



TRANSPORTATION RESEARCH BOARD

CONFERENCE PROCEEDINGS ON THE WEB 18

Transportation Systems Performance Measurement and Data

*Summary of the 5th
International Conference*

June 1–2, 2015
Denver, Colorado



The National Academies of
SCIENCES • ENGINEERING • MEDICINE

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Transportation Systems Performance Measurement and Data

Summary of the 5th International Conference

Katherine F. Turnbull
Rapporteur

June 1–2, 2015
Denver, Colorado

Organized by
Transportation Research Board

Sponsored by
Federal Highway Administration
Federal Transit Administration
Performance Measures Technical Transfer Pooled Fund

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NOTICE: The project that is the subject of this report was approved by the Governing Board of the National Research Council, whose members are drawn from the councils of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. The members of the committee responsible for the project were chosen for their special competencies and with regard for appropriate balance.

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 Federal Highway Administration and the Federal Transit Administration, U.S. Department of Transportation; the Performance Measures Technical Transfer Pooled Fund the American Association of State Highway and Transportation Officials; and the Transportation Research Board.

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The **Transportation Research Board** is one of seven major programs of the National Academies of Sciences, Engineering, and Medicine. The mission of the Transportation Research Board is to increase the benefits that transportation contributes to society by providing leadership in transportation innovation and progress through research and information exchange, conducted within a setting that is objective, interdisciplinary, and multimodal. The Board's varied committees, task forces, and panels annually engage about 7,000 engineers, scientists, and other transportation researchers and practitioners from the public and private sectors and academia, all of whom contribute their expertise in the public interest. The program is supported by state transportation departments, federal agencies including the component administrations of the U.S. Department of Transportation, and other organizations and individuals interested in the development of transportation.

Learn more about the Transportation Research Board at **www.TRB.org**.

Preface

The 5th International Transportation Systems Performance Measurement and Data Conference was held June 1–2, 2015, in Denver, Colorado. The conference was organized by the Transportation Research Board (TRB) of the National Academies of Science, Engineering, and Medicine and was sponsored by the Federal Highway Administration (FHWA), the Federal Transit Administration (FTA), and the Performance Measures Technical Transfer Pooled Fund project.

The conference brought together personnel from public agencies, universities, and the private sector to address developing, applying, and delivering performance measures to support transportation decisions. The conference attracted 320 participants from 12 countries, and sessions were streamed live to 100 remote-access participants.

TRB assembled a committee, appointed by the National Research Council, to organize and develop the conference program. The planning committee was chaired by Daniela Bremmer, Washington State Department of Transportation, and Joseph L. Schofer, Northwestern University. Committee members provided expertise in performance management, data analytics, planning, and policies.

The conference was organized around four broad themes:

1. Driving decisions—aligning performance measures to support decisions;
2. Tracking the moves—intermodal performance measurement;
3. Untangling the data web—using advances in data and technology to support performance measurement; and
4. The state of the practice and opportunities.

A plenary session and four breakout sessions were associated with each theme.

These proceedings follow the conference format with the plenary sessions and the breakout sessions tracks presented in order. Full summaries of the plenary sessions presentations and brief summaries of the breakout session presentations are provided. The titles of the posters presented in an interactive session are provided in Appendix A. The list of attendees is provided in Appendix B.

The planning committee was responsible solely for organizing the workshop, identifying speakers, and developing breakout session topics. Katherine F. Turnbull of the Texas A&M Transportation Institute prepared this report as a factual summary of what occurred at the workshop. The conference PowerPoint presentations are available at <http://onlinepubs.trb.org/onlinepubs/conferences/2015/performance/Program.pdf>. Links to specific PowerPoint presentations are also provided in the summaries.

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 National Research Council'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 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: Jane Hayse, Atlanta Regional Commission; John Selmer, Iowa Department of Transportation; Reginald Souleyrette, University of Kentucky; and Jack Stickel, Alaska Department of Transportation and Public Facilities. 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 Susan Hansen of Clark University (emerita). Appointed by the National Research Council, she was responsible for ensuring an independent examination of this report was conducted in accordance with institutional procedures and that all review comments were carefully considered.

The conference planning committee thanks Katherine F. Turnbull for her work in preparing this conference summary report and extends a special thanks to FHWA, FTA, and the Performance Measures Technical Transfer Pooled Fund project 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.

The views expressed in the proceedings are those of the individual conference participants, as attributed to them, and do not necessarily represent the views of all conference participants, the conference planning committee, TRB, or the National Research Council.

List of Acronyms

| | |
|--------|--------------------------------------------------------------------|
| AASHTO | American Association of State Highway and Transportation Officials |
| ARRA | American Recovery and Reinvestment Act |
| CDC | Centers for Disease Control and Prevention |
| CMM | capability maturity model |
| CREATE | Chicago Region Environmental and Transportation Efficiency Program |
| CSCT | Commodity Supply Chain Table |
| DOT | Department of Transportation |
| FHWA | Federal Highway Administration |
| FTA | Federal Transit Administration |
| HOT | high-occupancy toll |
| HPMS | Highway Performance Monitoring System |
| ITS | intelligent transportation systems |
| LBT | Long Beach Transit |
| MAP-21 | Moving Ahead for Progress in the 21st Century Act |
| MAPSS | mobility, accountability, preservation, safety, and service |
| MBTA | Massachusetts Bay Transit Authority |
| MPO | metropolitan planning organization |
| MTC | Metropolitan Transportation Commission |
| MWCOG | Metropolitan Washington Council of Governments |
| NHTSA | National Highway Traffic Safety Administration |
| NPMRDS | National Performance Management Research Data Set |
| NPRM | notice of proposed rule making |
| NYCT | New York City Transit |
| RETAC | Rail Energy Transportation Advisory Committee |
| RTA | Chicago Regional Transportation Authority |
| RTD | Denver Regional Transportation District |
| SANDAG | San Diego Association of Governments |
| SCOPM | Standing Committee on Performance Management |
| SHA | Maryland State Highway Administration |
| SHSP | Strategic Highway Safety Plan |
| SMART | State Measurement for Accountable, Responsive, and Transparent |
| STB | Surface Transportation Board |
| STIP | state transportation improvement plan |
| TPM | transportation performance management |

| | |
|----------|-----------------------------------|
| TRB | Transportation Research Board |
| UP | Union Pacific Railroad |
| U.S. DOT | U.S. Department of Transportation |
| VCAP | value, condition, and performance |
| VMT | vehicle miles traveled |
| WA | Western Australia |

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OPENING PLENARY SESSION

Conference Welcome

Daniela Bremmer, *Washington State Department of Transportation*

Joseph L. Schofer, *Northwestern University*

Michael Lewis, *Colorado Department of Transportation*

CONFERENCE INTRODUCTION

Daniela Bremmer and Joseph L. Schofer

Daniela Bremmer, Washington State Department of Transportation, and Joseph L. Schofer, Northwestern University, cochairs of the conference planning committee, welcomed participants to the 5th International Transportation Systems Performance Measurement and Data Conference. They provided an overview of the conference and thanked the various groups responsible for organizing and sponsoring the conference. Bremmer and Schofer covered the following topics in their presentation:

- Bremmer reported that the first TRB conference on performance measurement occurred 15 years ago in 2000. She noted that the first conference focused on the basics of performance measurement, which was just being introduced at state departments of transportation (DOTs), transit agencies, and other organizations. She observed that performance measurement has become an accepted practice, with subsequent conferences in 2005, 2007, and 2011 addressing data needs, analysis techniques, and communication methods.

