. Since 2004, there has been legislative support for one-time additional funding for transportation, along with changes in project delivery through the Transportation Partnership Opportunity Fund and incentives for takeover of local roads by localities.
- In 1995, the legislature approved the Public–Private Transportation Act (PPTA). It allows unsolicited and solicited transportation projects to expedite projects or reduce project costs. Initial proposals under the PPTA focused on using traditional financing to deliver new construction, with limited private-sector financial risk. In 2005, revisions to the PPTA were approved to address the experience to date. Most agreements signed between 1995 and 2002 were sole-source contracts using public funds and debt financing, with no financial risk or investment by the private sector. Federal funding was not part of the package.
- The current PPTA law requires greater commitments or guarantees by proposers, including mandatory risk sharing. It increases flexibility in the development of interim agreements to accelerate required activities, and it promotes transparency and public involvement. Current policies focus on returning unsolicited proposals that do not include private risk, establishing controls related to possible lobbying and conflicts of interest, and requiring the ability to use federal funding. Proposals must clearly address the priorities of the commonwealth. Proposers with accepted projects become partners with the commonwealth.
- In 2008, regional transportation authorities were empowered to use the PPTA to deliver projects, assess taxes and fees, and establish toll facilities. Northern Virginia has the potential to generate \$400 million per year through this approach, whereas the Hampton Roads area could generate \$200 million annually. Tolling, particularly open road tolling and congestion pricing, are viewed as statewide solutions to addressing congestion issues.
- Initial steps in developing the concession approach included working with the legislators and industry to provide policy direction for use of any lease payments, which are to be used in the corridor for transportation purposes. There was also agreement to define transportation facilities under long-term leases as property indirectly owned by the commonwealth, which provides tax benefits to the concessionaire. Finally, legislation addresses toll violation and enforcement.
- To date, 53 unsolicited proposals have been received. A total of 11 agreements have been signed, worth \$8.7 billion. Solicited proposals were received for the reconstruction of I-81 and Route 460 from Hampton Roads to I-295 in Petersburg. Eight proposals, with a construction value of more than \$11 billion, are currently active. These projects are all potential new toll facilities.
- The Pocahontas Parkway was the first facility constructed under the PPTA. It was originally financed using tax-exempt bonds. The traffic and revenue projections did not materialize, however, and the bonds were downgraded. VDOT has had to provide loan financing. The PPTA agreement was amended and reassigned to a different concessionaire as a 99-year concession in 2006. As part of the reassignment, all outstanding debts and loans were paid off. The approach to risk focused on who was in the best position to manage it.
- The experience in Virginia highlights several lessons learned. First, public–private partnerships are not appropriate for every project. VDOT estimates that

20% of needed roadway capacity can be addressed through public–private partnerships. Second, the engineering aspects of a project represent the easier elements, with the financing and operations elements representing the critical components. Third, private partners need to have some risk in the operation of the completed project. Fourth, developing expertise in the use of public–private partnerships takes time. Transportation agencies need to have strong legal and financial advisors and excellent traffic modeling capabilities. It is also important to communicate and coordinate with federal partners. Finally, public–private partnerships require significant time commitments by both public and private partners, especially at the management level.

- The VMS, Inc., contract to maintain sections of I-95 and I-81 provides a different example. The contract requires VMS, Inc., to maintain pavements and bridges in current or better condition from the beginning of the contract using an agreed-on rating program. Measures for other assets addressed outcomes, targets, tolerance, and unit of measure. The asset condition is reviewed and rated annually and includes  $\frac{1}{10}$  of a mile sample segments.

- Several lessons learned from public–private partnerships providing maintenance and operations services can be identified. For example, it is not reasonable to expect a contractor to invest in maintenance of long-life assets on a short-life contract. Short-term public–private partnerships offer more efficient delivery of ordinary and reactive maintenance, such as filling potholes, replacing guardrails and signs, mowing, picking up litter, and landscaping. Operations concessions should be based on performance measures, especially when tolls are to be used.

- The future of public–private partnerships in the commonwealth includes using concessions for private operation of the public transportation infrastructure. It focuses on expanded capacity, rather than greenfield development. System operations are viewed as critical. There is general agreement in the commonwealth that traditional methods of funding cannot meet future transportation needs. Performance measures have not been adequately addressed or incorporated into previous public–private partnerships. It is anticipated that performance measures will be an integral part of future concessions.

### How Public–Private Partnerships Can Create Project Efficiencies

*Geoffrey Yarema*

Geoff Yarema discussed the benefits of public–private partnerships, including creating project efficiencies. He described the elements and benefits associated with different approaches. Yarema covered the following points in his presentation:

- Most public transportation projects are delivered under the traditional design, bid, build model. With this model, the public agency designs the project to the 100% level and achieves environmental clearance. The agency typically divides the project into biddable scopes and follows appropriate procurement methods. The agency provides design oversight and construction management to the awarded contractor. The agency pays invoices out of allocated state and federal funds, tax and other fee revenues, or bond proceeds. The agency performs operations and maintenance itself or through a separate contractor. With this application, the agency retains integration, construction, long-term performance, and revenue risks. With this approach, the private sector designs a project and performs construction under separate standardized contracts. Private firms have standardized rights to claims and change orders.

- The traditional design, bid, build model works well for most highway projects. Public–private partnerships can offer benefits not available through the traditional model, however. Examples of these benefits include accelerating a project by beginning construction activities before completion of final design, creating cost and schedule certainty by fixing costs and the completion date early in the design phase, and capturing private-sector innovation by using outcome-based performance specifications. The private sector can create innovative solutions to meet transportation agency performance benchmarks. By contrast, standard specifications stipulate certain means and methods, which often limit innovation.

- The public–private partnerships model shifts major risks from the public agency to the private party responsible for designing, constructing, financing, operating, and maintaining the project. Risks associated with integration, construction, revenue, and long-term performance may be shifted to the private sector. The streamlined process can lead to a more efficient and less contentious relationship, resulting in reduced change orders. The model also encourages life-cycle cost efficiencies and quality facility performance. Public–private partnerships can align the agency’s and private sector’s interests by tying the private sector’s compensation to the quality of construction, operations, and maintenance. The public–private partnerships model can close funding gaps by accessing the private equity market, delivering improved mobility sooner.

- In addition to asset creation and efficiency, public–private partnerships can offer increased up-front capital formation that municipal revenue bonds cannot. Tax-exempt financing has more conservative debt coverage ratios than private financing. Investor classes are different, offering different risk tolerance. Private investors are willing to take more risk of toll revenues underperform-

ing. With some pilot programs, private financing can access tax-exempt borrowing rates. Accelerated depreciation and the ability to deduct interest expenses create significant value for private equity that the public sector cannot realize.

- The use of toll concessions is suitable when a project is close to environmental clearance and is sufficiently designed to permit price and completion date guarantees. Typical goals of toll concession projects may include raising more capital from future project revenues, transferring the risk associated with revenue underperformance, and seeking longer-term certainty of asset maintenance.

- In the toll concessions model, the public agency achieves environmental clearance and oversees design, construction, operations, and maintenance. The agency also imposes performance requirements rather than regulation of means and methods. Agencies typically contribute little or no tax revenues to project costs. The agency is also liable for fewer claims and change orders than with conventional delivery methods. The public agency is responsible for deciding on the toll rate-setting mechanism over the contract life. The agency is relieved of all or most project revenue risk and receives revenue share as benchmarks are met.

- With this approach, the developer is responsible for completing the project. The concessionaire assumes integration and other development risks conventionally retained by public agencies. The developer guarantees the price and completion date, with limited rights to claims and change orders. The developer assumes lifecycle performance risks, collects tolls in accordance with the rate-setting mechanism, and pays excess toll revenues to the public owner. The developer transfers the project to the agency on the basis of a preagreed condition. The developer receives tax ownership and depreciation tax benefits.

- The toll concession competition structure may follow two approaches: an auction (in which the best price wins) or a best value approach (which considers price and other factors). The auction approach may consider the highest up-front and annual payment, the lowest public contribution, and the responsiveness to all non-price elements. The best value approach may consider other relevant factors, such as maintenance of traffic. Examples of the use of these approaches include Segments 5 and 6 of TX-130 in Texas, CA-91 and CA-125 in California, and the Dulles Greenway in Virginia.

- Different types of toll regimes are being used with recent projects. The Chicago Skyway and the Indiana Toll Road projects use a fixed toll schedule with maximum annual escalators. The concessionaire keeps all the toll revenues on these projects. There is no direct toll regulation on SR-125. Rather, the concessionaire's return on investment is regulated.

- Availability payment concessions are similar to toll concession, except the public owner retains project tolls and related risks and pays the private party on the basis of project availability and performance over an extended period. The private party assumes concession-type development and performance risks but not the collection of tolls. If the payment method includes some form of shadow tolling, the private party may assume a usage risk. The competition structure for availability of payment concessions may be either the auction or the best value approaches. Examples of the use of these approaches include the Port of Miami Tunnel, the Sea-to-Sky Highway in British Columbia, and the Bay Area Rapid Transit Oakland Airport Connector.

- Several factors may influence the value of private financing versus municipal financing. These factors include the type of public debt used, whether the private debt includes Private Activity Bonds, the ability to depreciate assets, the value of deducting interest expenses, and whether there is high or low forecast revenue. There is a need to account for real costs of public funds dedicated to a project. Private financing can maximize capital through the use of private risk capital. The private equity layer also leverages cash flows. The benefits of maximizing capital include more projects leading to more mobility, freeing of scarce federal and state grant funds, and more concession payments to the public owner.

## Research Needs

The following research needs were identified by participants in this session:

- Conduct a research study examining opportunities and issues associated with the use of public-private partnerships in the United States and develop strategies to maximize the benefits of this approach to both the public and private sectors. The following topics will be examined in the study:

- Strategies to align contractor performance measures with agency objectives;
- Strategies to create incentives for contractors to improve performance within current market conditions and future market conditions;
- Techniques for providing contracting procedures to allow for greater innovations;
- Strategies to allow for private equity and to stimulate greater competition related to standard specifications;
- Strategies to provide incentives to contractors to maintain a roadway or other transportation facility in good condition so that it is in good condition when it is turned back to the public sector;

- Strategies to provide flexibility in long-term contracts to react to future conditions and needs;
  - Strategies to provide incentives for contractors;
  - Strategies to assist transportation agencies in defining goals and objectives of using public–private partnerships; and
  - Techniques to develop leadership in the use of public–private partnerships among state departments of transportation and other agencies.
- Complete a synthesis on the use of public–private partnerships by state departments of transportation and other transportation agencies. A major focus of the synthesis will be on establishing performance measures for public–private partnerships. The synthesis will provide best-practice case studies and will highlight tips for the successful use of public–private partnerships. Examples from Canada, Mexico, and Europe will be included.
    - Conduct a study to explore how state departments of transportation and other agencies can become more innovative in planning, designing, financing, constructing, operating, and maintaining transportation facilities. The study will explore changes in legislation and policies that may be needed for public agencies to adopt and implement innovative strategies themselves, as an alternative to public–private partnerships.
    - Conduct a technology transfer project on the basis of the use of an internet system in the United Kingdom for comparing contractor performance. The U.K. system lists the performance of each contractor by a variety of measures. It provides additional motivation for contractors to meet and exceed performance targets. A pilot test could be conducted in the United States as part of a technology transfer effort.

*Paresh Tailor, Highways Agency, United Kingdom, and Anthony Kane, American Association of State Highway and Transportation Officials, moderated this breakout session, and Francine Shaw-Whitson, Federal Highway Administration, and Joe Crossett, Transtech Management, served as rapporteurs.*

## CONSTRUCTION PROJECT DELIVERY IN TODAY'S ENVIRONMENT: AN INTERNATIONAL PERSPECTIVE ON PERFORMANCE ASSESSMENT AND REPORTING APPROACHES

### Public–Private Partnerships in Alberta: Construction Assessment and Reporting

*Carl Clayton*

Carl Clayton discussed the use of public–private partnerships in Alberta, Canada. He described the perfor-

mance measures associated with projects, including those related to construction and project delivery. Clayton covered the following topics in his presentation:

- Alberta is approximately the same size as Texas, but it has a population of only 3.3 million people. Edmonton and Calgary are the two largest cities in the province, accounting for some 2 million of the population. The major industries in Alberta include agriculture, oil and gas, and tourism.
  - In the mid 1990s, Alberta experienced a financial crisis and the department of transportation reduced staff from approximately 3,600 employees to 600 employees. As a result, the department uses contractors and contract services extensively. The use of public–private partnerships in Alberta is not the result of funding limitations. The province has had budget surpluses for several years. Transportation does compete for funding with other public services, including education and health, however.
    - The use of public–private partnerships comes from a belief among policy makers that design–build saves money and delivers projects faster but creates long-term maintenance risks. The use of public–private partnerships realizes the benefits of design–build and has the additional advantages of ongoing maintenance responsibility by the private sector and third-party financial oversight.
      - Public–private partnerships are currently being used on sections of highways in Edmonton and Calgary. Some of these public–private partnership projects are nearly complete, whereas others are just beginning. Projects in Edmonton include southeast and northwest Anthony Henday Drive. The southeast section will open in October 2007, 1 month ahead of schedule. The northwest section is in the prequalification stage. The project in Calgary is northeast Stony Trail. This project is in the construction phase.
        - The department reports on performance measures on a regular basis. Performance requirements are currently built into 3-year rolling plans and reported on annually. The major categories of performance reporting are congestion, facility condition, and safety. Congestion is measured by the level of service. Condition is measured through the asset management system comparisons for pavements and bridges. The asset management system is one of the more sophisticated ones in North America. Safety is measured by collision statistics. Similar to other areas, a challenge has been to identify acceptable levels of performance for the various measures.
          - A fixed-price contract is currently used on most construction projects, with most of the construction cost being paid when the road opens. Fixed-price annual payments are made for the 30-year maintenance period. The need for future road upgrades because of higher traffic volume is the department's risk.

- Performance benchmarks are needed for construction. End-product specifications have been used since the late 1980s. Most end-product specifications have graduated penalties for nonconformance. The challenge for public–private partnerships is identifying appropriate criteria, especially for opening day. Many projects use a pass–fail benchmark for opening day, rather than graduated payment.

- The technical specifications address design, construction, maintenance, and internal requirements. The three major categories are acceptable design codes, methodologies, and guidelines. These include the bridge code, the department’s lighting guide, and other related guides. There is a design review process, which provides 10 working days for the department to review and comment on the design. The minimum material characteristics are defined and cross-referenced to AASHTO or Canadian Standards Association guidelines.

- The opening day infrastructure characteristics and measurement protocols are identified for geometrics, smoothness, rutting, skid resistance, and bridge components. Payment is based on meeting these measures.

- Performance benchmarks are also needed for maintenance over the 30-year time period and turning the road over to the public sector at the end of the 30 years. Alberta has experience in this area from the privatization of routine maintenance in 1990s. Pavement and bridge management systems have also been in use for a long time. The challenge for public–private partnerships is to determine the acceptable criteria for the condition of the infrastructure at the end of the 30-year period. Acceptable levels and response times were identified, as were measurement protocols. Annual payments may be reduced for noncompliance. Typical construction criteria are included, as well as routine maintenance, such as grass cutting, snow removal, lighting, and markings and signing. Special items, such as road noise mitigation, are also included.

- Contracts include mandated ongoing inspection and reporting requirements, which are consistent with current practices. Protocols are defined for various items. The department has the right to inspect projects at will and repair roads if a public danger exists.

- There are two approaches to reporting performance. One is to the public and one is internal. Reporting to the public focuses on completing roadway projects on time and on budget. Internally, reporting focuses on the design review process, fixed benchmarks, no sliding approval scales, and ongoing schedule monitoring and reporting.

- There are still approaches to enhance the public–private partnership process. Elements to consider from a scheduling perspective include streamlining the approval process and adding an independent design check. From a construction perspective, elements to consider include

more use of life-cycle costing. Operations and maintenance input appears to be valued, and the overall quality appears to be good. It is too early to tell whether any changes will be needed in the maintenance area of the public–private partnership process. To date, the public–private partnership process appears to be working well in Alberta. It does require a change of mindset, however, and it is important not to be too prescriptive or to promise more than you can deliver.

## Project Delivery at Caltrans

### *Karla Sutliff*

Karla Sutliff discussed performance measures related to project delivery at Caltrans. She described the contracts for delivery initiative, the quarterly reports to the California Transportation Commission (CTC), and the Industry Capacity Expansion initiative. Sutliff covered the following points in her presentation:

- The contracts for delivery initiative are a very simple concept, but they have been very effective. The contract for delivery was developed by Will Kempton when he became Caltrans director 3 years ago as a way to provide a simple approach to measuring the department’s delivery of projects. The Caltrans development plan, which contains some 2,000 to 3,000 projects, did not provide the focus the director wanted. As a result, the director initiated the contract for delivery process.

- The directors of each of Caltrans’ 12 districts signed an annual contract with the director. The primary goal of the contracts was to identify and deliver projects on time by quarters. The milestone used is the “ready to list date,” which is the date when the plans, specification, and estimates are completed. That means the project is ready to let, but funding may not be available. This target was established when Caltrans did not have adequate funding. It showed that the department was still meeting its targets. The contracts for delivery have been successful in improving project delivery. Stars are awarded when staff members meet targets a day early. People work very hard to get the stars, so the program has been successful at motivating employees. A new column has been added to monitor the actual contract award date, which is also of interest to the director and the CTC.