- According to Bremmer, this conference builds on the previous events, focusing on sharing best practices and addressing new challenges. Examples of the new challenges include maximizing the use of big data and evolving technologies, focusing on intermodalism and freight supply chains, setting realistic targets, and communicating with policy makers.

- Bremmer recognized and thanked the many agencies, organizations, and people contributing to the success of the conference. She acknowledged the assistance from TRB staff members Tom Palmerlee and Mai Le. She thanked FHWA and FTA for their sponsorship. She also noted the support from the 25 state DOTs participating in the Performance Measures Technical Transfer Pooled Fund project, which is being led by the Iowa DOT. She thanked members of the conference planning committee for their outstanding job developing an informative and interactive program.

- Bremmer reported that approximately 320 participants were registered for the conference from 12 countries, highlighting the international interest in transportation performance measurement. She noted that the conference plenary sessions were also being streamed live to 100 remote-access participants. She encouraged the active participation of all attendees, noting that sharing ideas, experiences, and issues was a key part of the conference.

- Schofer provided an overview of the conference program. He noted that the conference was organized along the four broad themes of driving decisions: aligning performance measures to support decisions; tracking the moves—intermodal performance measurement; untangling the data web—using advances in data and technology to support performance and management; and the state of the practice and opportunities. Schofer said there was a plenary session and four breakout sessions on each of these themes. He noted that the breakout sessions provided more opportunities for interaction and discussion on key topics, as did the poster session that evening. Both days ended with a plenary session highlighting the key themes from the breakout sessions.

- Schofer stressed that participants had something to contribute to the conference and something to learn from the conference. He challenged participants to actively engage in discussions, to stay focused on the topic, to absorb information, and to contribute.

WELCOME FROM THE COLORADO DEPARTMENT OF TRANSPORTATION

Michael Lewis

Michael Lewis provided an official welcome from the Colorado DOT. He thanked the conference planning committee, TRB staff, FHWA, FTA, and other state DOTs for organizing and sponsoring the conference. Lewis also recognized officials from Colorado and federal agencies participating in the conference.

Lewis stressed the importance of performance measurement at the Colorado DOT. He noted the progress made in implementing performance measurement at state, metropolitan, and local transportation agencies over the past decade. He encouraged participants to actively engage in the conference sessions and to share their ideas and experiences with others.

DRIVING DECISIONS PLENARY SESSION

Aligning Performance Measures to Support Decisions

Max Tyler, *Colorado General Assembly*
Jeffrey Paniati, *Federal Highway Administration*
Deb Miller, *Surface Transportation Board*
Kenneth McDonald, *Long Beach Transit*

MAKING MEASURES RESONATE WITH ELECTED OFFICIALS

Max Tyler

Colorado State Representative Max Tyler discussed communicating performance measures and other information with elected officials. He provided recent examples of different approaches and outcomes in Colorado. Tyler covered the following topics in his presentation:

- In describing the roles of the Colorado Legislature and the Colorado DOT, Tyler noted that the legislature does not decide where roads are constructed or which highways are expanded, nor does it decide on projects to be funded by the gasoline tax or other sources. He explained that the statewide Transportation Commission is responsible for distributing funds based on a bottoms-up approach of priority identification. He also described the Taxpayer Bill of Rights, which requires the state to return excess revenues to its citizens.

- Tyler described the 2010 State Measurement for Accountable, Responsive, and Transparent (SMART) Government Act, which introduced performance-based budgeting in Colorado. He explained that the act requires state departments to create 5-year strategic plans that include goals and performance measures. He noted that the Colorado DOT Policy Directives 13 and 14 had already established strategic planning within the department. He also suggested state DOTs by their nature take a long-term approach to strategic planning.

- Many other state agencies did not follow all the statutory requirements and best practice guidance put forth by the Colorado Office of State Planning and Budgeting in the development of their FY 2013 SMART Government Act strategic plans, according to Tyler. He indicated that 14 of the 24 department strategic plans, or 48%, lacked at least one of the five basic required components stipulated in the statute.

- Tyler reported there were areas for improvement with the Colorado DOT's SMART plan, including soliciting input from employees and from other groups outside the agency. He noted that communicating with citizens and interest groups is not easy, but it is key to good planning. He mentioned that the range of available technologies is changing the methods and approaches for gaining input from the public.

- Tyler discussed the Colorado DOT's Responsible Acceleration of Maintenance and Partnerships program, which focuses on better coordination of project expenditures and available funding. He noted that the Colorado DOT was very conservative in cash management, which resulted in \$1 billion in reserve funds. He reported that the Responsible Acceleration of Maintenance and Partnerships program resulted in an additional \$300 million of projects being funded each year.

- Tyler discussed the importance of understanding the difference between data and information. He suggested that too often, agency staff provide data, when legislators and other policy makers really want information. He cited a recent example of requesting information from the Colorado State Patrol on the number of crashes, including fatalities, in urban and rural areas; crashes involving motorcycles; and fatalities involving belted versus nonbelted vehicle occupants. He said even after numerous requests, no information had been provided, and he stressed the importance of turning data into information. He noted that legislators are often faced with considering bills during the session on the basis of very limited information. He suggested that engineers and project managers are not always good at communicating different aspects of complex projects to various stakeholders, which often take many years to complete.

- Tyler used the example of the innovative public-private partnership on the US-36 express lanes project to highlight the difficulty in communicating innovative funding methods to the public. The project included high-occupancy toll lanes on US-36 from Denver to Boulder. He noted that although the project also included bus rapid transit, a separate bike path along the full corridor, and other innovative elements, there was strong public opposition. The controversy created by the project damaged the credibility of both the public-private approach and the Colorado DOT. Tyler suggested that although there were years of planning with stakeholders, there was very little actual citizen input. He summarized many of the public flash points and misperceptions with the project, which included misconceptions about all lanes being tolled, a foreign company financed by Goldman Sachs owning the road, a comparison to the sale of the Chicago parking meters, and the general secrecy associated with the contract.

- The second example Tyler discussed was the rebuilding of a major intersection in his neighborhood. He observed that the Colorado DOT had undertaken citizen participation on the project a number of years ago, with a public scoping meeting in 2007 and environmental approval in 2010. The length of time it took to move

the project forward, however, resulted in current businesses and residents not being fully aware of its scope and scale. Furthermore, concerns were voiced over the lack of access to businesses and the loss of residential property and trees. He commented that residents and business owners characterized Colorado DOT employees as unsympathetic and gruff, with the exception of the staff responsible for land acquisition, who were characterized as sympathetic but not very knowledgeable about the project plan. Tyler said it took assistance from City of Denver staff to help communicate with residents and businesses. He noted that when the reasons for the various project elements—including removing some trees, planting new trees in different locations, and adding a culvert because the intersection is in a flood plain—were fully explained, the residents better understood the benefits of the project.

- Finally, Tyler suggested these examples reinforce the importance of ongoing communication with stakeholders, policy makers, and the public using different methods and techniques, including social media and other new technologies. He concluded with restating the importance of providing information, not just data, to elected officials, policy makers, and the public.

The PowerPoint for this presentation is available at <http://onlinepubs.trb.org/onlinepubs/conferences/2015/performance/tyler-1PS.pdf>.

PERFORMANCE MANAGEMENT: ADVANCING A NATIONAL TRANSPORTATION SYSTEM

Jeffrey Paniati

Paniati discussed the importance of transportation performance management and some of the factors at the national level that are driving interest in performance measures and performance management. He described the activities FHWA was undertaking to implement Moving Ahead for Progress in the 21st Century Act (MAP-21) requirements and the role performance management would play in the future. Paniati covered the following topics in his presentation:

- Paniati recognized the hard work of the conference planning committee, as well as the American Association of State Highway and Transportation Officials (AASHTO), FHWA, and TRB staff involved in organizing the conference. He suggested that the implementation of a performance-based Federal Aid program would be transformational, and he noted that the conference provided the opportunity to discuss many of the tools and techniques to advance transportation performance management.

- Paniati observed that numerous factors and changing circumstances, such as the poor condition of the transportation infrastructure coupled with resource constraints, were influencing interest in transportation performance management. He also

indicated that the public expects federal, state, and local agencies to manage resources effectively, to communicate openly about priorities, and to provide opportunities for participating in the priority-setting process. He commented that performance management is an accepted and proven approach in industry and business.

- Paniati noted that transportation performance management represents a logical evolution of the federal program. As highlighted in Figure 1, the initial Federal Aid program in the 1950s focused on building the Interstate system. He suggested that the focus at the state and federal levels at that time was on oversight of delivering specific projects. The Intermodal Surface Transportation Efficiency Act of 1991 focused more on the planning, project selection, and environmental review processes. He said the focus of MAP-21 is on performance outcomes and management of the system, which represents a transformational change.

- Paniati discussed how MAP-21 included national goals for performance management focused on increased accountability and transparency, with an ultimate objective of efficient investments and the best use of public funds. Paniati reviewed the MAP-21 national goal areas and goals in Table 1. He noted that MAP-21 directs the U.S. DOT to define performance measures related to these national goals. Paniati reported that the philosophy of FHWA has been to establish a few key performance measures for each goal to provide a basic understanding of system performance throughout the country and communicate a national picture of performance. He indicated that the focus at the national level does not provide all the performance measures needed by a state agency operating the system. He commented that

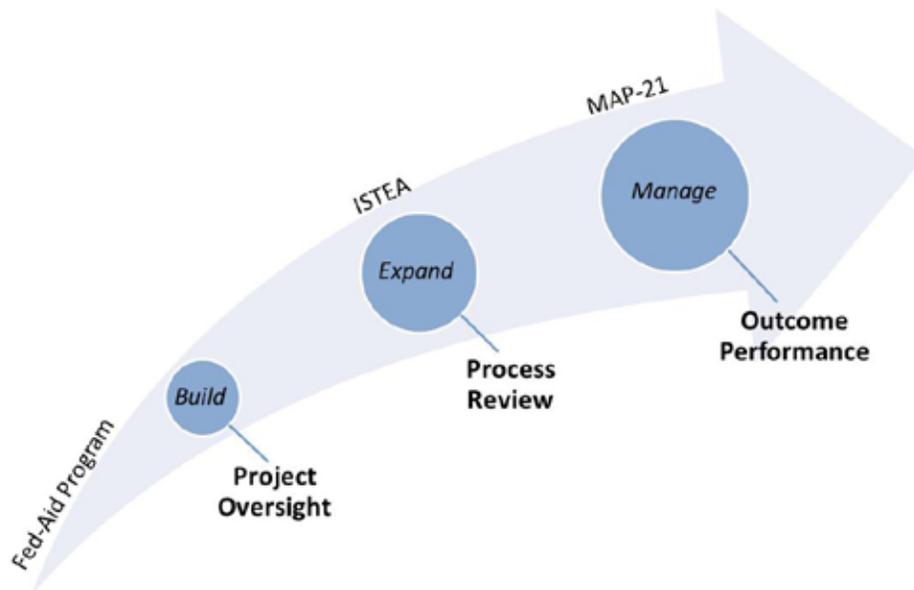


FIGURE 1 Evolution of the Federal Aid program. (SOURCE: FHWA.)

TABLE 1 MAP-21 National Goal Areas and Goals

| Goal Area | National Goal |
|-------------------------------------------------|------------------------------------------------------------------------------------------------------|
| Safety | Reduce fatalities & serious injuries on all public roads |
| Infrastructure condition | Maintain a state of good repair |
| Congestion reduction | Significantly reduce congestion on the NHS |
| System reliability | Improve the efficiency of the surface system |
| Freight movement & economic vitality | Improve the national freight network, access of rural communities to markets, & economic development |
| Environmental sustainability | Enhance system performance while protecting and enhancing the environment |
| Reduced project delivery delays | Accelerate project completion by eliminating delays in the project delivery process |

NOTE: NHS = National Highway System.

SOURCE: FHWA.

many state DOTs have extensive systems of performance measures. He cited the Washington State DOT’s Gray Notebook as one example of an extensive performance management system. He indicated that the level of detail in the Gray Notebook is not the focus at the national level.