- The contracts for delivery have been successful in meeting performance measure targets. In FYs 2005 and 2006, Caltrans delivered 173 of 174 projects. The one project that was not delivered was a major seismic retrofit project, which was held up in the permitting process. Even though staff made a significant effort, the schedule was not met. This past fiscal year, Caltrans delivered all 286 projects.

- For the past 15 years, Caltrans has provided quarterly reports to the CTC. The scope and format of these reports have changed over the years. The report contains a number of sections. The key information from the contracts for delivery is included in the quarterly reports.

- Within any given year, additional projects are amended into the Caltrans development plan. These projects often focus on safety and emergency projects, which tend to be smaller funding levels. Information on these projects is included in the CTC reports. Information on tracking the status of awards has been added to the CTC report. Milestones on environmental documents, right-of-way acquisition, and construction are reported. The interest of the director in meeting milestones has had a significant impact on the department's improvement in meeting the various milestones.

- When Caltrans had little funding for new projects, many contractors switched to other types of construction activities. When funding began to increase, Caltrans found that fewer construction firms were bidding on projects. Caltrans currently has a construction budget of approximately \$10 billion. Additional funding will be available as the Proposition 1B projects are implemented.

- Experience at Caltrans indicates that the number of bidders on a contract and the cost of the bids are related. When only one bid is received, it tends to be above the estimated cost. When multiple bids are received, the low bid tends to be below the estimated cost. Thus, Caltrans has a direct interest in ensuring an available and a competitive construction industry. Caltrans monitors the number of bidders on a project, the cost of the bids, and cost range of the bids.

- The CoCalifornia Industry Capacity Expansion (ICE) action plan, which is part of the Governor's Strategic Growth Plan, focuses on a recommitment to partnering with the construction industry. Caltrans developed a plan to provide an ongoing dialog with construction industry partners. Two workshops were held with industry representatives to develop an action plan. Industry representatives identified actions Caltrans could initiate to enhance the contracting and project delivery process. The action plan focuses on the areas of equipment and materials availability, contractors' and subcontractors' capacity, technology, recruitment and training, regula-

tory environment, contract administration, bonding and insurance, funding, project quality, and communication and outreach.

- The action plan is updated on a quarterly basis. Additional workshops have been held, and other activities have been initiated. Two strategies that have received major emphasis focus on increasing the available labor pool and increasing the availability of construction materials. Caltrans has placed a major emphasis on workforce development. Elements of this effort include recruitment, training, coordinating with other agencies, and reaching out to educational institutions.

### Research Needs

The following research needs were identified by participants in this session:

- Develop a synthesis on the use of performance measures with construction project delivery. The synthesis will address the current use of performance measures with different construction contracting methods and the benchmarks used by various agencies. It will include best practice case studies.

- Conduct a research study that builds on the synthesis and explores potential performance measures associated with innovative construction contracting techniques. The research will examine alternative techniques to measure construction contracting with the use of public-private partnerships and other innovative procurement techniques. The performance measures used with related activities, such as the Caltrans ICE initiative, will also be examined. New performance measures will be identified and evaluated. The techniques to communicate these performance measures to policy makers, contractors, the public, and other groups will also be explored.

*Daniela Bremmer, Washington State Department of Transportation, moderated this breakout session, and Kingston Chirwa, University of Southern California, served as rapporteur.*

## RESOURCE PAPERS

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## RESOURCE PAPER

# Multimodal Trade-Off Analysis for Planning and Programming

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Kimberly Spence, *Commonwealth of Virginia*  
 Mary Lynn Tischer, *Commonwealth of Virginia*

This paper reviews existing methodologies and the state of the practice in multimodal trade-off analysis. Barriers to multimodal trade-off analysis are discussed, the types of methodologies that could be used to make trade-offs are reviewed, the means by which states and regional planning bodies are applying performance measures within the transportation planning process are presented, and finally, the activities performed in Virginia to quantify and compare projects that span transportation modes are discussed.

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Most states and regional planning bodies have transportation performance measures. Many use them to inform planning, and some use them to allocate resources and prioritize projects. However, the amount of money spent on each mode is often determined by law or formula, and individual program categories within modal programs can be predetermined as well. As a result, project prioritization occurs within the program category rather than across categories or modes. For example, transit projects are usually prioritized relative to other transit projects and highway projects are prioritized relative to other highway projects, but the prioritization of a transit project relative to a highway project is not typically considered at the planning stage. Although it is widely recognized that a true picture of system performance and the effective use of limited monies can be obtained only by considering all modal facilities and services on a comparable basis, examples of cross-modal prioritization of potential projects are few.

Virginia began the development of the state's long-range multimodal transportation plan, known as VTrans2025, in 2001. At the direction of the state secretary of transportation, efforts were made to make the plan truly multimodal and not merely a compilation of individual modal plans. A concept for the methodology was developed to translate the policy objectives in the plan into a system for determining multimodal priorities. The concept was well received as progress toward planning and prioritizing multimodal projects at the state level and was viewed as a potential approach to allocating scarce funding for transportation in the future. Planners from Virginia's five modal transportation agencies are continuing to refine the methodology to include consideration of emerging policy issues, such as freight mobility, land use, economic vitality, and quality of life, and will apply the methodology to identify multimodal project priorities as the VTrans2025 plan is updated.

## BARRIERS TO MULTIMODAL TRADE-OFF ANALYSIS

Transportation planning is carried out at state, regional, and local levels, with each level addressing the different functionalities of the constituent systems and subsystems. At all levels, deficiencies are identified and various solutions that can be used to address them are evaluated. This process of evaluating potential solutions presents an opportunity to explore the trade-offs of investing in one mode or program over another. As Lambert noted

(Jim Lambert, personal communication), in multiobjective optimization, a trade-off refers to a gain in one category of performance at the expense of a loss in another area. However, the investment decision can involve a comparison of desirable solutions. Ideally, this multimodal analysis will involve the prioritization of candidate investments across multiple modes and determination of the better overall investment. In practice, such an analysis is difficult. This becomes even more difficult when the investments are not mutually exclusive and involve a combination of modes (multiobjective combinatorial optimization).

Participants in FHWA's Multimodal Trade-Offs Workshop in October 2005 noted several barriers to multimodal trade-off analysis, including the following:

- Limited flexibility in federal and state funding programs,
- Organization around individual modes,
- Lack of mode-neutral performance measures that facilitate comparisons across modes,
- A lack of data and analytical tools, and
- Politics.

A lack of flexibility in funding programs is often cited as a barrier to investing in multimodal projects. Most federal transportation funding levels are determined by formulas, and state transportation programs tend to follow federal structures. Too, there is often a need to distribute funds among regions and between urban and rural areas in a state, which can result in additional constraints on funding. Public policy results in the development of program categories, and the legislators who create the programs generally attempt to ensure that the funds are spent to achieve particular goals. Congress wants the states to use bridge funds to fix bridges, Congestion Mitigation and Air Quality Program (CMAQ) funds to clean the air, and so on. Although there is flexibility to shift some funds from one mode to another or among program categories, the lack of adequate funding overall is generally used as a reason to limit the flexible shifting of monies among the modes and programs. When funding categories are fixed, there is little reason to prioritize projects across modes or program categories.

The organization of state transportation planning functions often mirrors that at the federal level. Transportation planning is typically compartmentalized by mode. Young et al. (2002) suggest that "each modal division tends to define benefits in a way that focuses on that mode's particular strengths." The planning and implementation of multimodal projects are made more difficult by the complex and cumbersome process of coordinating the efforts of multiple departments and agencies. As a result, multimodal plans tend to be an aggregation of individual modal plans and not plans that

result from an integrated analysis of a multimodal transportation system.

One key issue is that performance data are more readily available for some modes than for others. Similarly, data are available at various levels of geographic scale, and it is difficult to obtain consistency statewide. Most states do not collect data at the levels of detail and geographic scale necessary to facilitate comparable evaluations of multiple modes at the long-range planning level. The tools used to evaluate the impacts of transportation at the statewide level tend to be highway oriented and lack sufficient detail for the simultaneous evaluation of improvements to the transit or pedestrian mode.

More and more often, decision makers at all levels identify specific projects for funding without the benefit of an analysis of the trade-offs associated with alternative improvements. This may be an attempt to be more responsive to constituents and streamline what can be a lengthy process. It may also reflect a desire to ensure that each mode and geographic region receives some share of the available funding. A total reliance on performance-based planning and programming processes can reduce this flexibility and can be perceived unfavorably by decision makers. However, such processes can also provide a technical basis from which to defend decisions regarding the allocation of scarce resources.

## STATE OF THE ART

Ideally, one would want to compare modes early in the planning process. That can be accomplished by the use of mode-neutral performance measures; a methodology such as benefit-cost analysis that reduces noncomparable impacts to a single ratio; or other approaches, such as goal achievement, which uses comparable metrics even if the measures are not the same. Each approach has a number of variations.

## Mode-Neutral Approaches

Mode-neutral approaches facilitate the comparison of competing modes and permit an unbiased assessment of modal alternatives. An example of a mode-neutral measure is person miles of travel, which addresses travel without regard to vehicle type, in contrast to the more often used vehicle miles of travel, which reflects motor vehicle usage. However, it is not always easy to find measures that are not dependent on a particular mode or program category, and not everything can be measured in the same way. For example, accessibility to the automobile may be appropriately captured by automobile ownership, whereas access to transit might be determined by the distance to a transit stop. Additionally,

there is often a different geographic scale to the modal analysis. The ability to take transit decreases as one goes from the local to the regional to the state levels. Thus, the use of mode-specific measures may limit the objectives that are addressed.

Cambridge Systematics proposed a conceptual framework for assessing multimodal trade-offs in statewide transportation planning [NCHRP Project 8-36, Task 7 (Cambridge Systematics, Inc., 2001)]. It suggests that there are two dimensions in which trade-offs can be assessed: the vertical dimension, in which trade-offs are evaluated within a single program or mode, and a horizontal dimension, in which trade-offs are evaluated across multiple programs or modes. Program- or mode-specific objectives and criteria would be identified to facilitate the evaluation of trade-offs within the vertical dimension (e.g., the prioritization of maintenance projects). Goals and objectives provide the mechanism by which trade-offs may be assessed in the horizontal dimension (e.g., choosing between a transit project and a highway improvement). This two-dimensional framework recognizes that the same performance objectives generally cannot be applied to every mode or program.

A similar two-dimensional framework for coordinated multimodal and modal prioritization was described by Lambert et al. (2007) and the Virginia DOT (2004). In the latter case, each modal agency advances its project into multimodal consideration in which (a) one mode is dependent on another to be successful, like a bus needs a road; (b) the project would substitute for another mode, for example, a rail line versus a road; (c) the project connects two or more modes, like a road connects to an airport; or (d) the project is multimodal by definition, like high-occupancy vehicle (HOV) lanes. Once the multimodal decision is made and the appropriate project is determined, it is fed back into each of the modal plans. In this framework, the existing modal plans would not be replaced. However, a separate evaluation process would take place for multimodal priorities.

### Benefit–Cost Analyses

One tool often used to compare alternative solutions is benefit–cost analysis, which generates a single ratio of monetized discounted benefits to monetized discounted costs for each project. The ratio of benefits to costs determines the relative value of the project. The analysis involves the addition of all the discounted costs of a project or program, the addition of all the benefits, and then comparison of the costs and benefits to choose the project with the best ratio. The concept is simple and has the advantage of leveling the playing field by converting disparate impacts to a common monetized or efficiency

metric. However, in practice, making this conversion is not always straightforward. It can be data intensive if a large number of factors are considered and requires consensus on which factors are to be considered and their monetary values. Quantification of these factors often requires nonrepeatable value judgments, and there can be significant variability in the estimates of factors, such as environmental and quality-of-life considerations. In addition, as Hill (1973) notes, “When costs and benefits are not available in market prices, the cost–benefit model imputes them as if they were subject to market transactions.” In other words, the attribution of some benefits may be arbitrary.

Lambert and Joshi (2006) suggest the use of net benefits, or the difference between benefits and costs, in addition to the benefit–cost ratio. They note that “a high-cost project with a relatively lower benefit-to-cost ratio might be preferred to a low-cost project with a relatively higher benefit-to-cost ratio and that an opportunity to invest more in order to achieve more benefits can be masked by presentation of the benefit-to-cost ratio alone.”

Several notable examples of statewide benefit–cost models exist. Virginia’s Rail Enhancement Fund benefit–cost model is a project-level analysis tool. It is used to evaluate rail projects and can be used to compare passenger rail and freight rail proposals. The U.S. Department of Transportation’s (USDOT’s) Highway Economic Requirement System (HERS) and Highway Economic Requirement System–State Version (HERS-ST) models provide national and statewide analysis capabilities. The application of the HERS model at the level necessary to estimate multimodal trade-offs would require a significant data collection effort, however, since it currently addresses only highways. USDOT has also developed a benefit–cost approach to the evaluation of bridge improvements (the National Bridge Investment Analysis System and the National Bridge Inventory) and transit improvements (the Transit Economic Requirements Model and National Transit Database), but the approaches can be used to evaluate only the projects within their respective programs. To make the transit analysis comparable to the highway analysis in the HERS model, the user would need to have or would need to collect similarly detailed transit data.

### Cost-Effectiveness Models

Cost-effectiveness models seek to measure how closely a given project corresponds to a predefined goal, such as performance, in relation to its cost. Objectives or outcomes are identified, and the costs required to achieve each are compared. Like many multimodal trade-off analysis tools, cost-effectiveness models provide decision makers with useful information about the relative prefer-

ability of one solution over another rather than identifying the single best solution. Like benefit–cost analysis, the complex impacts of transportation improvements are reduced to monetary values; however, rather than addressing benefits, cost-effectiveness analysis compares the degree to which goals and objectives are met relative to the cost required to do so. FTA evaluates new transit proposals using a cost-effectiveness index of cost per new transit rider. The Hampton Roads Planning District Commission in Virginia evaluates CMAQ projects across modes on the basis of the cost per ton of emissions reduced. This approach works best when fewer objectives are associated with the decision.

### Least-Cost Planning Approaches

Least-cost planning is an approach that identifies the lowest-cost project that meets the performance goal. The definitions and approaches vary. Mozer (1993) suggests that the goal is “to minimize the total societal cost of meeting service needs.” Mozer defines societal costs to include “all of the costs associated with constructing and operating a resource over its entire life, including environment costs such as the health effects of air, noise and water pollution, any waste disposal and demolition cost.” Conceptually, more strategies can be considered and transportation demand management or transit projects can be placed on the same footing as a major highway construction project (Victoria Transportation Policy Institute, 2007). Washington State has legislation requiring least-cost planning, and it has been implemented in regional plans. The Puget Sound Regional Council has implemented various approaches built around benefit–cost analysis of system alternatives. It has developed a series of performance measures that it uses to prioritize highway, HOV, and transit (including ferry) projects as part of its Congestion Management Plan.

### Multicriteria and Goals Achievement Analyses

Ideally, the analytical tool or process used should permit the analysis of all modes simultaneously to evaluate the trade-offs between solutions for multiple modes adequately (Fontaine and Miller, 2002). In practice, conventional benefit–cost analysis focuses on the evaluation of a single investment scenario at a time. In contrast, a multicriteria analysis evaluates several alternatives over a common set of evaluation objectives and comparatively ranks the alternatives [NCHRP Project 20-92(2)]. The framework begins with objectives and the corresponding indicators that can be weighted to arrive at a project score and overall ranking (Bristow and Nellthorp,

2000). This type of analysis, also called goals achievement (Hill, 1973), permits the linkage of indicators or metrics to a set of goals or objectives that define a desired outcome. Objectives are associated with metrics that measure the degree to which a given improvement meets broader goals.

Transportation Decision Analysis software (TransDec) is a tool that can be used to quantify the degree to which a project meets performance objectives. The use of TransDec involves the identification of transportation policy goals, objectives, and performance measures; the assignment of a 10-point scale to each objective’s measure; the identification of investment alternatives; the attachment of a weight to each of the objectives; normalization of the data; and the identification of project rankings. Various methods can be used to determine the weighting scheme, including the use of expert panels or surveys (Virginia DOT, 2004).

The Multimodal Investment Choice Analysis (MICA) model, which was developed for the Washington State DOT was a hybrid of the benefit–cost and the multicriteria analysis methodologies. The model measures the performance of projects relative to particular metrics and ranks projects on the basis of the weights assigned to the metrics to determine the optimal set of projects for a given funding level and policy scenario. As Young et al. (2002) have noted, “By using the outcome objective score, the user can prioritize spending on projects that may not be the most cost-effective in terms of traditional benefit–cost values but that may address a particular [state] concern.” Attempts to use the MICA model for transportation prioritization in Washington State have not been successful to date.