- Paniati reported that FHWA has focused on striking a balance between consistency and flexibility in the development of notices of proposed rule making (NPRMs), while ensuring the national program is reliable and credible. He suggested that the development of the national performance management system will continue to evolve. He noted there are more appropriate measures but no data to support them, and available data do not match with meaningful measures. He commented that the key is to focus on meaningful measures that can be addressed with available data.

- Paniati stressed the importance of communicating with diverse stakeholders in developing the national performance measures. He said further that FHWA used numerous outreach methods, including webinars, national online dialogues, virtual town hall meetings, subject matter meetings, and direct contact through PerformanceMeasuresRulemaking@dot.gov. He reported that FHWA received more than 10,000 different comments from individuals through all these outreach methods. Paniati noted that FHWA has also focused outreach on specific topics, including performance measures, target setting, and reporting and assessment.

- Paniati discussed the principles behind the NPRMs, including minimizing the number of measures, phasing in requirements, and increasing accountability and transparency. Other principles focused on considering risks to state and local agencies, understanding that priorities differ among states and areas, and recognizing that consistency and fiscal constraints are important.

TABLE 2 Schedule for Performance Measure NPRMs

| Performance Areas | NPRM | Comments Due | Anticipated Final Rule |
|--------------------------------------------------|---------------------------------|------------------------|------------------------|
| Safety Performance Measures | March 11, 2014 | Closed June 30, 2014 | September 2015 |
| Highway Safety Improvement Program | March 28, 2014 | Closed June 30, 2014 | August 2015 |
| Statewide and Metro Planning; Non-Metro Planning | June 2, 2014 | Closed October 2, 2014 | September 2015 |
| Pavement and Bridge Performance Measures | January 5, 2015 | Closed May 8, 2015 | TBD |
| Highway Asset Management Plan | February 20, 2015 | Open until May 29 2015 | TBD |
| System Performance Measures | <i>Projected</i> August 2015 | 90 days | TBD |

SOURCE: FHWA.

- Paniati noted that performance management was contained in different sections of MAP-21. As a result, he said the rule-making process had to follow these different sections, making coordination of the rule-making process important. He described the elements contained under the measures rules, the planning rules, and the program rules. The measures rules focus on the three areas of safety; the infrastructure, pavement, and bridges; and congestion, freight, and the environment. The program rules include the Highway Safety Improvement Program in the areas of safety and asset management.

- Paniati reviewed the general schedule for the different NPRMs contained in Table 2. He complimented AASHTO for organizing feedback and providing thoughtful, meaningful, and useful comments on the NPR. He noted that most of the NPRMs will be finalized in 2015 and 2016.

- Paniati said FHWA was taking a “stewardship heavy and oversight light” approach to implement the NPR. He noted that this approach fits the two roles of FHWA. The first, the stewardship role, includes providing technical assistance, training, and other related activities. The second is an oversight role of the federal program. He said FHWA is developing and delivering a transportation performance management technical assistance program and training, as well as fostering partnerships and collaboration with state and local agencies. He also said FHWA will be cataloging and sharing successful practices, case studies, and lessons learned.

- Paniati noted that FHWA is developing an online system for easier data reporting by state DOTs to assist in communicating transportation performance results in a



FIGURE 2 Example of communicating information on bicycle safety. (SOURCE: FHWA.)

transparent manner. He also noted that FHWA has developed a website to make the performance data submitted to FHWA available. Paniati stressed the importance of communicating the results to Congress and other policy makers. He said he believed focusing on turning data into useful information and knowledge was important. He described one example of this approach, highlighted in Figure 2, illustrating trends in bicycle safety.

- Paniati suggested that the development and use of transportation performance management would continue to improve and that ongoing learning and sharing of best practices would be important. He commented that developing synergies between national and other measures used by agencies would be beneficial and would assist in refining the national measures. He suggested that discussing the value of adding other performance management areas in the future would be beneficial. He also commented that continuing to improve data collection, integration, mining, reporting, and visualization would be important. He noted that research could play an important role in this area.

- Ultimately, Paniati said, transportation performance management would lead to better outcomes, with investments being made in the most beneficial projects. He suggested transportation performance management would improve communicating the link between investments and results, as well as the ability to depict future scenarios under varying funding levels. He further suggested that performance management would help increase consistency across the country and increase coordination across agencies and jurisdictions. Finally, he noted that performance

management would improve the understanding of the investments that work best in different situations.

- In summary, Paniati said MAP-21 provides the framework and goals for performance management, which reflects the logical evolution of the federal program. He noted that FHWA is focusing on consistency and flexibility in rule making, a stewardship-heavy and oversight-light approach, tailored technical support and guidance, and communicating the performance story to policy makers. He suggested this coordinated effort by all agencies will result in a higher-performing, more efficient transportation system. In closing, he recognized Pete Stephanos for his leadership in the Office of Performance Management. More information is available at www.fhwa.dot.gov/tpm.

The PowerPoint for this presentation is available at <http://onlinepubs.trb.org/onlinepubs/conferences/2015/performance/management/Paniati-1PS.pdf>.

WHY PERFORMANCE MANAGEMENT MATTERS, NO MATTER WHAT CHAIR YOU ARE IN

Deb Miller

Deb Miller discussed performance management and the Surface Transportation Board (STB), which is the economic regulator of freight railroads in the United States. She summarized the key responsibilities and organization of the STB, the use of performance management in the railroad industry, and recent STB requirements for additional performance data from railroads. Miller covered the following topics in her presentation:

- Miller provided an overview of STB. She noted that the Interstate Commerce Commission, which was established in 1887 as the first regulatory agency in the country, was the predecessor agency of the STB. She explained that STB was an adjudicatory and regulatory body overseeing railroad rates, service issues, and rail restructuring transactions, including mergers, line sales, line construction, and line abandonments. STB also monitors Amtrak's on-time performance. In addition, STB oversees certain trucking company, moving van, and noncontiguous ocean shipping company rate matters, as well as certain intercity passenger bus company structural, financial, and operational matters. She further noted that STB oversees the rates and services of certain pipelines not regulated by the Federal Energy Regulatory Commission. She stressed that although STB was part of the U.S. DOT, it was decisionally independent.

- Miller summarized STB's organization. With a staff of only 145 people, she noted that it was one of the smaller federal agencies. Its three board members are appointed by the President and confirmed by the Senate. She noted that STB had a reputation for being very deliberate in its work, which often resulted in a slow

process. Miller said that when she was appointed to STB, she found it did not have performance measures for internal use.

- Miller described the Rail Energy Transportation Advisory Committee (RETAC), which was established by STB in 2007 to provide advice and guidance to the Board. She noted that RETAC, which meets at least twice a year, also serves as a forum for the discussion of emerging issues, especially regarding the transportation of energy resources by rail. Miller reported that STB members serve as ex officio members of RETAC, along with representatives from the U.S. Departments of Agriculture, Energy, and Transportation and the Federal Energy Regulatory Commission. She noted that performance measures related to railroads serving the various energy sectors were presented at every meeting. She indicated that the summaries were very important for STB and other groups.

- Miller discussed performance management in the railroad industry. She noted that, as with state DOTs, railroads were data rich and very operationally focused. She described two examples to highlight the use of data management and data measures in the railroad industry, which appear to be embraced at every level through industry companies.

- The first example Miller offered was at Union Pacific (UP) Railroad. She noted that UP has a multipronged approach to performance management focusing on two key areas. The first area, UP Way, engages all employees to continuously improve safety, service, and productivity by improving the methods, tools, and processes to standardize work, eliminate variability and waste, and solve problems at their root cause. The second area, the Critical Element Cascade, focuses on ensuring top-level goals were embraced by all levels within UP and were translated into actions that turn a goal into reality. She explained that critical elements cascaded through all levels of the organization and were translated into specific actions and metrics at each level to ensure consistent and high-quality performance.

- Miller described one application of the Critical Element Cascade in addressing the dwell time of UP trains operating through Kansas City, Missouri. She noted that dwell time (the time a train is idling and not moving) was a critical issue for railroads. Moving trains quickly is obviously a key goal for railroads. Although train speed is the major element to moving trains quickly, reducing dwell time is a critical component to increasing overall speed and reducing travel time. She noted that UP monitors dwell time as a performance measure for efficient operations. In the Kansas City example, the responsibilities to reduce dwell time for five levels, from the general superintendent to the clerk, were identified and measured. Miller noted that the result was a reduction in train dwell hours and an increase in train speeds through Kansas City.

- The second example described by Miller was the Norfolk Southern Railroad “bang for the buck” metric. She noted that the use of this metric was related to selecting the best projects that link to the performance goals and then measuring performance to ensure the desired outcomes were met. She indicated that Norfolk

Southern used simulations to provide data to assess the relative performance benefits of each project and combinations of projects on train delay, train speed, and fuel consumption. The benefits are weighted against the costs associated with the project. The “bang for the buck” is calculated as the delay reduction divided by the cost. She explained that several potential projects may be identified to increase capacity in a congested rail corridor. These projects are run through a series of simulations to determine which combinations would be the most effective. She noted that this process was used on all projects in the Norfolk Southern capital budget.

- Miller discussed STB’s response to the deterioration in rail service that occurred in 2013 and 2014. She said a number of factors, including an extremely cold winter, resulted in poor service during 2014. She said further that this poor service was the key issue when she joined STB in 2015. Miller noted that she was surprised the railroads were not providing better data to shippers on the status of the rail system and service times. This lack of transparency on the part of the railroads was an important issue with shippers and other groups. As a result, STB used an emergency order to require Class 1 railroads to submit weekly reports that included data on system average train speed by train type, cars on line by type, system average dwell time, dwell time at the 10 largest terminals, average dwell time at origin, and trains held by train type and cause. Additional information was required for grain and coal services. She reported that the goal of this effort was to facilitate recovery, to provide stakeholders with actionable information, and to improve transparency. She said STB has rule making under way to make this reporting requirement permanent. She discussed how STB tracked and reviewed the data to monitor improvements, develop baselines for comparative purposes, identify incongruities that may indicate service issues, and predict possible future service challenges.

- Miller suggested STB has not focused on analyzing the available complex data and turning them into useful information for decision making. She noted that STB is trying to improve in this area and has a responsibility to request only the data that would be used and to provide those data to diverse stakeholders.

In closing, Miller reported that a performance management system working group has been formed at STB and that the working group’s goals were to improve work flow and ensure timely decisions. The PowerPoint for this presentation is available at <http://onlinepubs.trb.org/onlinepubs/conferences/2015/performance/Measurement/Miller-1PS.pdf>.

KEEPING SCORE FOR THE GAME OUR CUSTOMERS CARE ABOUT

Kenneth McDonald

Kenneth McDonald discussed performance management at Long Beach Transit (LBT). He described the economy of the Long Beach area, the services operated by LBT, his management philosophy, and the LBT strategic priorities and performance measurement scoreboards. McDonald covered the following topics in his presentation:

- McDonald noted that the City of Long Beach, which is located approximately 25 miles south of Los Angeles, had a population of approximately 465,000 and covers a 52-square-mile area. Long Beach is the seventh largest city in California. He commented that the population was relatively young, with a median age of 33 and a newly elected mayor who was 37 years old.

- McDonald discussed the economy in the area. He highlighted the importance of the tourism industry, with over 5.5 million visitors annually, and the 15,000 or so businesses in the city. Some of the largest employers include the Port of Long Beach, the Long Beach Airport, Boeing Aerospace, and California State University–Long Beach. Carnival Cruise Lines serves the port. The Aquarium of the Pacific, the Convention Center, and the 11 miles of coast attract visitors.

- McDonald reported that LBT, which has been in operation for 51 years, covers a 98-square-mile area, serving Long Beach and 12 surrounding cities. The system operates 250 buses and four water taxis. He noted that LBT recorded approximately 29 million annual boardings and had an annual budget of approximately \$108 million.

- McDonald described his management philosophy, which focused on the three “Rs” of management: respect for self, respect for others, and responsibility for safety, customer service, and revenue. He also discussed his teachable points of view, which are shared with employees and can be linked to data collection and performance measures. The first point of view was trusting the data. He suggested it was also important to verify the accuracy of data. His second teachable point of view was that “bad news does not get better with time.” He noted that if performance measures indicated problems and poor performance, responding with the appropriate actions was important. His third point of view was “if you are not a part of the solution, you are a part of the problem.” He suggested that by allowing ongoing poor performance and not addressing issues, an individual became part of the problem.

- McDonald reported that when he joined LBT, he found the agency was doing many things well. However, although the agency collected a lot of data, the data and reports were not organized to provide useful information for decision making. For example, he noted that performance trends were not tracked.

- McDonald described the five strategic priorities established by the LBT executive team. These strategic priorities were to improve safety and service

quality, exercise financial accountability, foster employee engagement, enhance customer experiences, and promote community and industry focus. He noted that with the help of a consultant, organizational goals were developed for each strategic priority. Department-level goals and objectives were then developed by department personnel for each organizational goal. Finally, individual goals were established. He presented the goals for the “improve safety and service quality” strategic priority. The organizational goal was to improve the LBT quality of service rating score from 92% to 95%, as reported in the annual customer survey. The service delivery department goal was to improve bus on-time performance from 77.4% to 80%. The individual goal for each operator was to reduce early bus departures by 10%.