### Regional and Project-Level Evaluations

Numerous analysis tools are available for the project-level evaluation of multimodal alternatives. USDOT developed a corridor analysis tool called the Sketch Planning Analysis Spreadsheet Model (SPASM) to help evaluate demand management strategies and multimodal improvements. As a sketch planning tool, SPASM is not well suited for the detailed analysis of multimodal alternatives or for systemwide use. A more robust version of SPASM called the Surface Transportation Efficiency Analysis Model (STEAM) was developed to facilitate systemwide analysis and the detailed evaluation of alternatives. STEAM is typically used with the results of a regional travel demand model to convert benefits and impacts to dollar values to facilitate comparison (DeCorla-Souza and Hunt, 1998). Microsimulation tools such as VISSIM can be used to model project-level impacts, and although the model permits the evaluation

of motorized and nonmotorized traffic, most examples are highway oriented. The Real Accessibility Index is another tool used to measure multimodal accessibility at the community level, but it requires the collection of significant amounts of data. The Highway Economic Analysis Tool (HEAT), an analysis package developed by Cambridge Systematics, has also been used to evaluate the potential economic benefits and costs of highway improvements in an objective, consistent, efficient, and accurate way.

## STATE OF THE PRACTICE

Two major products of the transportation planning process are the long-range plan (LRP) and the transportation improvement program (TIP). Most states and regional planning bodies engage in some level of performance-based planning through the development of a vision, goals, and objectives in the long-range plan; and many identify and use performance measures to examine the transportation system and identify areas of deficiency. Few use performance measures to prioritize projects for the program, and those that do generally use them within modal and program categories.

### Long-Range Planning

Bremmer et al. (2004) have described a generational model of performance management that reflects three levels of increasing maturity and sophistication in the states' application of performance measures. In each state, the process is evolutionary, and as the planners and decision makers become more experienced with the concepts, they expand to the use of new, nontraditional measures and more integrated planning and programming practices.

States that prepare LRPs based on performance measures include the following:

- Florida identifies multimodal goals and objectives in the Statewide Transportation Plan (STP), but the allocation of resources among the various program categories is determined primarily by formula. To choose projects for programming, it uses a decision-support tool that uses the goals and measures but not in a quantifiable way. Additionally, Florida has been a leader in developing and applying for each mode level-of-service (LOS) methodologies that could be used as a way to compare modes. However, a LOS of C, for example, does not mean the same thing across modes and considers only one factor. Winters et al. (2001) suggest the use of a method, referred to as the slide rule, that makes the
- LOS ratings more comparable. They also suggest weighting of the LOS by volume, cost, corridor, or location.
- The Intermodal Transportation Plan in Idaho identifies performance measures and reports progress toward the achievement of modal plans.
  - New Mexico's *Good to Great* document outlines goals, targets, and performance measures.
  - Tennessee uses report cards of measures and targets from Plan GO of the Tennessee DOT.
  - Alaska, Arizona, California, Georgia, Idaho, Kentucky, Louisiana, Maine, Maryland, Michigan, Minnesota, Missouri, Montana, Nebraska, North Carolina, North Dakota, Ohio, Oregon, Pennsylvania, Texas, Utah, Virginia, and Washington, among others, develop performance measures as part of their long-range planning processes.
- Several states and regions use long-range goals and measures to monitor the condition of the transportation system on a periodic basis. Most performance reports include information about all modes. Examples include but are not limited to the following:
- Alaska, California, and Florida provide performance review reports.
  - Maryland publishes the *Attainment Report on Transportation System Performance*.
  - Maine reports on the state of the system using performance measures for each mode.
  - In Washington State, the STP outlines transportation goals and objectives for the entire state and provides policy guidance for transportation investments in the areas of preservation, safety, economic vitality, mobility, environmental quality, and health. Washington State's *Measures, Markers, and Mileposts* (also called the Gray Notebook) contains data on a large number of performance measures and is a notable example of statewide performance measurement).
  - Virginia published *Virginia's Transportation Performance Report—2006* and updates the report annually.
  - The Wilmington, Delaware, Area Planning Council produces a regional progress report to summarize efforts undertaken to fulfill the goals set out in the Regional Transportation Plan (RTP). Performance indicators are identified for each goal and objective to determine which aspects of the plan are moving in the right direction, as well as those that need attention.
  - The Metropolitan Washington, D.C., Council of Governments publishes a report on the results of a regional state-of-the-commute survey. The survey documents trends in commuting behavior, such as commute mode shares and distance traveled, and prevalent attitudes about specific transportation services that are

available to commuters in the region. The survey also helps examine how other commute alternative programs and marketing efforts are influencing commuting behavior in the region.

- The Metropolitan Transportation Commission in the San Francisco, California, Bay Area reports on the state of the system annually. The report summarizes the performance of the Bay Area transportation system for freeways, local roadways, transit, goods movement, and bicycle and pedestrian travel.

- The Southern California Association of Governments (SCAG) uses its *State of the Region* report to track on an annual basis the region's progress in achieving the goals in SCAG's *Regional Comprehensive Plan and Guide*. It uses a set of performance indicators to compare the region's recent performance with its own previous record and that of the other large U.S. metropolitan regions.

- The North Central Texas Council of Governments publishes a report called *Transportation: State of the Region* to provide a summary of the transportation system's performance in the Dallas–Fort Worth area.

Several states provide the performance measures and describe the system on the Internet. Virginia and Minnesota have dashboards, Missouri reports on the performance of the Missouri DOT and 18 desired outcomes on its Tracker system, and Nebraska uses its performance measures to monitor the system and reports online.

### Project Lists

Most state LRP's are vision plans; few include specific projects. However, Arizona's MOVEAZ plan provides a list of projects selected through the use of performance measures. Bundles of smaller projects were evaluated as well, and although alternatives to highways were discussed in the plan, modal assessment was done separately. Utah also provides a list of capacity projects outside the urbanized areas in its 2007 to 2030 Long-Range Transportation Plan.

Regional planning bodies prioritize projects in various ways. The Hampton Roads, Virginia, Planning District Commission uses performance measures to analyze projects within categories for Regional Surface Transportation Program funding. The categories include bicycle and pedestrian, transit and transportation demand management, signal system integration or retiming, and other [intelligent transportation systems (ITSs), signage, park-and-ride lots]. The Capital District Transportation Committee (CDTC) in Albany, New York, does much the same by evaluating projects in 17 categories (e.g., highway operations, ITS capital investment, stand-alone goods movement actions,

intermodal facility capital investment, and transit). However, CDTC states that the

New Visions plan established new CDTC policy regarding planning and investment: transportation investment is based on function and need, not upon facility ownership. This results in an agreement to put all funds [National Highway System (NHS), CMAQ, STP] “on the table”; the best projects are selected according to CDTC investment strategy, and then money is assigned. This is noticeably different from how most MPOs (metropolitan planning organizations) approach the TIP or LRP: normally, federal funds type determines project selection [e.g., NYSDOT (New York State Department of Transportation) owned facilities compete against themselves for NHS funding, and the locally owned facilities compete against each other for STP funding].

The Atlanta, Georgia, Regional Commission bases project selection on criteria that include cost-effectiveness (reductions in the cost of delay and wasted fuel), safety, congestion (intensity, duration, and extent), support for the regional plan, regional equity, and project status. Other factors used to rank projects include environmental, demographic, historic, and land use impacts.

### Use of Trade-off Methods in Programming

Many states, for example, Arizona, Arkansas, California, Iowa, Indiana, Louisiana, New Mexico, North Dakota, and Oregon, among others, use the HERS-ST model to identify highway projects. Utah develops cost–benefit ratios using its asset management model. Additionally, the model develops treatment plans and recommended budget splits for the asset groups. These budgets are then applied within each asset management system and a 10-year list of projects is generated. The projects are then harmonized to ensure that, for example, a road improvement and a bridge project are treated holistically if they are on the same segment. Georgia uses HEAT to determine the costs and benefits of highway projects and to test scenarios. It also identifies build–no build scenarios in which the build alternative is defined as full funding for each mode.

Most states assume a funding level for each program and mode and then prioritize within those levels. Although few states use performance measures or the benefit–cost methodology to program projects, Montana used a trade-off analysis within categories (i.e., district, system, and type of work). For a project to get funded, it must contribute to the performance goals of the overall transportation system. In Montana's Performance Pro-

gramming Process (called P<sup>3</sup>), individual projects are nominated for funding by the districts and must support the overall vision and performance goals established in the STP. Funding levels are tied to performance.

### Multimodal Analyses

The status and sophistication of multimodal planning among the states have been the subjects of a number of recent surveys (Transmanagement, Inc., 1998; Peyrebrune, 1999; Fontaine and Miller, 2002; AASHTO, 2006; AASHTO, 2007; Roerden, 2007; Lambert et al., 2006). All show that planning methods that attempt to identify trade-offs between the modes are not well developed.

The planning process in Minnesota focuses on trade-offs within program categories by using metrics such as bridge sufficiency ratings and pavement serviceability ratings. A statewide vision is determined in the Statewide Strategic Plan as well as by the use of performance measures and targets for its implementation. Most goals and measures reflect the characteristics of highways, although one of the 10 goals is to provide cost-effective transportation options for people and freight. In the programming process, each district identifies investment priorities on the basis of the performance measures and targets in the plan.

Oregon uses its STP to provide the framework for prioritizing investments across all modes. Management systems developed for pavement, bridges, congestion, public transportation, safety, and other elements assist with the establishment of investment decisions at the modal level. A prioritization system based on benefit–cost assessment was developed as part of the state’s Intermodal Management System. The system permits the analysis of trade-offs in terms of dollar value and system performance between 10 intermodal facility types (i.e., bus station, rail station, air passenger terminal, marine terminal, rail truck facility, grain reload facility, petroleum terminal, truck terminal, air cargo facility, and connector and mainline roadways) (Merkhofer et al. 1997).

Washington State compares costs and benefits within each funding program and project type, as noted above. However, the mobility program includes bicycle and HOV improvements.

Several approaches to implementing multicriteria and goal-achievement analysis for project selection are used, including the following:

- Delaware identified 10 factors related to three long-range goals. Roadway projects are scored by using a scale of +5, +3, 0, –3, and –5 and are ranked within pools of similar projects. Transit, bicycle, and pedestrian

projects are scored separately. The projects are compared to determine which ones best meet the goals.

- Ohio essentially evaluates highway projects but gives additional points if a project expands connections to water ports, airports, rail, transit, or train facilities; increases unique multimodal aspects; supports reinvestment in an urban core; or helps a city retain existing jobs (i.e., urban revitalization). The capital costs of ITS projects are also evaluated. The total number of points that a project can obtain is 130, of which up to 30 are bonus points.

- In New Jersey, projects are evaluated for inclusion in the state’s Capital Investment Strategy (CIS) on the basis of the degree to which the project satisfies the long-range goals of the strategy. The CIS uses specific performance measures to calculate the achievements of the capital program achievement against annual target allocations for each investment objective. Performance measurement and management system data (for bridges, pavement, safety, congestion, etc.) are used to link the projects selected for capital funding and broad program objectives. Performance analyses are developed to evaluate how well the present and the proposed capital programs meet the objectives. Nine program categories are used to evaluate the projects.

- The North Jersey Transportation Planning Authority provides a ranked listing of projects for inclusion in the transportation improvement program using the six goals of the RTP. Numerical scores are assigned on the basis of the degree to which the project satisfies the goals. The maximum total scores that projects can receive are 850 points for transit projects and 825 for all other projects.

- Michigan identified needs by categories (which included multimodal project preservation and multimodal project expansion), identified unmet needs, and evaluated four funding scenarios to determine the best set of projects that should be funded to meet the goals. The scenarios included the same funding share, the same overall funding level but a reallocation of shares to increase funding for multimodal projects, a 16% increase in funding, and a more significant increase in funding.

- Oregon employs a traditional four-step model to generate nontraditional measures. It estimates access to activity centers on the basis of the number of attractions that are available by automobile and separately by transit. The University of Minnesota is engaged in counting attractions that are accessible in Minneapolis–St. Paul. The Northern Virginia Transportation Authority performed a similar analysis, which is described in its *Trans-Action 2030* report.

Berechman and Paaswell (2005) developed transportation and economic development benefits and costs

to score several projects in New York City and ranked them by using a goal–achievement matrix.

When a large number of alternatives need to be analyzed, it makes sense to use some process to reduce the number of projects to be evaluated. One way to do this is to evaluate the alternatives on a modal basis and further analyze those that rank the highest. Stuart and Weber (1977) used a travel demand model (and, depending on what was being analyzed, other performance measures) to evaluate the effects of improvements resulting from alternative multimodal service combinations. Multiple computer model runs were used to evaluate the impact of improvements to one mode at a time. The highest-ranking modal projects were then evaluated on the basis of additional criteria. A simple scoring mechanism could also be used to reduce the number of projects to be evaluated. Determination of the high-level impacts of projects on the basis of key criteria could facilitate the identification of project groupings, assuming that the impacts are independent. These impacts could then be analyzed in more detail to determine their collective impact.

These tiered approaches have many variations. For example, Khasnabis et al. (2002) evaluated two approaches. The first was an analytic hierarchy process,

in which alternatives were ranked by individual (mostly) quantitative performance measures (e.g., the number of passengers per hour) on the basis of the quantitative score (which was weighted) for the measure. They were ranked again on the basis of the number of measures on which they ranked highly. Alternatively, they evaluated a simplified goals achievement technique in which the alternative with the highest score for a particular performance measure was assigned a score of 100 and the other alternatives were normalized accordingly. They were then weighted and ranked. The authors found that the ratings resulting from the two approaches were not significantly different, but they concluded that the former approach had a stronger mathematical basis.

Whether the trade-off analysis attempts to monetize impacts for benefit–cost analysis or assigns scores to capture the degree to which a project meets predetermined goals, the factors are measured differently and the scales have different meanings. It is important for the decision maker to understand the somewhat subjective nature of the comparisons and to apply the results of the trade-off analysis accordingly. The use of a goal-achievement process can be more transparent, as scores and rankings for each measure can be easily summarized and understood.

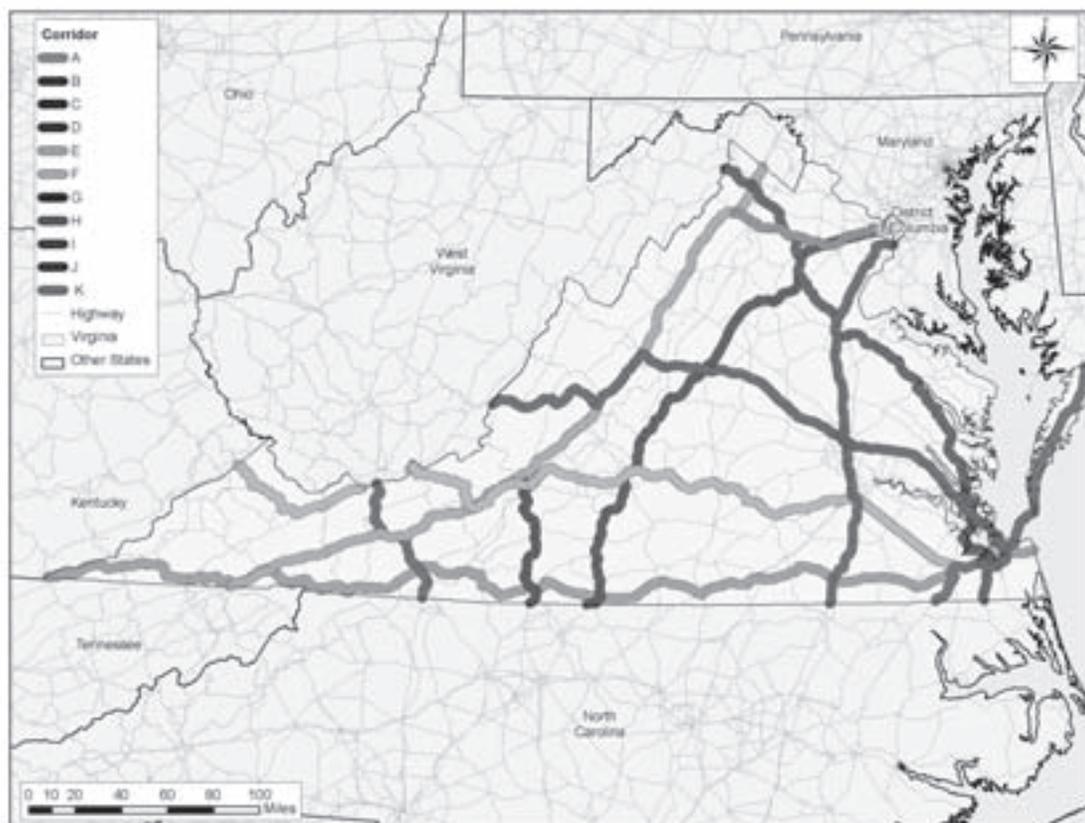


FIGURE 1 Virginia statewide multimodal corridors.

**TABLE 1** Sample Weighting Factors for Transportation Planning Goals

Criterion	Expert Panel	Stakeholder Feedback	Average
Safety and security	30	16	23
Preservation and management	10	20	15
Efficient movement of people and goods	30	28	29
Economic vitality	15	21	18
Quality of life	15	15	15
Total	100	100	100

## THE VIRGINIA APPROACH

A major element of Virginia's long-range transportation plan, known as VTran2025, is the concept of the statewide multimodal corridor. Like Florida, North Carolina, and Pennsylvania, multimodal corridors of statewide interest are identified. The corridors, shown in Figure 1, are major conduits for the movement of passengers and goods, include multiple modes, connect major activity centers or regions, and support the goals of the commonwealth (e.g., tourism and economic prosperity). The purpose of focusing statewide planning around these corridors is to ensure that statewide resources are directed to those corridors that serve statewide needs.