- McDonald compared performance management to playing a favorite sport in that you must know the rules of the game and be dressed and ready to play. You must know how to keep score, what the score is, and whether you are winning or losing to make adjustments in your day-to-day operations.

- McDonald noted that LBT uses a variety of scoreboards to analyze and report data on performance measures. He described the use of performance measures focused on monthly ridership and farebox cash by month for a 3-year period. These graphs indicated that although ridership varied by month, it followed a similar annual pattern.

- McDonald said the LBT performance management process focused on measuring weekly, comparing monthly, making decisions on a quarterly basis, and reassessing the key performance indicators annually. He noted that the LBT culture had shifted to align with the strategic priorities and the key performance indicator scoreboards to make clear and effective decisions. He said the information was also provided to customers and employees.

- In closing, McDonald discussed some of the future activities at LBT. He noted that the demand for transit services continues to change. A comprehensive operations analysis was being undertaken by LBT to review current services and examine projected demands. He said the comprehensive operations analysis was assessing service optimization, organizational ability, and performance enhancement. McDonald also noted that LBT was developing Better Together, a business partnership with the Port of Long Beach and the Long Beach Airport. He reported that the partnership was focusing on coordinating the environmental and sustainability efforts of all three agencies, which focused on green initiatives (including reducing fossil fuel use), expanding vehicle electrification projects, and reducing greenhouse gases. He explained LBT was purchasing electric rather than diesel buses and that the agencies would also be measuring the economic impacts of these actions.

The PowerPoint for this presentation is available at <http://onlinepubs.trb.org/onlinepubs/conferences/2015/performance measurement/McDonald-1PS.pdf>.

Patricia G. Hendren, Spy Pond Partners, LLC, presided at this session.

DRIVING DECISIONS BREAKOUT SESSION

A Few Good Measures

What Decision Makers Will Use

Cory Pope, *Utah Department of Transportation*

Charles (Muggs) Stoll, *San Diego Association of Governments*

Geoffrey Whitfield, *Centers for Disease Control and Prevention*

The three speakers in this breakout session addressed performance measurement for transportation and economic competitiveness, social equity, and healthy and active lifestyles.

Cory Pope of the Utah DOT discussed transportation and economic competitiveness. He reviewed the development of asset management at the Utah DOT and highlighted some of the keys to success, which included having accurate and repeatable data, measuring and reporting results, conducting risk analyses, and providing transparency. He presented different measures of pavement quality and bridge conditions and described how the results are used in funding decisions. The PowerPoint for this presentation is available at <http://onlinepubs.trb.org/onlinepubs/conferences/2015/performance/Pope-1DD.pdf>.

Charles (Muggs) Stoll of the San Diego Association of Governments (SANDAG) discussed the drivers of performance management in California, the development of state-level indicators, and the development of the SANDAG Regional Transportation Plan, called San Diego Forward. He reviewed the draft performance measures, which focus on innovative mobility and planning, a vibrant economy, and a healthy environment and community. He described the community-based organization partner network created by SANDAG to help ensure all communities were meaningfully involved in the development of San Diego Forward. He reviewed outreach activities to disadvantaged groups and the social equity analyses conducted as part of San Diego Forward. The PowerPoint for this presentation is available at <http://onlinepubs.trb.org/onlinepubs/conferences/2015/performance/Stoll-1DD.pdf>.

Geoffrey Whitfield of the Centers for Disease Control and Prevention (CDC) discussed the Healthy Community Design Initiative at the CDC National Center for Environmental Health and health impact modeling in Nashville, Tennessee. The initiative focuses on the built environment, health, and how community design affects the health of residents, including chronic diseases, injuries, and environmentally mediated illness. He noted that community design elements include transportation, public spaces, and zoning. He described the Nashville Area Metropolitan Planning Organization (MPO) Middle Tennessee Transportation and Health Study, including

the use of the Integrated Transportation and Health Impact Modeling Tool, which computes impacts across three areas of physical activity, air pollution, and crashes. He said also the health and economic impacts of different levels of physical activity were analyzed in the study by using the impact modeling tool.

The PowerPoint for this presentation is available at <http://onlinepubs.trb.org/onlinepubs/conferences/2015/performance/Whitfield-1DD.pdf>.

Margaret Schilling, Federal Transit Administration, presided at this session.

TRACKING THE MOVES BREAKOUT SESSION

Mapping Business to System Performance

Page Siplon, *TeamOne Logistics*

Theodore Prince, *Tiger Cool Express, LLC*

The two speakers in this breakout session provided a private-sector perspective on supply chain management and the transportation system. They explained the challenges facing global supply chains and opportunities to improve the operation of the transportation system. Following the presentations, participants discussed possible opportunities and threats related to supply chains and steps to improve freight movement in the United States.

Page Siplon of TeamOne Logistics discussed the increasing complexity of global supply chains. He highlighted some of the factors influencing this growing complexity, including the options available for online shoppers to customize purchases, the increasing availability of 3-D printing, the use of drones for last-mile deliveries, and the current and forecast shortage of truck drivers. The PowerPoint for this presentation is available at <http://onlinepubs.trb.org/onlinepubs/conferences/2015/performance/Measurement/Siplon-1TM.pdf>.

Theodore Prince of Tiger Cool Express, LLC, described some of the challenges associated with intermodal transportation, which he defined as moving containers by multiple modes of transportation without any handling of the freight itself when changing modes. He noted that the intermodal network for imports typically includes ocean-going container ships, drayage trucks at ports, railroads, and trucks for the final-mile delivery. He discussed transportation economics and presented examples of corridor truck and rail travel times. The PowerPoint for this presentation is available at <http://onlinepubs.trb.org/onlinepubs/conferences/2015/performance/Measurement/Prince-1TM.pdf>.

Nicole Katsikides, Federal Highway Administration, presided at this session.

UNTANGLING THE DATA WEB BREAKOUT SESSION

Communicating Your Data

Hyun-A Park, *Spy Pond Partners, LLC*

Peter Rafferty, *University of Wisconsin–Madison*

Gregory Slater, *Maryland State Highway Administration*

William Johnson, *Colorado Department of Transportation*

This breakout session featured four speakers discussing innovative approaches for turning data into information for decision makers and the public.

Hyun-A Park, Spy Pond Partners, LLC, discussed NCHRP Project 20-24(93) B(02), “Communicating Performance Management: State Departments of Transportation Continuing to ‘Tell Their Story.’” The project provides a resource base for guiding state DOTs in communicating transportation system performance. She highlighted examples of approaches used in different states and MPOs and presented the communication templates developed as part of the project. The PowerPoint for this presentation is available at <http://onlinepubs.trb.org/onlinepubs/conferences/2015/performance measurement/Park-1DW.pdf>.

Peter Rafferty of the University of Wisconsin–Madison provided an overview of multistate mobility performance measures. Various corridor mobility measures and scanning tools were described, including travel speeds over 45 mph, travel rates (in minutes per mile), and speed density plots. He presented the application of these measures in different freeway corridors in the Midwest. The PowerPoint for this presentation is available at <http://onlinepubs.trb.org/onlinepubs/conferences/2015/performance measurement/Rafferty-1DW.pdf>.

Gregory Slater of the Maryland State Highway Administration (SHA) described the SHA performance-based planning program. The use of an online dashboard was described and demonstrated. The dashboard was developed to increase transparency, showcase SHA performance-based approaches, and make information easily available to policy makers and the public. The dashboard reports annual key mobility performance indicators and mitigation strategies and presents interactive charts, maps, and corridor-level impact analyses. The PowerPoint for this presentation is available at <http://onlinepubs.trb.org/onlinepubs/conferences/2015/performance measurement/Slater-1DW.pdf>.

William Johnson of the Colorado DOT discussed the department’s Asset Investment Management System, which includes data on pavement and bridge conditions, maintenance levels of service, the Colorado DOT fleet, intelligent transportation systems (ITS), buildings, culverts, tunnels, and geohazards. He

reported that the management system is used for analyzing funding needs, trade-off scenarios, cross-asset optimization, and other strategic activities. He presented examples of these analyses for internal and external use. The PowerPoint for this presentation is available at <http://onlinepubs.trb.org/onlinepubs/conferences/2015/performance/Johnson-1DW.pdf>.

Timothy J. Lomax, Texas A&M Transportation Institute, presided at this session.

STATE OF THE PRACTICE BREAKOUT SESSION

What's Our Destination?

Target Setting and Performance Management

Deanna Belden, *Minnesota Department of Transportation*

David Vautin, *Metropolitan Transportation Commission*

Shintaro Terabe, *Tokyo University of Science*

The speakers in this session highlighted performance measurement and target setting at the Minnesota DOT, the Metropolitan Transportation Commission (MTC) in the San Francisco Bay area, and in Japan.

Deanna Belden discussed target setting for performance measurement at the Minnesota DOT. She noted that the 2003 statewide transportation plan, *Moving People and Freight from 2003 to 2023*, was the first performance-based plan completed by the department. Efforts are under way on the fourth performance-based statewide plan. Other performance-based planning activities include the multimodal plan, investment plans, and ongoing performance monitoring, which evaluates progress and reports performance to decision makers and the public. She reviewed the performance-level concept, which considers risks and costs, and targets included in the 2014–2033 Minnesota DOT *20-Year State Highway Investment Plan*. She also highlighted the techniques, including an online scorecard, used to evaluate progress and to communicate results to policy makers and the public. The PowerPoint for this presentation is available at <http://onlinepubs.trb.org/onlinepubs/conferences/2015/performance/Belden-1SP.pdf>.

David Vautin described the use of state of good repair measures by the MTC to capture user impacts and address key objectives. He noted that the transition from infrastructure-based measures to user-based measures is not easy, but that the benefits are worth the effort. Examples of benefits included better communication with the public, improved prioritization of limited resources, and enhanced understanding of how state of good repair affects other regional priorities. He described the MTC process to evaluate transit and roadway projects by user-based measures. The PowerPoint for this presentation is available at <http://onlinepubs.trb.org/onlinepubs/conferences/2015/performance/Vautin-Carnarius-1SP.pdf>.

Shintaro Terabe of the Tokyo University of Science discussed target setting for transit in Japan. He highlighted the Index of Comfortable and Easeful Public Transportation performance measures that the major railway and bus companies are required to report to the national government on an annual basis. Examples of the easeful performance measures include the congestion rate during peak times, the percentage of stations with barrier-free access, and the percentage of low-floor

WHAT'S OUR DESTINATION?

vehicles. An example of a comfortable performance measure is the percentage of air-conditioned vehicles. He also described the safety performance measures for railway stations, which focus on the station platform design and equipment, train operation, and passenger characteristics. The PowerPoint for this presentation is available at <http://onlinepubs.trb.org/onlinepubs/conferences/2015/performance/Program.pdf>.

Keith Williams, Federal Highway Administration, presided at this session.

Intermodal Performance Measurement

Louis-Paul Tardif, *Transport Canada*
Marygrace Parker, *I-95 Corridor Coalition*
Page Siplon, *TeamOne Logistics*

AN EVIDENCE-BASED FRAMEWORK AND ANALYSIS OF THE CANADIAN TRANSPORTATION SYSTEM

Louis-Paul Tardif

Louis-Paul Tardif described the development and use of a multimodal analysis process by Transport Canada to support evidence-based investment decisions. He discussed the global economic opportunities facing Canada, the current policy context and issues, and the development and application of the freight fluidity index. He highlighted the transportation demand and transportation supply analyses, as well as the ongoing transportation challenges in Canada. Tardif covered the following topics in his presentation:

- Tardif discussed the interest in Canada to better align the transportation infrastructure with global economic opportunities. He noted that the changing poles of international economic growth increase the complexity of global supply chains. He said Asian countries are expected to act as key poles for global growth in the medium term, with the economic recovery in the United States acting as another pole for growth. Tardif suggested that the supply chains to Asian countries were much different and more challenging than the supply chains to European countries. He described the importance of direct and indirect access to global supply chains and the ongoing need to redefine competitive advantages and transportation-related requirements. He also discussed the adaptation and resilience of the Canadian transportation system to ensure continued access to markets.

- Tardif described the policy context and the policy questions currently being considered in Canada. He noted that the commitments at the 2014 North American Leaders Summit included promoting trilateral exchanges on logistics corridors, including automotive supply chains. He described the Commodity Supply Chain Table (CSCT) launched by Canadian Transport Minister Lisa Raitt in June 2014. CSCT established a national forum for shippers, railways, ports, terminals, and other supply chain partners to work together to improve the reliability and efficiency of the supply chains for all commodities. He said further that the private sector is key to this effort, with Transport Canada providing data and policy guidance.

- Tardif reviewed the four major objectives of CSCT. The first objective is to promote strategic exchanges on logistical and/or capacity issues affecting supply chain efficiency for commodities shipped through Canada’s gateways. The second objective is to provide a forum to assess evolving domestic and international trade and market trends for commodities, including anticipated future demand and system needs. The third objective is to explore, assess, and identify potential solutions to system inefficiencies through enhanced collaboration across supply chains. The fourth objective is to discuss the development and implementation of evidence-based performance metrics to increase the visibility of supply chains and improve performance.