The goals identified in VTrans2025 were developed through extensive outreach to the public and stakeholders and serve as the basis for the objective, performance-based criteria used to rate projects. The degree to which projects meet these goals influences funding priorities. The system serves as a decision-support tool by providing a list of investment options for decision makers that is based on objective performance-based criteria.

Planners from each modal agency worked with representatives of regional planning bodies and others to identify the corridors as well as the multimodal performance measures that would be used to facilitate evaluation of the system and potential improvements. Performance measures were developed for each of the five goals identified in the plan to ensure a link between the long-range vision described in the plan and project identification and prioritization. Deficiencies in the system were identified, and a goals achievement matrix was developed to evaluate quantitatively the projects within the corridors according to the performance measures. Initially, ratings for each measure were based on whether the project had a positive impact on the measure (+1), a negative impact on the measure (-1), or no impact (0). Various weighting systems were also considered to reflect the different policy priorities shown in Table 1. These were defined from the responses to a telephone survey and by an expert panel. The stakeholder feedback weights were based on a survey of 1,200 Virginians that examined public opinions, attitudes, and values about transportation by focusing on alternative visions for the transportation system and the relative importance of the long-range goals. In

**TABLE 2** Excerpt of VTrans2025 Goal-Achievement Score Sheet

<i>Goal 3. Facilitate the efficient movement of people and goods and expand choices and improve interconnectivity of all transportation modes (20%).</i>			
Factor	Objective	Performance Measure	Score
3.1. Mobility (33%)	3.1.a. Reduce congestion (33%)	3.1.a. Does the project reduce congestion in terms of the volume-to-capacity (V/C) ratio, level of service (LOS), and/or travel time?	-1
	3.1.b. Provide mode/route choice for all people and goods (33%)	3.1.b. Does the project provide mode/route choice for all people and goods?	1
	3.1.c. Increase capacity for the movement of people and goods (33%)	3.1.c. Does the project increase capacity in terms of tons of freight moved, 20-ft equivalent unit (TEUs), and/or person trips?	1
3.2. Accessibility (33%)	3.2.a. Improve access to major activity centers (50%)	3.2.a. Does the project improve access to major activity centers in terms of the number of modes serving the activity center, frequency of service, and/or barriers removed?	1
	3.2.b. Improve accessibility of transportation services or facilities (50%)	3.2.b. Does the project improve accessibility of transportation services or facilities in terms of the number of mode choices for people and goods in the corridor, the cost per trip, and/or the cost per ton mile?	1
3.3. System connectivity (33%)	3.3.a. Provide seamless connectivity between modes (33%)	3.3.a. Does the project reduce transfer time between modes, reduce travel time to the main line/hub of network, and/or increase the number modal connections?	0
	3.3.b. Provide interconnected networks that facilitate the "complete journey" (e.g., origin to destination and all connections between) (33%)	3.3.b. Does the project provide system continuity?	-1
3.4. Reliability	3.4.a. Provide transportation services, facilities, and information that improve predictability and reliability (33%)	3.4.a. Does the project improve on-time performance of modes and/or reduce travel time variability?	0

some cases, the relative importance of the goals defined by stakeholder feedback was different from that defined by an expert panel. Equal weighting and an average were also evaluated. Weighted scores were summed to generate a composite score; and projects were sorted into tiers of immediate, midrange, and long-range priorities. Table 2 shows a portion of a sample score sheet.

The use of scores of +1, 0, and -1 ignores information useful for the differentiation of projects because the

degree to which a project meets the goal is not considered. However, it can be used as a screening device to reduce to a manageable number the number of projects for which further analysis is required.

Although multimodal prioritization was put on hold, the highway programming process benefited from the long-range planning effort. The goals and performance measures developed in the plan were used to prioritize more than 1,000 highway construction projects. Multi-

**TABLE 3 Virginia Highway Project Prioritization Matrix**

Planning Factor	Planning Objective	Measure
<i>Goal 1. Provide a transportation system that facilitates the efficient movement of people and goods.</i>		
Mobility	Reduce congestion	Current-day LOS
		Current-day volume-to-capacity ratio
	Maximize benefits for the greatest number of users	Current-day passenger car equivalents (both directions)
<i>Goal 2. Provide a safe and secure transportation system.</i>		
Safety	Improve safety for roadway users	Crash rate
<i>Goal 3. Improve Virginia's economic vitality and provide access to economic opportunities for all Virginians.</i>		
Economic development	Enhance the movement of goods throughout the commonwealth	Average daily volume of trucks
	Provide transportation investments in economically disadvantaged areas	Local unemployment rate
<i>Goal 4. Improve quality of life and minimize potential impacts to the environment.</i>		
Community character and environmental quality	Minimize cultural and environmental impacts	Potential environmental or cultural impacts
	Minimize community impacts	Use of existing state-owned right-of-way
<i>Goal 5. Preserve the existing transportation system and promote efficient system management.</i>		
System management	Encourage access management	Interchange spacing/main line adequacy
	Reduce reliance on single-occupant vehicles	Inclusion of HOV, bicycle, and/or pedestrian facilities or provisions for other modes
System preservation	Minimize long-term maintenance costs	Bridge conditions: bridge deficiencies are based on bridge sufficiency ratings
Cost-effectiveness	Maximize the use of limited highway funding	Cost-effectiveness of the proposed recommendation
Additional points		
Multimodalism	Support recommendations identified by the Virginia Department of Transportation (VTRANS)	Highway component of an identified VTRANS multimodal investment network (MIN)

modal elements were included in the evaluation; for example, improved access to ports, airports, transit, park-and-ride lots, or other intermodal facilities was one of the measures. The evaluation also included truck volumes; consideration of whether accommodations for HOV lanes, bicycles, pedestrians, and other modes were included; and whether the project improved a component of an identified statewide multimodal corridor. The highway project prioritization matrix is shown in Table 3.

The update to the long-range plan will expand the current approach to include measures that reflect the importance of alternate modes, freight mobility, land use, economic vitality, and quality of life. The plan will be financially constrained as well as unconstrained. Virginia will screen the number of projects to be addressed in detail, will apply a performance-based approach using a goal-achievement matrix, and consider project cost in the more detailed evaluation.

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#### Definition

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LOS is a standard highway performance measure used to indicate congestion and the degree to which the highway facility is meeting the needs of the traveling public. Scores are assigned on the basis of an LOS analysis. Scoring is as follows: LOS A = 0 points, LOS B = 2 points, LOS C = 4 points, LOS D = 6 points, LOS E = 8 points, LOS F = 10 points. For stand-alone interchange improvements, scoring is handled differently. Each stand-alone interchange recommendation begins with 0 points. By using the following criteria, points (maximum of 10 points) are added: (a) substandard interchange design = 3 points, (b) main-line traffic-weaving problem = 2 points, (c) cross-route weaving/congestion problem = 2 points, and (d) traffic backup onto main line during peak hour = 3 points.

A roadway's volume-to-capacity ratio is another, more specific measure of congestion. Scoring is based on a formula used to determine percentile ranges. On the basis of these ranges, recommendations can receive from 0 to 10 points. For stand-alone interchange improvements, the scoring is handled differently. Each stand-alone interchange recommendation begins with 0 points. By using the following criteria, points (maximum of 10 points) are added: (a) substandard interchange design = 3 points, (b) main-line traffic-weaving problem = 2 points, (c) cross-route weaving/congestion problem = 2 points, and (d) traffic backup onto main line during peak hour = 3 points.

Current-day passenger car equivalents (both directions). By using a nationally accepted method, heavy trucks are converted into passenger cars. Scoring is based on a logarithmic formula used to define 10 value ranges. On the basis of these ranges, recommendations can receive from 0 to 10 points.

Segment crash rates from the HTRIS database. On new location facilities, the crash rate from the parallel or bypassed facility is used. Scoring is based on a logarithmic formula used to define 10 value ranges. On the basis of these ranges, recommendations can receive from 0 to 10 points.

The 2003 average daily volume of trucks. Scoring is based on a logarithmic formula used to define 10 value ranges. On the basis of these ranges, recommendations can receive from 0 to 10 points.

By using official data from the Virginia Employment Commission, this measure is defined as the maximum 2003 unemployment rate from all jurisdictions affected. Scoring is based on a formula used to determine percentile ranges. On the basis of these ranges, recommendations can receive from 0 to 10 points.

Based on a spatial analysis of the recommendation's terminus/location and the environmental layers in the geographic information system integrator. Potential impacts fall into seven categories: (a) wetlands, (b) streams, (c) agricultural/forest districts, (d) cultural resources, (e) conservation lands, (f) Virginia Outdoor Foundation easements, and (g) threatened and endangered species. Each recommendation begins with 10 points. With each potential impact, 1,438 points are subtracted.

On the basis of the current facility and the extent of the recommended improvement, this performance measure is defined as the potential for the improvement to be constructed within the existing state-owned right-of-way. For scoring, yes = 10 points and no = 0 points.

Improvements to existing facilities will get full points. In urban areas, new interchanges should not be within 1 mi of an existing interchange unless a collector-distributor road is included (if not = 0 points). In rural areas, a new interchange should not be within 2 mi of an existing interchange (if not = 0 points). Proposed new interchanges will also receive 0 points if they do not include an improvement to the main line and the main line is deficient (LOS F) within the planning horizon (2025).

Yes is defined as the inclusion in the recommendation of HOV facilities, bicycle or pedestrian accommodations, park-and-ride lots, bus lanes, rail facilities, and bus pullouts. For scoring, yes = 10 points and no = 0 points.

By using bridge sufficiency ratings from the Structure and Bridge Division, this measure entails the lowest bridge sufficiency rating (BSR) from all Statewide Planning System segments associated with the recommendation's termini. Scoring is based on BSR ranges. These ranges are as follows: 0 to 20 = 10 points, 21 to 40 = 5 points, 41 to 60 = 3 points, and 61 and over = 0 points.

Cost-effectiveness is measured by using the following formula: total estimated cost of improvement divided by the 2025 estimated vehicle miles traveled. Scoring is based on a logarithmic formula that defines 10 value ranges. On the basis of these ranges, recommendations can receive from 0 to 10 points.

Points will be assigned to highway improvements that are components of MIN. Points will be assigned on the basis of what tier the MIN is assigned to: Tier 3 = 0 points, Tier 2 = 5 points, and Tier 1 = 10 points.

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## LESSONS LEARNED FROM THE LITERATURE AND THE VIRGINIA EXPERIENCE

- Get buy-in up front—and again and again. The long-range planning effort took 3 years and involved a substantial public involvement process, a staff-level Technical Committee, as well as a Policy Committee that included members of the Commonwealth Transportation Board (CTB). Periodic presentations were made at various board and other meetings throughout the state. Ultimately, the CTB members who had also been Policy Committee members were enthusiastic about the use of goals and performance measures and were supportive of their use for project prioritization. However, the board members who had not been involved throughout the process were less enthusiastic. The tools need to be considered to be credible by the decision makers and transparent to stakeholders. They need to buy-in up front and throughout the process.

- The process must be simple to understand, implement, and explain. This is critical to ensuring the acceptance and the institutionalization of the process.

- Multimodal trade-offs are doable. Whether one uses a complex methodology, a simplified scoring process, or a nonquantitative approach, it is possible to compare a transit project with a highway project and decide which one is the better investment. Utah's use of cost-benefit ratios to determine asset management budgets, Michigan's approach to integration, and Florida's Decision System Tool are all examples of reasonable approaches to trading off program or modal projects.

- There is greater consideration of multimodal trade-offs than initially meets the eye. Even when the evaluation is made by mode, the way in which the goals are described, the types of performance measures that are used, and the way in which projects can be bundled are indicative of an increasingly multimodal approach to transportation.

- The use of performance measures blurs the differences between the modes. When the goal is mobility and not highway construction per se, the debate is changed.

- Not all projects are multimodal. Sometimes a highway project is just a highway project. Maintenance and operational projects typically involve only one mode, although the importance of a transit project versus that of a highway maintenance project can be estimated once there is an agreement on the value of the goal.

- Scale matters. Trade-off analyses can occur at different levels—statewide, regional, or local—as well as at the planning or the programming phase. The data requirements vary considerably, and the tool must fit the scale. The performance of a detailed benefit-cost analysis for all potential projects over the course of 20 years would be costly and unnecessary.

- If tools are provided, the states will use them. This is demonstrated by the large number of states that started using the HER-ST model once FHWA made it available.

- Cost matters. When they are asked, the public clearly prefers the “Cadillac” to the “Volkswagen”; however, the cost of a project is sometimes so prohibitive that an alternative becomes disqualified on the basis of that criterion alone. Lambert et al. (2007) show project cost by the size of the bubble on a two-dimensional graph.

Whether decision making is based on a purely objective project selection system, solely on political judgment, or somewhere in between, decision making for project selection is becoming more closely linked to the planning process that preceded it. More and more, projects under consideration have resulted from a planning process that considered all modes and are consistent with the overarching vision set forth in the long-range plans. However, as Meyer and Miller (2001) note, “attempts to analytically structure the priority-setting process are a useful exercise for both planners and decision-makers, but the final decision will still be based on political judgment.”

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## RESOURCE PAPER

# Measuring the Value and Impact of Agency Communication with the Public

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At the conclusion of the Second TRB Conference on Performance Measurement in 2004, Lance Neumann, the conference cochair, observed how performance measurement could serve as a communication tool. At that time, however, research gaps included an understanding of how performance measurement influences behavior, methods for the reporting of performance measurements, and difficulties with the communication of risk (Turnbull, 2005).

This paper relates and builds on the summary conclusions from the 2004 conference. It provides examples of subsequent research and transportation agency practices that respond to previously identified gaps. The paper also references research relevant to but not specific to transportation. These examples are intended to reinforce certain points by noting that other industries apply similar approaches. In some cases, the non-transportation-specific examples suggest alternate approaches or fill in the gaps in the literature and, thus, are intended to expand what practitioners in the transportation industry may consider applying to their own circumstances.

In the end, the paper attempts to explain the value of public engagement in the development and implementation of performance measurement programs for the public agencies responsible for surface transportation. It also shows progress in each of the three areas identified as research gaps in 2004: assessing the impacts of communication, communication methods, and risk communication.

In researching the paper, the author conducted a comprehensive review of English-language research related to the subject at hand: communicating surface transportation agency performance measurement with the

public. The author reviewed bibliographies collected by the TRB Performance Measurement Committee; reviewed recent transportation performance measurement discussion boards; searched the Transportation Research Information System and the Research in Progress database; and conducted limited Internet searches using the following key words: measures of effectiveness, performance measurement, public involvement, public participation, and public opinion.

The paper is divided into six parts, each of which outlines a different concept or provides a set of examples and each of which builds on the previous topic:

1. Why communicate performance measurement?
2. The public, customers, and market segmentation
3. Partnerships: two-way communication and concepts of integration
4. Perceived value of customer communication
5. Assessing the impacts of customer communication
6. Communication methods: the nuts and bolts

## WHY COMMUNICATE PERFORMANCE MEASUREMENT?

Although many of the people reading this paper may have a preconceived notion that they should communicate performance with the public (a view that may now also be broadly held by transportation agencies), it still is important to describe the basis for this belief.

The research literature suggests the following seven reasons for the communication of performance measure-

ment. (In reality, the communication of performance measurement is done for a mix of one or more of the indicated reasons.)

- **Legislative direction.** The I-95 Corridor Coalition (2005b) conducted a survey of its members about the use of performance measurement. One of the questions asked about communication about performance with legislators; few member agencies responded that they were communicating about performance with legislators. Although it is not commonly noted as a reason for communicating performance (perhaps because it is obvious), Padgett (2006) wrote about the importance of reporting on performance measurement in response to legislative demands. In some cases, this is a direct reflection of a legislative mandate. In other cases, proactive communication with advisory boards and oversight agencies can help guide the types of questions that they may ask the boards and agencies. Communication can clarify and even lead to shared assumptions about realistic program outcomes and controls. Emerson and Carlson (2003), writing about the measurement of environmental conflict resolution programs, similarly note that administrative and legislative bodies are important audiences.

- **Public awareness.** The communication of performance can educate the public about agency priorities or manage expectations by describing the challenges and external influences that affect transportation programs. Public awareness was a specific component of the design of the annual Metropolitan Atlanta Performance Report prepared by the Georgia Regional Transportation Authority (2007). In regard to nontraditional measures, over which transportation agencies frequently have shared or limited control, Hendren and Meyer (2006) noted the importance of education. Similarly, in the environmental sector, the Government Accountability Office (2004) found that after assessing conditions and trends, the most frequently cited reason for performance measurement among federal, state, and regional organizations was to educate the audience, raise awareness, and communicate complex issues, in descending order.

- **Support for new revenue.** A report for Transport Canada (Transportation Association of Canada, 2006) suggested that performance measurements can provide data to justify program expenditures, support requests for the allocation of additional resources, and support public agency demands for greater accountability as reasons for applying performance measurement, at least in regard to communicating with the public. Hendren and Meyer (2006) also noted that demonstrating performance is important when revenue is sought. Cameron et al. (2003) suggested that the communication of perfor-

mance measurement is important for gaining stakeholder trust, particularly when agencies are seeking funding and raising awareness of agency priorities.

- **Customer feedback.** Communication is a two-way street: it allows agencies to gain input and guidance on how and what to communicate about performance as well as provide information about performance. Schaller (2005) noted that communication with customers is one of five reasons that transit agencies conduct surveys. Hendren and Meyer (2006) suggested a shift from a focus on the system to a focus on the customer in non-traditional performance measurement and the importance of customer feedback. Stein and Sloane (2003) wrote about keeping customers informed to demonstrate that agencies are providing transportation services that meet customer needs.

- **Accountability.** Padgett (2006) wrote that in several departments of transportation the senior leadership provides information on performance to the public as a means of reinforcing accountability. Accountability can be considered analogous to legislative reporting for a more general audience. The work of the Virginia Department of Transportation (DOT) is a good example (and will be described in more detail below) of the importance of reporting performance measurement in public accountability. Hendren and Meyer (2006) similarly noted that accountability and credibility are important issues related to nontraditional performance measurements, which include measurements of interest to other agencies and public groups, such as measurements related to land use, environment, and quality of life.

- **Trust building.** Cameron et al. (2003) suggested that the communication of performance measurement is important for gaining stakeholder trust. Trust building requires transparency and accountability. The Missouri DOT (2007) identified transparency as an important reason behind communication with the public in its Tracker performance measurement report. An NCHRP report (2004) noted the New Mexico DOT's commitment to an open and public process in the communication of performance in the environmental management area. The Virginia DOT found accountability to be an important element of the communication of performance (Jones, 2007).

- **Collaboration.** The Missouri Department of Transportation (2007) noted that the creation of opportunities for collaboration is another important reason behind communication with the public by use of its Tracker performance measurement report. However, Missouri appears to be unusual among agency performance measurement programs by naming collaboration as a reason. This issue will be discussed further in the section on partnerships below.

## THE PUBLIC, CUSTOMERS, AND MARKET SEGMENTATION

As noted in the section above, agencies reference a variety of audiences when describing the purpose of the communication of performance. In this regard, customers may include any external audience: decision makers, partner agencies, commuters, residents, and visitors. For example, the Florida DOT conducted customer surveys of residents, local officials, visitors, seniors, and commercial divers (Florida DOT, 2005). The Michigan Transportation Summit provides another example. The Michigan DOT engaged multiple segments of the public and the business community in the development of the department's strategic plan. Schwartz (2006) noted that this effort goes beyond surveying customer satisfaction after goals and measures are developed.

Schwartz (2006) and Stein and Sloane (2003) differentiated between stakeholders, partners, and customers. Stein and Sloane (2003) went on to describe the value of segmenting customers and discussed the societal changes that have led to increased segmentation for transportation on the basis of geography, demographics, travel behavior, and socioeconomic. Schaller (2005) also noted the importance of customer segmentation specific to transit service, including the value of segmentation when one is communicating with different customer groups.

This paper takes a broader view of customers so that they include both external audiences and, in some instances, audiences internal to large organizations. This seems to be consistent with the approach taken by several state departments of transportation, whereas others (Florida Department of Transportation, 2005) do divide customers into multiple segments. Although the methods of communicating performance to different segments may vary, as will be described in the final section of this paper, the importance of communicating performance to each segment may be similar, regardless of which segment it is.

Private industry frequently uses the American Customer Satisfaction Index (ACSI) to infer the quality of communications with groups in the area of transportation services. ASCI compares customer expectations and the perceptions of service quality. The measurements allow a correlation to be made between expectations and perceived quality, which leads to customer satisfaction.

Van Ryzin et al. (2004) described how the city of New York applied ASCI to government performance in areas including road smoothness, street cleanliness, subway service, and bus service. New York City is well known for its diversity; the data captured by ASCI allowed the segmentation of the results by geography (each borough

of the city), race-ethnicity, and income. In this example, the city of New York was interested in providing city leaders with information about how resident satisfaction correlated with confidence and trust in government services. Overall, road conditions were a strong driver of the overall perceived quality of and public satisfaction with city services. Transit services, on the other hand, appeared to matter more to residents in the outer boroughs and those with lower incomes.

ACSI was not designed to assess public confidence or trust, however. Van Ryzin et al. (2004) noted that about one-sixth of the variation in confidence was captured by ASCI. Public appreciation of agency control (or a lack thereof) and external factors can cloud the results. The public may not hold an agency accountable for conditions or may not attribute outcomes to actions that the agency has taken. This allows the application of ASCI or similar survey instruments to be a useful approach for measuring either changes in service quality or communication that could appreciably modify the expectations of a segment of the population or the general public.

## PARTNERSHIPS: TWO-WAY COMMUNICATION AND CONCEPTS OF INTEGRATION

Surprisingly, it appears that few agencies have considered or embraced the communication of performance measurement for the purpose of seeking cooperation and building partnerships, although at the 2004 TRB Performance Measurement Conference, Klein (2005) spoke about integrating measurement across agencies, and Joshua (2005) talked about how a metropolitan planning organization (MPO) can use its formal structure, which consists of a policy board and advisory committees, to engage customers in the development of performance measurements.

Some examples exist in the area of nontraditional measures, such as environmental measures. Hendren and Meyer (2006), in writing about nontraditional transportation performance measures, noted that the measures may be outside the typical control of transportation agencies. It is in these cases (e.g., energy and resource conservation, environmental quality, quality of life, and sustainability) in which partnerships may be of particular importance. The chapter *Organizational Environmental Stewardship Practices of Environmental Stewardship Practices, Policies, and Procedures for Road Construction and Maintenance* discussed partnerships and shared reporting between agencies and industry in the measurement of environmental mitigations (AASHTO Standing Committee on the Environment, 2004). Likewise, a report of context-sensitive solutions

(NCHRP, 2004) discussed the collaborative aspect of performance measurement, as performance measurements may be linked to local land use and community needs. They are also linked to land use systems and ecosystems in the environment. This is therefore an additional reason for collaboration.

Groups that may be involved in partnering with transportation agencies in the area of performance measurement include other transportation agencies, such as public transportation providers and ports. In addition, performance measures in nontraditional areas for transportation fall outside the jurisdiction of transportation agencies (e.g., health). The communication of performance measures in these areas could lead to new collaborations among agencies. Such collaborations may include stakeholders with a more narrow interest in the transportation program, such as air quality districts, public and traffic safety organizations, health providers, and land use and environmental regulatory agencies. They may also include nongovernmental organizations and advisory groups.

The Wilmington Area Planning Council (WILMAPCO), the designated metropolitan planning organization for the Wilmington, Delaware, area, provides an example of partnering and coordination. The metropolitan area includes parts of Delaware and Maryland. WILMAPCO developed a long-range transportation plan with performance measurement data and information from multiple agencies (Wilmington Area Planning Council, 2007). The plan meshed the goals of the Delaware Department of Transportation (DelDOT) and the Maryland State Highway Administration (MDSHA) for road and bridge conditions and of Maryland DOT and DelDOT for on-time transit performance (Figure 1).

When one thinks of how the communication of performance measurement may aid with the building of part-

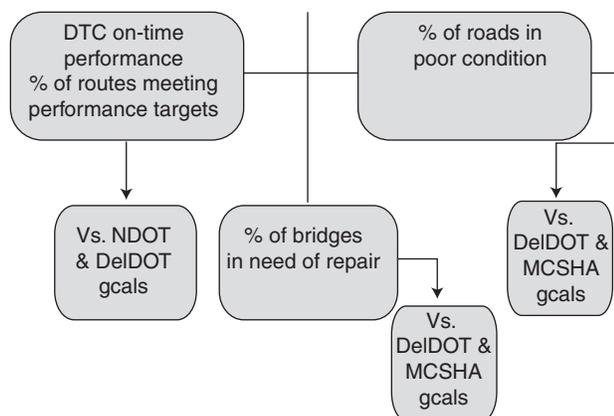


FIGURE 1 WILMAPCO draft long-range transportation plan (DTC = Delaware Transit Corporation. Source: [www.wilmapco.org/RTP/Update.htm](http://www.wilmapco.org/RTP/Update.htm)).

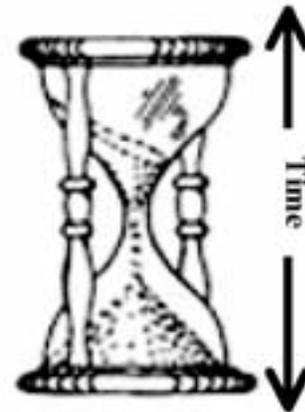


FIGURE 2 Hourglass of communication, starting with broad input, a narrowing, and then completion with a broad output.

nerships, it may be helpful to consider communication in the shape of an hourglass, with the width being the level of effort or engagement outside the organization and the length of the hourglass being time (Figure 2).<sup>1</sup>

By use of the hourglass model, communication about performance measurement with external organizations frequently starts at the top of the hourglass with extensive engagement; communication then decreases (the narrowing of the hourglass) as an organization works internally to develop, implement, or modify a performance measurement program; communication again becomes extensive (at the bottom of the hourglass) as the organization reports and discusses the results.

An illustration of this is from the Delaware Valley Regional Planning Commission (DVRPC), which is the designated metropolitan planning organization for the Philadelphia, Pennsylvania–Camden, New Jersey, area. DVRPC used a steering committee to incorporate feedback from external sources into the performance measurement program (Delaware Valley Regional Planning Commission, 2006).

Another example of an agency and stakeholder partnership used for the development of performance measurements is the Sustainable Region Showcase for Greater Vancouver, British Columbia, Canada, which developed diverse measures, including measures related to transit and pedestrian priority, hybrid buses, a greenway, transit villages, goods movement, and household-based marketing (Transportation Association of Canada, 2006).

At the output end of the hourglass is the Smart Commute Initiative (2003) in the greater Toronto, Ontario, Canada, area. That initiative is a public–private transportation demand management organization that used a

<sup>1</sup>Zoe Neaderland of DVRPC introduced the author to the analogy.

partnership to increase the dissemination and discussion of regional performance measures. The Smart Commute Initiative included demand strategies that were measurable and that were developed and implemented across multiple jurisdictions and by both public and private partners. The intent of the initiative was to link the performance measures for the system at the regional and local levels.

The Smart Commute Initiative also illustrates another way to look at the communication of performance measurement: communication may be vertical (between one office and the larger organization or between a local agency and a regional council of governments) or horizontal (among local agencies). WILMAPCO demonstrates an example of an agency that uses vertical communication, in which communication was between local agencies and the MPO (WILMAPCO) and between the metropolitan planning organization and the states of Delaware and Maryland. NCHRP (2004) described a case of vertical integration between micromasures (project level) and macromasures (agencywide) for context-sensitive design. As an example of horizontal integration, Emerson and Carlson (2003) also noted the use of the benchmarking of measures for environmental conflict resolution programs to demonstrate aggregate outcomes, which required coordination, quality control, and clarity regarding data management. A final example of horizontal integration is from the Baltimore, Maryland, Neighborhood Indicators Alliance (2006). The alliance reported on indicators such as travel time and mode split by neighborhood to an audience of the general public and policy makers with the purpose of influencing government programs.

## PERCEIVED VALUE OF CUSTOMER COMMUNICATION

Behind the reasons for communicating performance (legislative direction, public awareness, etc.), agencies and their employees anticipate some benefit. The Virginia DOT is an example of an agency that found a clear benefit in effectively communicating performance. Before adopting current performance measurement practices, the public and the media were skeptical of the Virginia DOT's performance (Jones, 2007). This led the department to focus on program delivery and the adoption of new mechanisms for reporting on performance by using a dashboard (Figure 3) (Virginia Department of Transportation, 2007). The new focus and the reporting of performance measurements increased the credibility of the department and improved press coverage.

The Missouri DOT (2007) found value in communicating performance as well. The department measured the percentage of customers who viewed the department

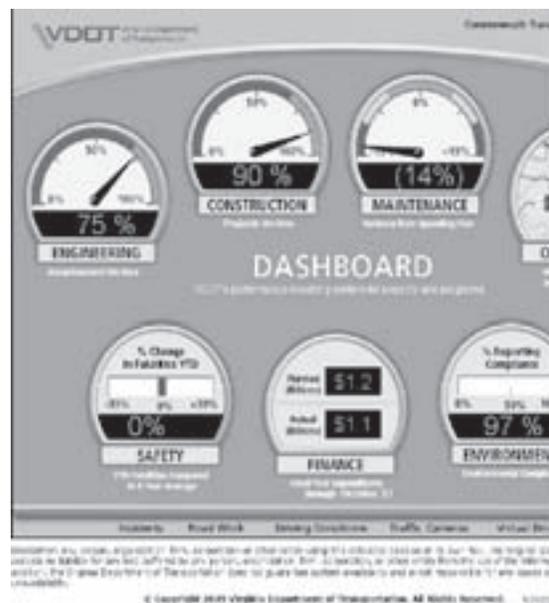


FIGURE 3 Detail of the Virginia DOT Dashboard. (Source: [dashboard.virginiadot.org/default.aspx](http://dashboard.virginiadot.org/default.aspx).)

as Missouri's transportation expert, which the department found to demonstrate its credibility with the public. More interesting was the department's measurement of the percentage of federal earmarked highway projects on the state highway system. This was designed as a similar indicator of credibility among a much smaller group, the state's congressional delegation.

The Missouri DOT also tracks more typical measures of customer involvement in transportation decision making as well as the percentage of customers who believed that the department included their views in the transportation decision-making process. Again, these measures illustrate an underlying basis for building public trust and confidence.

The city of Baltimore, Maryland, provides another example. The city developed CitiStat to manage the day-to-day operations of city departments (City of Baltimore, 2007). CitiStat employed a database to develop common maps, charts, and graphs showing agency performance. For transportation, performance included snow removal, street light repairs, and curb lane closures. The mayor and other executives meet biweekly to review performance. One unexpected result of the system was learning that the city responded to most pothole complaints within 48 hours. The mayor announced a public campaign promising responsiveness to pothole complaints, which the city was already doing. This led to increased public confidence and trust in city services (Baxandall and Euchner, 2003).

A final example is the Canadian Smart Commute Initiative (2003), which included the development of an

assessment tool for the tracking of stakeholder and public engagement with the initiative. The initiative considered benchmarking, regular monitoring, and public reporting as important methods for sustaining program goals.

A major legacy to which the Smart Commute Initiative aspires is to firmly establish the value of TDM [transportation demand management] measures in the public's mind and travel culture to such an extent that there will continue to be widespread municipal and private-sector support to maintain and expand these programs beyond the timeframe of the Showcase Program. Reporting accomplishments on an annual basis provides the Smart Commute Initiative the opportunity to measure its success at reaching this major goal. (Transport Canada, 2007)

Although it is too early to tell if the Smart Commute Initiative was able to build value by discussing performance with customers, Wang and Wart (2007) provided an interesting and perhaps important consideration about the relationship between trust and public communication. They conducted a national assessment of larger local governments in the United States that identified important intermediate considerations that link public participation and increased trust. Transportation was one of 10 functions and fell in the middle in terms of public involvement in local government, with general land use, recreation, and public safety more frequently being topics of involvement. The most frequent process was program goals and objectives.

Wang and Wart (2007) started with considering the assumptions behind linking participation and trust, which they noted is widely accepted in the political science literature. They then tested five distinct intermediate factors commonly identified. They found that the most important intermediate element in contributing to increased public trust was service competence. Public trust, as defined in their article, is a broad sense that government will deliver what is needed, as opposed to satisfaction with a specific action or good or service.

Service competence suggests that the public trusts agencies more when agencies can demonstrate that the response for services is consistently well met. They suggest that fulfillment and demonstrating the delivery of results are critical to building trust.

Wang and Wart (2007) noted that there is a strong correlation between increased public interaction and accountability but that that does not translate into increased trust. They hypothesized that information alone does not change public attitudes or perceptions about government. They also noted that public communication can support the legitimacy of public actions, which is separate from trust. On the basis of their

research, transportation agencies may want to be cautious about using communication as a means of trust building.

## ASSESSING IMPACT OF CUSTOMER COMMUNICATION

ACSI and methods that use similar means to assess the impact of communication with customers use quadrant analysis, which compares satisfaction with importance (Van Ryzin et al., 2004). FHWA provided an example of quadrant analysis that supports agency performance measurement on the basis of a national survey of travelers in 2005. In a quadrant analysis, the upper right quadrant shows programs that customers found both satisfactory and important; going clockwise, the next quadrant contains programs that customers found unsatisfactory and important, the next quadrant contains programs that customers found unsatisfactory but unimportant, and the final quadrant contains programs that customers found satisfactory but less important (Table 1).

The fit between agency resources and the combination of customer satisfaction and importance is as important as noting which quadrant that an agency program or activity falls into. Accordingly, one method for assessing the impact of customer communication is the ability to match agency resources correctly to the combination of importance and perceived quality (Figure 4). The further that a program is tangentially below the diagonal line shown in Figure 4, the more that the public sees the agency as underperforming.

Schwartz (2006) makes a good argument for the value of customer communication. On the basis of a review of cases in state departments of transportation, MPOs, and public transit providers, Schwartz found that engaging with a broad range of stakeholders not only can increase public trust but also can lead to actual changes in programs.

This builds on a presentation at the prior TRB Conference on Performance Measurement that discussed resource allocation and program impact on the basis of customer understanding. This is part of the two-way discussion about performance that agencies have with customers through market research (Halverson, 2005).

TABLE 1 Typical Quadrant Analysis

Overall Grade	Importance	
	Low	High
High	Secondary strengths	Primary strengths
Low	Potential weaknesses	Critical weaknesses

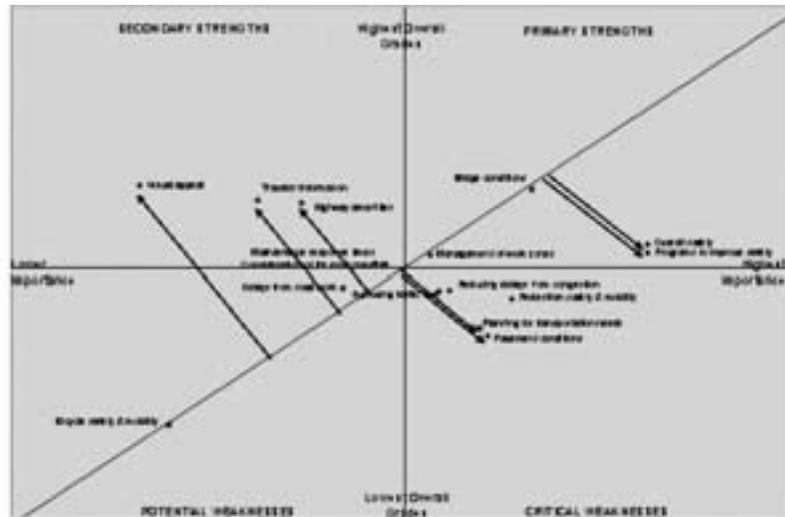


FIGURE 4 Best fit of resources (diagonal line).

### COMMUNICATION METHODS: THE NUTS AND BOLTS

Communication methods are described in this final section not as an afterthought but to reinforce the importance of public communication in implementing performance measures.

When one is considering how to communicate, it is important to return to the idea of audience segmentation. For technical audiences, which may include other transportation agencies, communication should include details. For officials, communication techniques should provide decision support. For the public and the media, the impact of the performance measurement should be apparent.

In general, for nontechnical audiences, agencies have used the following methods to communicate performance:

- Simple charts and tables;
- Dashboards, scorecards, and report cards;
- System maps; and
- Narratives.

These methods of communicating agency performance may be included in publications, brochures, executive summaries, and full reports and on posters. They may be reported at meetings and in presentations. They may also be sent to the media or contact lists for different groups of customers, stakeholders, and interested parties.

Besides the method used to report performance to customers, another consideration is the frequency of communication. Padgett (2006) mentioned that the regularity of reporting might be more important than the format. Report cards tend to be annual activities,

whereas dashboards and interactive maps can show more frequent and operational measurements (I-95 Corridor Coalition, 2005a). The I-95 Corridor Coalition report (2005a) and Government Accountability Office (2004) also raised cautions about the time lag of annual reporting.

On the basis of information collected from provincial and territorial transportation agencies in Canada (Transportation Association of Canada, 2006), it appears that performance measurement information in Canada is available to the public mostly through annual reports. An example of an annual report is that used in Austin, Texas, which has been effective at using a community scorecard to report performance (International City/County Management Association, 2007). The city of Austin reports on transportation as well as other municipal functions using a scorecard for quick comparison across time and across departments.

Although reporting methods were identified to be one of the research gaps in 2004, Larson (2005) also mentioned the use of geographic information systems and dashboards to communicate performance to customers, which suggests that the practices existed but were not widely adopted. Since then, Lindley (2005) made the point that the data-reporting methods can be complex to the point that customers may not have the knowledge to understand the method; nonetheless, they can understand the importance of the measure if it is communicated well. Reinforcing this concept is a report on environmental indicators (Government Accountability Office, 2004). The report discusses at length the important of communicating complex concepts such as risk among agencies and to the public and decision makers.

One example of a method of reporting that is easy to understand even when complex information is being



FIGURE 5 Current system operations on Kansas City Scout website.  
(Source: [www.kcscout.net](http://www.kcscout.net).)

related is dashboards. Padgett (2006) found that some departments of transportation used automated data management systems to provide performance information on dashboards that were accessible to agency leadership, legislators, stakeholders, and the general public. Cameron et al. (2003) also mentioned the use of dashboards to articulate performance to external stakeholders (Figure 3).

The number of current examples suggests that knowledge about the methods used to report performance is more widely applied today than it was in 2004. One exemplary instance is the Kansas DOT, which won a National Partnership for Highway Quality award for Kansas City Scout, which reports on the performance of the road system in the Kansas City, Missouri, metropolitan area and which is operated by the Kansas and Missouri DOTs (Figure 5). The award noted that the department was effective not only at supporting the development of system congestion measures but also at building partnerships with the media so that the public had access to the system measures (National Partnership for Highway Quality, 2006).

Similarly, the Smart Commute Initiative (2003) in the Toronto region of Ontario, Canada, included forms of public outreach in the development of strategies for the communication of performance, including a one-day retreat by a public-private working group and a stakeholders' breakfast to provide initial information. The Smart Commute Initiative also used incentives and awards that led to media coverage and participated in a national information network to promote coordination with external stakeholders.

Generally, the use of appropriate methods to create a straightforward message about performance and to reach a specific audience appear to be the keys to communicating with customers and other important external groups.

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## RESOURCE PAPER

# Performance-Based Contracting

## A Viable Contract Option?

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*“Just tell me what to do; I want to build it and move on.”*

*“Tell me what you want, but don’t tell me how to do it.”*

These statements are typical of what you might hear at a highway construction site anywhere in the country. It is also possible that you heard the same thing in 1970 or before. The first statement addresses the conventional approach to highway construction that puts the burden on the owners to design, specify, and control the work. The contractors are hired on the basis of the lowest price with the expectation that they will execute the work in accordance with the terms of the contract. Where does the risk lie? It lies mostly with the owner. Where is the innovation? Again, it is mostly from the owner.

The National Highway System (NHS) is not keeping pace with the demands placed on it to move people and goods safely and efficiently. Recent infrastructure report cards indicate that the system is deteriorating and facing increased congestion. Much of America’s transportation infrastructure is reaching the end of its design life and needs to be reconstructed. State highway agencies are under pressure to improve highway systems while maintaining traffic in work zones with limited resources. To accomplish this, states are increasingly experimenting with ways to accelerate construction and minimize disruption while maintaining or improving quality. One aspect of this initiative is the use of specifications and contracting strategies to motivate and empower the private sector. The traditional way of doing business, which is to use prescriptive requirements that tell the contractor

how to perform the work, does not motivate the contractor to provide more than the minimum or to find creative solutions to save time, minimize disruption, or enhance safety and quality.

The overriding reason for performance-based contracting is to craft a new business model between the owner and the contractor. What will this new model do? It will translate the performance requirements of the owner into language that will allow the contractor to understand, plan, and build the project accordingly. This new model will clearly address product performance requirements, the need to minimize disruption to traffic and the community, and the need to produce facilities with long lives.

Societal changes are driving changes in contracting strategies as well. With dramatic reductions in both the numbers and the experience levels of government inspectors and engineers, highway agencies are reexamining their roles and responsibilities. The complexity of high-speed construction, nighttime construction, and the performance of rehabilitation work under conditions in which traffic remains flowing—all of which the public demands—further stretches the available agency resources. Low-bid contracting is not the best approach for this type of work, as the growing interest in design–build contracting, public–private partnership (PPP) agreements, and long-term warranties and maintenance contracts indicates.

Performance-based contracting is not new. As noted in Figure 1, its roots are in older forms of design–build contracting by use of the integrated master-builder concept. In a sense, today’s design–build contracting, PPPs,

If a builder build a house for a man and does not make its construction firm and the house which he has built collapse and cause the death of the owner of the house—that builder shall be put to death.

If a builder build a house for a man and does not make its construction meet the requirements and a wall fall in—that builder shall strengthen the wall at his own expense.

**FIGURE 1** Excerpt from the Code of Hammurabi, King of Babylonia, 2200 B.C.

and other forms of integrated contracts have taken contracting full circle. Performance contracting is a common thread. Performance contracting is outcomes based. It works best in a best-value, lump-sum contracting environment rather than in a low-bid, quantity-based, unit-priced contracting environment. It motivates the contractor to focus on outcomes rather than output to be innovative and efficient.

Given the current pressures on the NHS and the promise of performance-based contracting, the question remains: Is performance-based contracting a viable contract option for building and maintaining the U.S. highway system? This paper first examines the state of the practice of performance-based contracting outside the United States. It then looks at the extent that these practices have taken root in the United States, the limitations to their use, and new initiatives to promote their implementation.

### STATE OF THE PRACTICE OUTSIDE THE UNITED STATES

The need to manage and improve an aging highway infrastructure program efficiently and effectively while being confronted with limited public funding and reductions in agency personnel is not a problem unique to the United States but is, instead, a universal issue facing the transportation sector throughout the world. By looking beyond U.S. borders, it can be seen that highway agencies in Europe, Latin America, and elsewhere have responded to this challenge by increasing private-sector involvement in highway construction, operation, and maintenance. In doing so, several of these agencies have gradually moved away from the use of traditional procedural (method) specifications to the greater use of performance-oriented contracts that include functional (end result- and outcome-based) specifications that capitalize on the expertise of the private sector. For example, a performance contract may specify pavement performance in terms of roughness, rutting, or surface friction. Left unstated is exactly how the contractor is to achieve the performance standard prescribed. This arrangement

thus allocates a greater performance risk to the contractor but also creates the opportunity for increased profit margins should contractor-initiated design, process, or technology innovations yield improved efficiencies or cost savings.

On the basis of the experiences of agencies outside the United States in implementing performance-oriented contracting, no single approach can be considered one that is typically used by all agencies. Cultural differences, societal needs, the experience of the road administrators with outsourcing work, and the size and the competence of local contractors, among other issues, all drive the contractual arrangements ultimately established with the private sector. In addition, the nature of the project itself [e.g., new construction versus the maintenance of existing assets and design-build versus design-build-finance-operate (DBFO)] also plays a large role in determining the amount of risk allocated to the private entity and the term for which the private entity is responsible for the asset. Examples of performance-oriented contracting used outside the United States include design-build and its variants, PPPs, and performance-based maintenance contracts. These techniques have been implemented with various degrees of success; however, the continued interest in and the expansion of these concepts are the best indicators of their long-term viability.

Agencies reporting the highest satisfaction with performance contracting embarked on their programs with an eye toward fostering a culture of trust and partnership with the private sector. This is not an environment that developed overnight; rather, as these agencies grew more comfortable with private-sector involvement in public works, the level of private participation increased. This progression is perhaps best exemplified by the evolution of design-build contracting in the United Kingdom (1). The early design-build contracts let by the United Kingdom's Highways Agency in the mid-1990s did not integrate the designer-builder until after the conclusion of the statutory planning stages, at which point the design was at least 80% fixed. Recognizing that the earlier involvement of the contractor could increase opportunities for innovation, improve risk management, improve constructability, and reduce impacts during construction, the Highways Agency created a new generation of design-build contracts that provided for earlier contractor involvement. Under these contracts with early contractor involvement, the designer-builder is selected, largely on the basis of qualifications, shortly after the identification of the preferred route and well before the start of any statutory planning stages that involve public hearings. After contractor selection, additional design and planning tasks are performed with the input of the entire delivery team to establish a target price for the project from that point forward. Various mechanisms are incorporated throughout the design and construction

process so that the contractor may share in the savings achieved and participate in any losses realized when the actual costs are compared with the target price. This scheme is intended to encourage additional innovation and continual improvement throughout the development of the project by the designer–builder.

As a natural outgrowth of its design–build program, the United Kingdom extended private-sector involvement to include finance, operation, and maintenance. Through its DBFO contracts, the Highways Agency engages the private sector in the finance, construction, and operation of new roadway facilities (2). Under the terms of these contracts, the agency monitors the performance of the contractor during the construction, operation, and maintenance phases to ensure that contractual obligations are met. A penalty point system assesses points for failure to perform on the basis of specific threshold triggers. Should a specified number of penalty points be assessed, the agency has the right to terminate the contract. As an alternative remedy, the agency also has the right to correct any defaults and invoice the DBFO firm accordingly. To ensure that the road is returned in a condition fit for service, the DBFO contract also includes specific clauses regarding hand back, with a required residual life specified for each element of the project road. For example, at least 85% of the road pavement must have at least a 10-year residual life on hand back.

Similar partnership arrangements between the public and the private sectors for infrastructure construction and operation are increasingly being used throughout Europe. This trend is attributable to the expectation of the higher efficiency and the faster implementation provided by private-sector involvement and the need for private capital to be added to limited public resources. Even Germany, which has historically been more prescriptive than some of its European counterparts, has seen a rise in PPP arrangements since 2000, with German municipalities reporting average efficiency gains of 10% through the use of this type of contracting initiative (3).

Where performance contracting has perhaps taken the greatest hold outside the United States is in the area of performance-based maintenance of existing highway assets. The Highways Agency in the United Kingdom has established managing agent contractor (MAC) contracts under which a service provider (typically, a joint venture between a contractor and a consultant) has single-point responsibility for the management and the maintenance of an area network (4). The MAC contract allows the service provider to design and undertake all projects up to a value of £500,000 (\$980,000 in 2006 dollars). The contract also incorporates performance specifications for routine and winter service and includes the requirement for the provider to measure and benchmark performance, with the expectation that the provider will achieve continual improvement. The asset modeling

required to determine the interactions and dependencies between routine and periodic maintenance and rehabilitation treatments is undertaken by the provider in collaboration with the agency.

The MAC contracts used in the United Kingdom are typical of the performance-based maintenance contracts used by many national highway agencies faced with staffing shortages (5). These contracts typically include key performance indicators against which the contractor's performance is measured. Typical indicators may include

- The international roughness index, which measures the roughness of the road surface;
- The absence of potholes and the control of cracks and rutting;
- The minimum amount of friction between tires and the road surface;
- The maximum amount of siltation or debris in drainage systems; and
- The retroreflectivity of road signs.

For each performance indicator included in a contract, a response time and, often, a penalty are defined for noncompliance. For example, in Argentina, where the rehabilitation and maintenance of over 14,000 km (approximately 45%) of the national paved roadway network has been contracted out, a penalty of \$440 (in 2000 dollars) is applied for each day that a pothole of more than 2 cm deep is left open (6). Similarly, in other countries the contractor may receive a bonus payment for exceeding the specified targets.

The extent to which such maintenance contracts involve the contractor in the engineering and design of the roadway asset varies from agency to agency. Some agencies are still using a hybrid approach of method- and performance-based specifications, whereas more advanced practitioners hold the contractor accountable for both rehabilitation and routine maintenance. For example, under the Argentine model of areawide performance-based contracts, contractors are responsible for the rehabilitation and subsequent maintenance of a roadway section for a defined period. Rehabilitation (e.g., slurry seal, surface dressing, overlay, and reconstruction) occurs during the first year. This is followed by maintenance activities (e.g., patching, cleaning, and sign renewal) in subsequent years. The contractor carries out the detailed design for all rehabilitation work on the basis of a minimum standard stipulated in the contract.

In keeping with this worldwide move toward performance contracting, the Netherlands National Public Works Department (NNPWD) has experimented with changing its business model considerably to move more toward the use of performance-oriented contracts for construction and maintenance. As described in the 2002 International Scan

TABLE 1 Levels of Requirements to Be Used in Different Forms of Contracts

Contract Type	Level 1: Drivers' Wishes	Level 2: Performance Requirement	Level 3: Construction Behavior	Level 4: Materials Behavior	Level 5: Raw Materials and Processing
Traditional	→	→	→	X	X
Maintenance performance	→	X	x	X	X
Design-build	→	X	X	Con	Con
DBM	→	X	Con	Con	Con
PPP	X	X	Con	Con	Con

Note: X = in these contract types, this will be the first level; x = in many cases, these levels will be used for considerable parts of the project; → = during the initial preparation of a project, the agency should always start with Level 1 and then move to the appropriate specification level for the contract type; Con = the contractor must translate the contract specifications into instructions for personnel at Level 5 or even lower.

Tour Report, NNPWD planned to pilot a number of integrated contracts containing design, construction, maintenance planning, and maintenance tasks (7).

With this new approach, the private sector will bear more responsibility and risk in the contract. This will be done on the basis of risk analysis. The contractor will no longer have obligations based on detailed technical prescriptions; instead, these obligations will be based on functional contract requirements describing the desired performance of the work.

In the proposed NNPWD model, there is a relationship between the form of the contracts and the levels of specifications. As shown in Table 1, Level 2 requirements are applicable in maintenance performance, design-build, design-build-maintain (DBM), and PPP contracts. However, when the desired lifetime is longer than the contract time under DBM and PPP contracts, there might be risks that make it necessary to go down to Level 3, in which the contractor must ensure future construction behavior.

Clearly, performance-based contracting has become a viable contract option outside of the United States, as evidenced by its sustained growth and development, particularly in Europe, where it has become a common business model for some transportation agencies. If broad comparisons can be made between the European and U.S. business models for the transportation industry, they might highlight the characteristics listed in Table 2.

This comparison does not represent the universe of contracting in either case. The models represent more the norm. The models that some European agencies use are more closely aligned with the U.S. model, whereas some agencies in the United States are actively moving toward the use of practices common in Europe (8).

## STATE OF THE PRACTICE IN THE UNITED STATES

Although the viability of performance-based contracting has been proven outside of the United States, barriers to the widespread development of performance-based contracts in the United States stem from the separation of services and the low-bid system ingrained in public-sector construction, the long-standing use of prescriptive or method specifications by the U.S. highway industry, and pressure from the industry to package construction contracts to accommodate smaller, mom-and-pop highway contractors and disadvantaged businesses. Despite these barriers, performance-based contracting has taken root in the United States in recent years because of economic, societal, and organizational pressures within U.S. transportation agencies. U.S. transportation agencies have adopted contracting concepts from Europe and have also developed home-grown approaches. Design-build, warranties, roadway maintenance, and pavement performance specifications are the areas in which performance-based contracting has made inroads.

### Design-Build

Design-build project delivery in the United States has been evolving rapidly over the past 10 years. As of January 2006, a report on the effectiveness of design-build contracting prepared for FHWA reported that more than 32 states have used or are considering the use of design-build on federal aid highway construction projects (9) (Figure 2).

TABLE 2 Comparison of European and U.S. Business and Contracting Models

European Model	U.S. Model
<ul style="list-style-type: none"> <li>• Large, vertically integrated companies compete for larger integrated service contracts (by using design-build, early contractor involvement, PPP, or other integrated contracts)</li> <li>• Industry is highly involved with the owner in project development, management, and implementation</li> <li>• Qualifications-based selection is widely used</li> <li>• Specifications are more performance based</li> </ul>	<ul style="list-style-type: none"> <li>• Specialty companies compete for smaller and separate design, construction, maintenance, or other contracts</li> <li>• The owner retains more control over project development, management, and oversight</li> <li>• Low-bid contracting is the standard procurement method</li> <li>• Specifications are largely prescriptive in nature</li> </ul>

That report indicated that FHWA had approved more than 400 design-build projects nationwide under Special Experimental Project No. 14 (SEP-14), and a large number of these were still not complete as of the date that the study was published (10). Although high-profile megaprojects such as the Utah I-15 project and the Colorado T-REX project have gained national attention, only about 20% of the SEP-14 projects are more than \$50 million (in 2003 dollars) in value. Although design-build represents a small portion of the projects, it is growing rapidly. Approximately 80% of the SEP-14 projects were approved after 1999.

One of the key advantages reported in the design-build effectiveness study was the potential to use performance specifications in design-build contracts to encourage greater innovation by the designer-builder and focus on project performance outcomes rather than conformance with product or prescriptive specifications. The excerpt from the I-15 design-build request for proposal in Figure 3 illustrates this emphasis on performance outcomes. On the basis of the results of the survey, more than half of the specifications for the design-build projects reported in the United States were entirely prescriptive.

The remainder of the specifications used some combination of prescriptive and performance-based specifications. Only 3% of the respondents reported that they used purely performance-based specifications. The survey also indicated that traditional design-bid-build contracts also incorporated a similar mix of prescriptive and performance-based specifications. The authors concluded that the rate of use of performance specifications has been growing for both delivery approaches but that there is still significant resistance from within owner organizations to relinquish control and to replace prescriptive requirements with performance requirements.

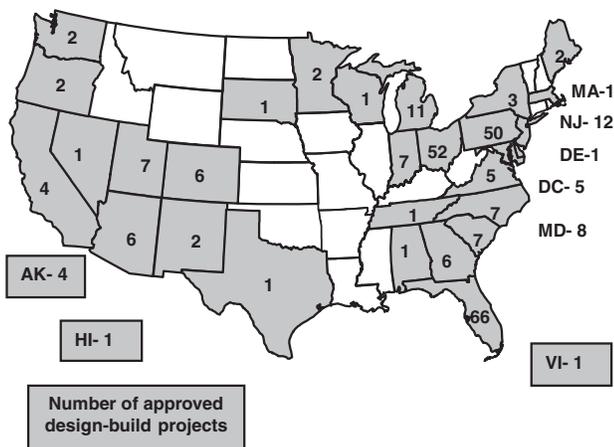


FIGURE 2 States with approved SEP-14 design-build projects (9).

The Performance Specifications included in Section 6 of the Utah I-15 RFP establish requirements that the Contractor's work shall achieve. They are intended to provide clear requirements for how the finished product is to perform while allowing the Contractor considerable flexibility in selecting the design, means, materials, components, and construction methods used to achieve the specified performance.

Additional standards and references are cited within the Performance Specifications under the headings "Standards" and "References" and within the body of the specification. The following distinctions apply. "Standards" constitute a further elaboration of the requirement. "References" constitute advisory or informational material, provided for the Contractor's benefit, that need not be followed, but in some cases provide acceptable solutions already in use by the Department. In most cases, the Standards are cited within the body of the Performance Specifications, and in a few cases, specific parts of References are cited as requirements.

FIGURE 3 Excerpt from Utah Department of Transportation OT I-15 design-build request for proposal (2002).

Recommendations for improving design-build programs on the basis of the lessons learned from design-build projects have included the following: (a) overprescription of design details or construction techniques may stifle potential innovation, and (b) to ensure that the contracting agency receives the expected product within budget, clear and concise performance specifications are essential to the success of a design-build contract.

## Warranties and Performance Contracting

Warranties are not a new phenomenon in the United States. They have been used for construction projects since the late 1800s. In the United States, one of the earliest providers of warranties on roadway construction was Warren Brothers Paving. From 1890 to 1921, Warren Brothers Paving owned a patent on hot-mix asphalt (HMA) and warranted the material and the workmanship of its HMA pavements for up to 15 years. This practice was commonplace for cities until the early 1900s, when AASHTO (now AASHTO) and state highway agencies began to develop and maintain method specifications to promote uniformity in specification use throughout the country.

With the issuance of an FHWA final rule in 1995 that allowed states to use warranties without approval, warranty use in the United States increased dramatically and then leveled off, especially for low-bid contracts. However, interest in warranties combined with nontraditional integrated services delivery in the United States appears to

be growing. The warranted components identified by various NCHRP synthesis studies include (11) the following:

- HMA concrete pavement,
- Portland cement concrete (PCC) pavement,
- Bridge components,
- Bridge painting,
- Chip sealing,
- Intelligent transportation system components,
- Landscaping and irrigation systems,
- Microsurfacing,
- Pavement markings, and
- Roofs.

Warranty provisions are performance based, in the sense that they incorporate performance indicators and thresholds to measure performance over a prescribed warranty period. Performance indicators and thresholds vary considerably among the agencies that have implemented them (Table 3). Warranty performance indicators are distresses, properties, or characteristics of the warranted component that can be measured and that are linked to the performance of the warranted component of the end product. For example, performance indicators for an asphalt pavement may include rutting and cracking. Thresholds are the allowable limits not to be exceeded over the performance period.

Practitioners agree that the basic benefits of a warranty are improved performance, the reduced need for inspections, and the potential for cost savings and innovation. However, if a warranty with material- and workmanship-type provisions is used, there is less of a likelihood that cost savings, innovation, and improved performance will be realized. In conjunction with a best-value design-build or an integrated services contract, the more performance oriented that the warranty is, the greater the ability that the contractor has to control the design, material selection, and workmanship so that they meet or exceed the desired outcome (8).

In the larger context of performance contracting, warranties represent a transition between a prescriptive or material and method specification and performance specifications, in the sense that warranty provisions do not include all the factors that contribute to performance. For example, warranty provisions for pave-

ments typically exclude subbase, drainage, and embankment features or other factors related to pavement design or construction methods that may affect performance. Although the scope of the warranted work and the performance indicators may not capture all of the factors that contribute to performance, they provide a tool that can be used to transfer the responsibility for performance to the private sector and ensure that the products of construction will meet the targeted performance thresholds for at least part of the life cycle of that product or component.

### Performance Standards Under a PPP Agreement

A PPP, by definition, is an agreement between a public owner and a private entity to develop, design, build, finance, operate, and maintain a transportation facility or system for a specified service life on the basis of a defined set of agreed-upon performance standards. The term “PPP” encompasses the term “concession,” which is used more commonly in Europe, in which a private operator purchases the right to develop, operate, and maintain a transportation facility for a specified number of years in return for a fee (tolls, fees, taxes, or other revenue sources). Typically, the financing is a blend of public and private funds or, in some cases, is wholly financed by the private sector.

The PPP contractor operates and maintains a facility on the basis of an agreed-upon set of performance standards, which apply the concept of a performance threshold to a long-term operation and maintenance period. PPP contracts also include the concept of hand-back or turnover requirements at the end of the operation and maintenance period (or lease) on the basis of a defined performance service level or residual life.

In parallel with its growing use in Europe, PPP contracts have been applied to a handful of high-profile projects in the United States, but they have recently gained new momentum as transportation system owners struggle to find resources to fund and deliver critical transportation projects. Some of the earliest examples of privately funded PPP projects developed in the United States were the Route 91 Express Lanes in California and the Dulles Greenway in Virginia, both of which were completed in

**TABLE 3 Performance Indicators and Thresholds**

Indicator Threshold	Mississippi	Wisconsin	Minnesota
Method or segment length	Deduct points	Segment = 1/10 mi	Segment = 500 ft
Rutting	>5.0 points >7.0 points	≥0.25 in. <0.50 in. ≥0.50 in.	≥0.375 in.
Transverse cracking	>3.0 points >5.0 points	>25 cracks that average 1 in. in width per segment	Three cracks per segment

1995. More recent examples include the Port of Miami, Florida, Tunnel and the Trans-Texas Corridor (12).

The Texas Department of Transportation (TxDOT) established operational and maintenance performance standards that the concessionaire must meet during the operation of the Trans-Texas Corridor. The pavement performance standards define the minimum standards (thresholds) that the concessionaire will be required to meet to operate and maintain the facility. Corrective action will be made if these thresholds are exceeded. The performance standards included (13) the following:

1. Pavement condition score—measurements and inspections are necessary to derive the pavement condition score (in accordance with TxDOT procedures).

2. Ruts on the main lanes, shoulders, and ramps—depths are measured with an automated device, in compliance with TxDOT standards, and a straightedge is used to measure the rut depths for localized areas.

3. Ride quality—the international roughness index is measured according to TxDOT standard Tex-1001-S (operating inertial profilers and evaluating pavement profiles).

4. Failures—instances of failures exceeding the failure criteria set forth in the TxDOT pavement management information system rater's manual, including potholes, base failures, punch outs, and jointed concrete pavement failures, are recorded.

5. Edge drop-offs—edge drop-off levels compared with the level of the adjacent surface are measured physically.

6. Skid resistance—the ASTM standard test method for skid resistance testing of paved surfaces at 50 mph (ASTM E274) is performed with a full-scale smooth tire meeting the requirements of ASTM E524.

These PPP performance standards and thresholds are similar to the performance characteristics and thresholds specified for warranty contracts, but they extend the performance period in some cases well beyond the service life of the pavement or component, which would entail major rehabilitation during the operation and maintenance period. They also do not include exclusions that may void the agreement. To achieve these standards, PPP specifications are performance based rather than prescriptive. For example, TxDOT will not, in theory, specify the pavement design and type and will limit its review and approval functions.

### Performance-Based Contracting for Maintenance

In traditional maintenance contracting, the owner directs a group of contractors to perform specific tasks. The owner specifies what work will be done and how it will

be done. Under this traditional approach, the owner retains complete control over the direction of the work but also retains all of the risk that must be undertaken to achieve the desired system condition. This desired condition is not always defined, which can lead to maintenance by crisis rather than the taking of a programmatic approach to optimization of the condition of the system.

Under a performance-based maintenance contracting system, the owner specifies what it wants to achieve in terms of performance standards; and the contractor selects the methods, materials, and techniques that will best meet the performance standards at a systemwide level. The contractor manages and directs the work, and the owner agency monitors the progress to ensure that it is getting the performance and system conditions that it is paying for. This arrangement promotes efficiency, the optimization of resources, and innovation and transfers the risk and responsibility for achieving performance goals from the owner to the contractor. Performance-based maintenance contracting is commonplace in Europe, Canada, and elsewhere; but its use in the United States has advanced through the implementation of long-term maintenance contracts in the Virginia DOT, TxDOT, and the District of Columbia. Several other agencies also plan to implement this approach.

The DC Streets project, which has been undertaken over the past 5 years by the District of Columbia DOT and FHWA, is an experimental project that uses federal-aid funds to lengthen the life cycle of the infrastructure and provide better service to the public. The project aims to rehabilitate the condition of the assets to a specified level and maintain them at or above the specified level under a performance-based preservation contracting environment. This \$70 million federal-aid project was the first urban, performance-based asset preservation effort of its kind in the United States. This was also the first time that FHWA teamed directly with a city government on a program to preserve its highway infrastructure.

The project entails a private contractor that manages, rehabilitates, and maintains more than 75 mi of the NHS in the District of Columbia. The District's portion of the NHS contains the city's most important and heavily traveled roadways. The DC Streets contract covers all of the NHS roadways, with the exception of those maintained by the National Park Service. The contract includes all transportation infrastructure assets, right-of-way to right-of-way, with the exception of traffic signals. Specifically, the following maintenance categories are included: pavement structures, roadway cleaning, drainage, roadsides, traffic safety (i.e., guiderails, barriers, attenuators, pavement markings, signs, and lighting), roadside cleaning, roadside vegetation, bridges, tunnels, pedestrian bridges, weigh-in-motion stations, and snow and ice control. The contract includes rehabilitation and maintenance, but it excludes reconstruction. The contractor is scored on the basis of

various performance criteria on a monthly and an annual basis, as illustrated in Table 4 (14).

### Product Performance Specifications

In the performance specification arena, NCHRP and FHWA research initiatives have resulted in the development of homegrown performance-related specifications for HMA and PCC pavements. These specifications, considered the next generation of quality assurance specifications, are a mix of prescriptive and performance requirements. Prototypes have been piloted on the basis of traditional low-bid highway contracts but continue to evolve and are not widely implemented by the industry. Performance specifications have also been proposed for bridges, landscaping, intelligent transportation system components, and other features. An example of a performance specification framework for bridges might include the considerations described below.

### Method or Prescriptive Techniques

Conventional AASHTO and state department of transportation bridge construction specifications generally require the contractor to follow prescriptive specifications that provide the physical configurations of various components made of specific materials.

The physical properties of those materials are typically specified by reference to AASHTO or ASTM specifications and are confirmed by agency-controlled

acceptance sampling and testing in the field and in the laboratory.

### Performance Requirements

The framework for a performance specification for an entire bridge structure may be to construct a bridge that will safely carry traffic for a prescribed period of time on the basis of specific loading requirements, the location of the bridge, geometric constraints, environmental conditions, and specific codes and criteria. Material properties must be based on ASTM or AASHTO standards. The contractor must use work practices that maintain quality, safety, and efficiency and that do not result in any short- or long-term durability or performance impacts on the structure.

Other performance specifications can be developed for components of the bridge. These performance specifications would establish conditions for acceptance at the time of construction, but they also contain some elements of future performance to confirm the structural integrity and functionality of the structure.

Examples of component specifications include the following:

- Deck smoothness, friction (safety), noise, and permeability could be specified. The specification could also control deck cracking and concrete spalling. Acceptable performance measures would be developed in each of these categories.
- Concrete spalling for components of the bridge other than the deck could be specified and measured in terms of an acceptable amount of spalling permitted over time.
- There are many examples of warranty specifications for paint that could be explored as well. Rather than specifying a specific painting system, it could be specified that the paint must last  $x$  years without repainting. Performance measures may be that, depending on the location on the structure, less than  $x$  percent of the structure area is peeling, cracking, rusting, blistering, and so forth.
- The performance of the rebar or prestressing strand exposure could be specified as well.
- The overall appearance and the functionality of expansion dams, joints, and bearings are other elements that could be specified.

Under a performance umbrella, the bridge is still designed according to the same parameters, but the contractor would be granted more freedom to determine the specific design and materials used to meet the performance requirements.

TABLE 4 Scores for Year 4.5 Evaluation (14)

Maintenance Category	Score	Maximum Score	%
Pavement structure	8.6	9.1	95
Roadway cleaning	7.7	7.3	106
Drainage	7.3	6.8	107
Roadside			
Curbs			
Gutters			
Sidewalks	7.6	6.7	113
Traffic safety			
Guardrails			
Barriers			
Attenuators	8.1	7.3	111
Roadside cleaning	8.0	6.6	120
Roadside vegetation	5.8	6.1	96
Bridges	7.3	8.2	89
Tunnels	8.7	8.7	101
Traffic safety			
Pavement markings	7.1	6.9	103
Signs	6.1	6.6	92
Lighting	6.4	7.0	91
Miscellaneous assets			
Pedestrian bridges			
Weigh-in-motion	4.9	5.5	90
Snow and ice control	7.2	7.2	100
Total score	200.8		

### Testing and Confirmation of Performance Requirements

Loading conditions will need to be monitored to determine if the actual loadings are consistent with the design loadings. This can be performed through the use of monitoring devices embedded within the structure. Conventional bridge inspection techniques may be used to monitor the bridge's condition.

Proper maintenance is a key to the life expectancy of a structure. To avoid concerns or claims from the contractor that improper maintenance caused the structure to not meet the performance specifications, the department of transportation may require the contractor to perform the maintenance that it determines is required. This could lead to a warranty that includes both planned and unplanned maintenance.

### NEW INITIATIVES

#### FHWA Highways for LIFE

The FHWA-sponsored Highways for LIFE (HfL) program (LIFE represents longer-lasting highway infrastructure using innovations to accomplish fast construction of efficient and safe highways and bridges) has recently developed a performance-based framework for designated HfL projects. Under the HfL program, performance contracting is defined as an approach by which a private contractor is responsible for achieving a defined set of goals and in which performance goals instead of methods are specified. The performance contracting framework allows agencies to define and communicate to construction contractors specifically what they and FHWA want to achieve. The construction contractors on HfL projects share the risks and rewards as a project partner, and the defined performance goals and measurement methodologies provide a basis for the application of incentives and disincentives. For a performance contract to be successful, the contractor must be provided with flexibility on how to perform the work (15).

The purpose of this framework is to provide the states participating in HfL projects with processes and materials that they can use to develop a performance-based solicitation package. The framework also helps to provide a consistent basis of measurement between HfL projects for use at the program level. The framework includes processes and sample materials for

- Performance goals,
- Performance measurement methodologies,
- Best-value awards, and
- Enhanced low-bid awards.

The framework focuses on processes and materials that would be different from those used for a traditional low-bid solicitation process for a nonperformance-based construction contract. The basis of any performance contract is the set of performance goals that defines what the contractor is to achieve under the contract. The development of these goals is time-consuming and needs to be a group activity within the agency. A goal development process is described in Figure 4.

The project team followed a similar process to develop a sample set of performance measures for HfL projects.

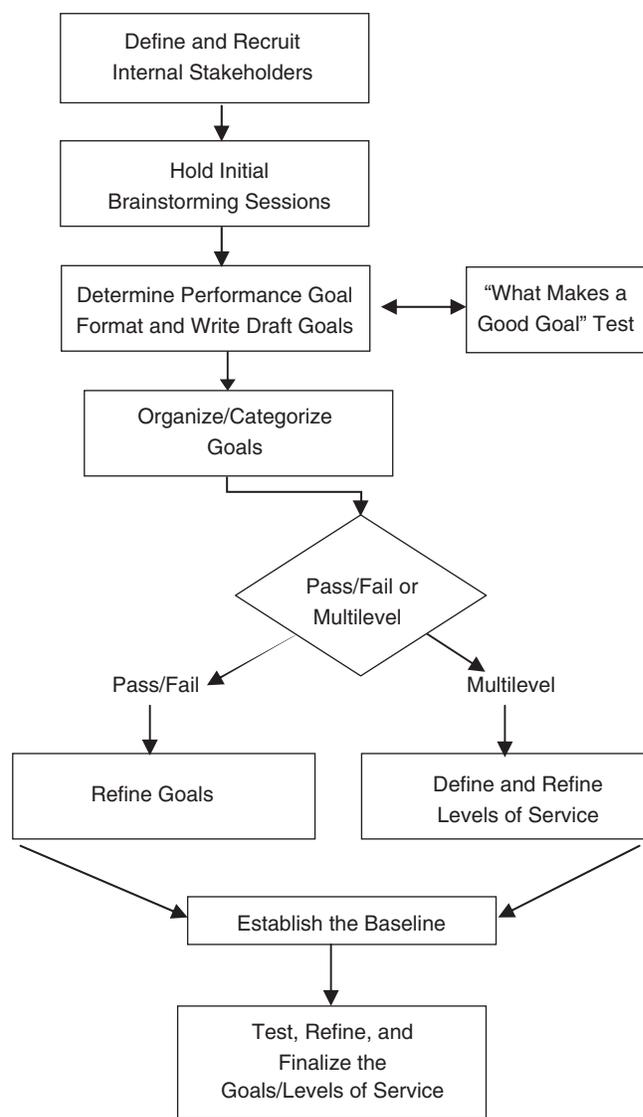


FIGURE 4 Process for defining performance goals and measures.

### Strategic Highway Research Program Project R-07 Performance Specifications for Rapid Highway Renewal

The Strategic Highway Research Program (SHRP II) contains four target areas: safety, reliability, renewal, and capacity. The renewal track looks at improving the aging infrastructure through the use of rapid design and construction methods that would cause minimal disruption and produce long-lived facilities. Project R-07 targets the development of performance specifications.

As recently defined by the FHWA-sponsored Performance Specification Technical Working Group and adopted by SHRP II, a “performance specification” is an umbrella term that more and more describes a family of specification types. An overview of construction specification types is shown in Figure 5. Under the umbrella, one might see end-result specifications, performance-related specifications, performance-based specifications, warranties, and incentive-based specifications. Table 5 compares the various types of performance specifications. A performance specification attempts to define the performance characteristics of the final product or service and links them to construction, materials, and other items under the contractor’s control. Performance characteristics may include end-result items such as pavement smoothness, bridge deck corrosion, and embankment slope stability; but they may also extend to other project performance objectives related to time, quality, safety, cost, or user satisfaction (16).

When the future performance of a product is estimated by using key construction tests and measurements linked to the original design by modeling and life-cycle costs, the specification is described as being performance related or based. When the condition of the product is measured after a predetermined time by using measurable parameters, the specification is known as a warranty. The Project R-07 definition of performance specifications expands the concept of performance specifications further to include incentive-based specifica-

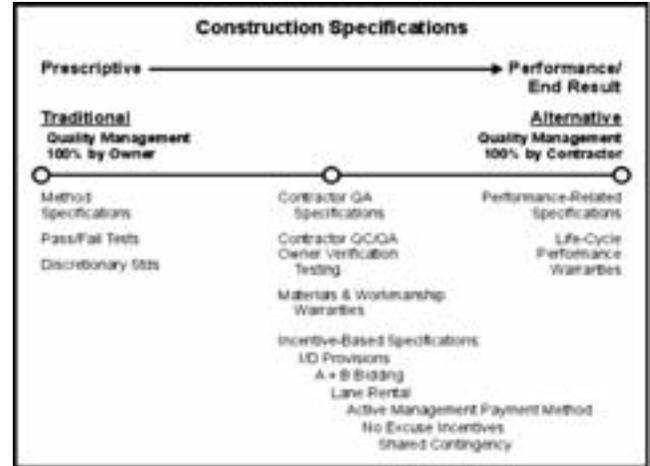


FIGURE 5 Spectrum of construction specifications (Std = standards; QA = quality assurance; QC = quality control; I/D = incentive/disincentive provisions; A + B = cost-plus-time bidding).

tions for time, safety, or other measurable performance goals for a project.

The objective of specification writers is to translate the highway agency’s intentions into clear, concise, complete, and correct (or unambiguous) instructions for the contractor. Today, more than ever, owners and practitioners recognize that this objective must also allow the contractor to exercise ingenuity in complicated rehabilitation and reconstruction projects. Less prescriptive specifications give the contractor more control and allow the contractor to exercise more creativity to meet project demands.

The overriding reason for the Project R-07 performance specification initiative is to craft a new language for communication between the owner and the contractor. It will translate the performance requirements of the designer into language that will allow the contractor to understand, plan, and build the project accordingly. This new language will address product performance requirements, the need to minimize disruption to traffic and community, and the need to produce long-lived facilities.

TABLE 5 Performance Specification Types: Reduce Noise by Reducing Tire–Pavement Noise (PCC Pavement)

Key Performance Drivers Under Contractor Control	End Result Through Physical Dimension Measurements	Performance Specifications Functional Measurement (One Time Only)
Material properties: the effects of large and coarse aggregates on noise for both micro- and macrotexture issues	Transverse and longitudinal fin spacing, depth, variability, e.g., leave randomized spacing of 16 to 26 mm (approximately 5/8 to 1 in.). The required tine width is 2 to 3 mm (approximately 1/12 to 1/8 in.), and the required tine depth is 3 to 8 mm (approximately 1/8 to 5/16 in.). Included is a sampling plan and measurement technique.	Noise generated from pavement–tire interaction shall not exceed a decibel value of x when it is measured by y placed z distance from the pavement under live (or controlled) traffic. Included are a sampling plan and percent-within-limits (PWL) analysis. Note that this is a one-time measurement and generally assumes, but is not made explicit, that downstream use will be adequate. May need material, construction, and end result.
Construction practices: burlap drag, astroturf drag, tining, raking, mix consistency and delivery, impact on skid and smoothness if changes are made only for noise reduction		

NOTE: Method and end result are both generally included in current specifications. Performance specifications must address the measurement technique, noise, and some level of understanding of the relationship between noise and other distresses, for example, smoothness and skid.

## SUMMARY: WHERE TO FROM HERE?

Despite the impediments, the use of performance-based contracting is advancing on several fronts in the United States, including design–build, warranties, PPPs, performance-based maintenance contracting, and various performance specification initiatives. The lessons learned from the experience gained to date in both the United States and overseas is that performance-based contracting is more effective when the contractor has greater flexibility, input, or control over factors that affect performance. This tends to move performance-based contracting in the direction of integrated services contracts, including design, construction, maintenance, and operations contracts, in which the use of prescriptive requirements is not economical or practical from a risk management perspective.

Are the contracting practices of Europe a window to the future? To some degree, the U.S. transportation industry is currently experimenting and adopting many of the performance-based contracting practices that have proven to be viable there. Should the United States simply copy what Europe is doing? This would not be practical without organizational and cultural changes. The United States cannot simply transplant these practices without changing the inherent business model and ingrained organizational culture. Is performance-based contracting a viable contracting option in the United States? Absolutely! The United States has a real-life laboratory to learn about performance specifications and contracts and will develop viable homegrown versions. The United States is learning from Europe's efforts; is experimenting with its own performance contracting and specifications; and will adapt those with the greatest potential to improve performance, accelerate construction, and reduce the life-cycle costs of the U.S. transportation system.

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### Performance-Related Specification Based on Prediction of Future Value

Noise generated from pavement–tire interaction shall not exceed a decibel value of  $0.9x$  when it is measured by  $y$  placed  $z$  distance from the pavement under live (or controlled) traffic. Included are a sampling plan and PWL analysis. Is based on a model (data) that shows that similarly designed and built pavements become noisier over a 5-year period.

### Warranty Specification

Noise generated from pavement–tire interaction shall not exceed a decibel value of  $1.1x$  at the end of a 5-year period. An actual periodic measurement schedule is used, and the actual traffic numbers and percentage of trucks are determined. Included are a sampling plan and PWL analysis. Is based on a model (data) that shows that similarly designed and built pavements become over in a 5-year period.

the value required at the end of operation, the value required at the end of the performance period, corrections for traffic and other factors that influence

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# APPENDICES



## APPENDIX A

# Summary of Suggested Research Topics

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## PERFORMANCE MEASURES AS AN ORGANIZATIONAL MANAGEMENT TOOL TO ESTABLISH ACCOUNTABILITY

- Examine best practices in performance measurement that have been used to generate financial and legislative support from both public and private agencies for ongoing transportation initiatives and projects.
- Assess analytical models and visualization techniques that address performance measures for different modes and multimodal systems.
- Examine performance measures, benchmarks, and targets used to evaluate air quality, environmental sustainability, and economic impacts of transportation projects. More research is especially needed in this area on nonhighway modes.
- Examine partnerships among state departments of transportation and other public- and private-sector agencies to develop, implement, and monitor performance measures.
- Conduct a study to examine the use of technology by public and private agencies to effectively communicate performance measures and transportation funding needs to policy makers.
- Examine the use of public opinion surveys to effectively select appropriate performance measures and prioritize policy choices.
- Examine the use of trip-time reliability as a transportation performance measure.
- Examine transportation agencies that have been successful in using performance measures to develop support from the legislature and other groups for addi-

tional funding. Identify and analyze case study examples where the use of performance measures by state departments of transportation, public transit agencies, and other agencies has resulted in broad support for new and ongoing initiatives and projects, including increased funding levels. Elements to be examined in the case studies include the performance measures, communication techniques, and new or sustained funding levels.

## COMMUNICATING PERFORMANCE RESULTS EFFECTIVELY TO YOUR CUSTOMERS

- Examine how the application of performance measures used in the environmental review process are associated with new and expanded capacity projects.
- Examine different approaches toward coordinating public and private performance measures used in freight and goods movement.
- Examine the costs and benefits of freight transportation projects in both the public and private sectors.
- Explore the use of performance measures that assess operational efficiencies in the trucking and freight industries.
- Conduct a detailed assessment of multijurisdictional and multimodal transportation systems.
- Conduct a study on the involvement of nonprofit and transportation resource agencies in the development and use of transportation performance measures.
- Conduct a study on the role of the private sector in the development and use of transportation performance measures.

- Conduct a study that examines performance measures currently being used by state departments of transportation.
- Conduct a study on the use of stated-preference surveys to assist in determining customer expectations related to different aspects of the transportation system for setting benchmarks.
- Conduct a study to examine the real cost of setting and meeting targets.
- Prepare synthesis reports on performance measures in the following areas:
  - Customer service issues (in both public and private agencies)
  - Internal operations at state departments of transportation, transit agencies, and other public-sector transportation organizations
  - Employee-based incentives at federal, state, and local transportation agencies
  - Use of performance measures at the corridor scale

## DATA AND TOOLS

- Complete a synthesis report on visualization techniques and other innovative technologies used in performance measurement (to include issues concerning the recruitment of skilled staff and expertise in visualization technology).
- Conduct a study to explore strategies for establishing collaborations between human factors researchers and transportation agencies to address safety, sustainability, congestion, and environmental issues.
- Complete a synthesis report on the evolution of performance measurement systems and the values associated with the measures.
- Complete a synthesis report that examines the challenges related to collecting, archiving, and reporting data with regard to performance measurement.
- Conduct a study to examine techniques used to improve current data collection methods and to explore future data collection strategies and techniques.
- Examine alternative methodologies to validate travel forecasting models.
- Assess the strengths and weaknesses or limitations of different travel forecasting models and methods.
- Conduct a study to examine techniques used in forecasting conditions in a multimodal system, including land-use considerations.

## HOT TOPICS

- Complete a synthesis report on the current use of performance measures related to sustainability at state

departments of transportation and other public-sector agencies. Follow up the synthesis report with a comprehensive assessment of these measures.

- Complete a synthesis report on performance measures used with tolling and congestion pricing projects in the United States, Canada, Mexico, and Europe. Follow up the synthesis report with a study that examines the application of these measures in tolling and congestion-pricing projects.
- Develop and maintain a safety countermeasure effectiveness clearinghouse or warehouse.
- Complete a synthesis report on currently available safety planning tools and techniques.
- Conduct a study that examines the relationship between demographics and crashes, including fatal crashes.
- Conduct a study that examines the effectiveness of safety strategies applied in urban and rural areas.
- Explore the potential to develop a national highway safety database.
- Conduct a study that examines methods to integrate safety data and visualization techniques to support comprehensive safety strategies.
- Examine the costs and benefits of safety programs across all of the 4Es of highway safety (engineering, enforcement, education, and emergency medical services), to include a cross-functional trade-off analysis.
- Explore the development and use of bipartisan road safety committees among states and local communities.
- Develop a “just-in-time” index for trucks and freight movement.
- Complete a synthesis report on freight-related performance measures used by state departments of transportation, metropolitan planning organizations, and other transportation agencies.

## PERFORMANCE-BASED CONTRACTING AND MEASURING PROJECT DELIVERY

- Conduct research that examines the opportunities and drawbacks associated with public–private partnerships (PPPs) in the United States and identify strategies that would most benefit both the public and private sector through this approach. The following topics could be examined in the study:
  - Strategies to align contractor performance measures with agency objectives;
  - Strategies to create incentives for contractors to improve performance within current and future market conditions;
  - Techniques in developing contracting procedures that allow for greater innovation;
  - Strategies related to standard specifications that allow for private equity and greater competition;

- Strategies that provide incentives to contractors to maintain a roadway or transportation facility so that it remains in good condition throughout the extent of the leasing period;
- Strategies to provide flexibility in long-term contracts that can address future conditions and needs;
- Strategies that provide incentives for contractors;
- Strategies to assist transportation agencies in defining goals and objectives in a PPP;
- Leadership techniques that are used in developing and managing PPPs.
- Explore how state departments of transportation or other transportation agencies can become more innovative in planning, designing, financing, construct-

ing, operating, and maintaining transportation facilities. The study should also address changes in legislation and policies that may be needed to support these initiatives.

- Explore the use of a web-based system for comparing contractor performance, which is currently being used in the United Kingdom.
- Complete a synthesis report on performance measures that are used in construction project delivery. Follow up the synthesis report with a study that builds on techniques outlined in the synthesis and further explores performance measures associated with innovative construction contracting and procurement techniques.

## APPENDIX B

# Conference Participants

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