- Tardif reviewed the following policy questions being examined by CSCT:
 - What is the capacity utilization of the transportation system?
 - To what extent does the transportation infrastructure allow Canada to capitalize or limit its export opportunities?
 - To what extent does the transportation infrastructure allow Canada to capitalize or limit export opportunities in the northern part of the country?
 - What is the rail performance in support of the fluidity of key commodities in a multimodal supply chain context?
 - Has the performance of Canada’s supply chains improved or deteriorated over time?
 - If performance has deteriorated, can it be improved through increased operational efficiency, or are infrastructure investments required?
 - What critical transportation bottlenecks may be impeding Canada’s competitiveness?

- Tardif stressed that the key drivers of transportation demand are changing. He noted the demand for the Canadian transportation system is expected to be largely affected by changes in the global poles of growth, Canadian direct and indirect access to global supply chains and markets through new trade agreements and Canadian comparative advantages, the demand for key Canadian commodities, and demographic and environmental factors. He observed that grain, coal, crude oil, potash, and forest products are the major Canadian export commodities.

- Tardif reported that the focus in Canada is on the east–west and north–south corridors for both internal and external trade. He noted that rail capacity is a key issue in both corridors. He reported that the most important rail corridor is east to west, which is expected to grow by 35% from 2014 to 2025. The second most important rail corridor is north to south, focusing on exports to the United States. Canada owns 18 ports, which are managed by semiprivate entities. Congestion is an issue at West Coast ports. He indicated that shippers typically have two key questions associated with the rail system. The first question is “As a shipper, what is my performance against the performance of my sector?” He noted that the large shippers have a good

understanding of their performance but less of an understanding of the goal and the overall performance of the sector. The second question is “What is the impact of the system on my growth?”

- Tardif reviewed some of the key drivers for transportation supply analysis. He noted that five key export commodities (grain, forest products, crude oil, coal, and potash) and containerized traffic are being examined for key transportation corridors by using a multimodal transportation system–based approach. He indicated that the transportation supply analysis focuses on capacity and performance. He noted that there is currently no clear definition of the capacity of supply chains in a policy context, but that Transport Canada is assessing the connectivity of the multimodal transportation capacity in a global supply chains context through the development and use of a flow indicator. He commented that the focus has been on the performance of the Canadian transportation system, including the identification of bottlenecks, first mile and last mile issues, optimization of the Canadian multimodal transportation system, and improving the direct and indirect access to global supply chains.

- Tardif described the flow analysis approach, which combines rail, trucking, and maritime data. He noted that this approach is relatively simple but that it addresses the key policy questions. He reported that the corridors included in the analysis are the Asia–Pacific corridor, which has capacity issues; the East–Atlantic corridor; and the Canada–United States–Mexico auto supply chain corridor. He repeated that grain, coal, potash, forest products, crude oil, and containers are monitored in these corridors. In addition, the performance of 13 border crossings points with the United States is monitored.

- Tardif reviewed the data used in the analysis. He noted that Transport Canada has developed strong partnerships with private sources to acquire much of the needed data. For ocean transit, approximately 98% of vessel movements are included with data from Lloyds, the Canadian Coast Guard, and other sources. Canada uses a single-window approach to custom data, providing 100% coverage, and port dwell times are available from terminal operators and port authorities. Rail transit and terminal dwell times are provided by CN Rail and CP Rail, which cover 100% of the rail system. He noted that truck data are obtained through partnerships with Ontario and other provinces, and some GPS data are available for major origins and destinations. Data on port drayage are available from the ports.

- Tardif described the framework for the commodity supply chain analysis framework, which is based on five pillars. These pillars are (1) commodity production and supply—projections on commodity production or supply; (2) stocks and inventory—indicators of volumes to be moved on the transportation system; (3) rail and truck movements—indicators of rail and truck movements and network fluidity, including border crossings; (4) port and marine movements—aggregate measures of port activities (rail, truck terminal, vessel); and (5) corridor analysis—monitoring of selected supply chains on a regular basis.

INTERMODAL PERFORMANCE MEASUREMENT



FIGURE 3 Grain supply chain monthly summary. (SOURCE: Transport Canada.)

Tardif presented examples of the various analyses that have been conducted. Figure 3 presents the monthly summary prepared on the grain supply chain. He noted more detailed information to the railcar level is available. Figure 4 highlights 2013 origin-destination flows for coal shipments from Alberta and Wyoming to western Canadian ports. He suggested that, as Figure 4 illustrates, the coal supply chain is a North American, not just a Canadian, issue.



FIGURE 4 2013 origin-destination for coal rail flows. (SOURCE: Transport Canada.)

- Tardif described some of the metrics produced for each supply chain, which include the number of train cars loaded and unloaded, train dwell time at ports, and the number of vessels arriving and departing ports. He stressed that the metrics were developed to be neutral and balanced.

- Tardif noted that the emergence of global freight supply chains requires an understanding of the reliability, variability, and resiliency of geographically dispersed transportation and logistics systems. He reported that the fluidity indicators are a suite of multimodal, integrated supply chain tools that measure in near-real time the performance of individual segments of the supply chains, as well as the end-to-end transit time of freight flows. The fluidity indicators also build on historical flows to provide a predictor of the same flow in a multimodal context. He highlighted examples of fluidity analysis capabilities, including reliability and variability in transit times, identification of bottlenecks and impediments, and immediate and residual impacts of disruptions to the transportation network. Other capabilities include examining the effect of routing on marine transit times and vessel reliability, estimating border wait times, and measuring the carbon footprint of freight.

- Tardif explained that the different analyses point out ongoing issues with supply chains between Asia, West Coast ports, and Toronto or Chicago. These supply chains involve vessel travel times, dwell time and unloading time at ports, and rail travel times to Toronto and Chicago. He commented that a problem in any link causes a cascading effect on the total supply chain.

- Tardif discussed how Transport Canada monitors 13 border crossing points into the United States in British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, and New Brunswick. He noted that in 2014 traffic increased at the major western Canadian border crossings by 3% to 6%. He said further that border wait times have been generally stable and that a traffic increase in the 3% to 6% range is not expected to increase border wait times significantly.

- Tardif noted that the Windsor–Quebec corridor and highways in southern Ontario are forecast to continue to dominate the goods movement by truck, but that the growth in western corridors is also forecast to play significant roles in goods movement. He described some of the rail capacity concerns in the Vancouver area.

- In closing, Tardif highlighted some of the next steps with the multimodal freight flow analysis. One activity is to analyze the 5 years of available data and to quantify the capacity of the transportation system in a policy context. Another activity is to quantify the performance of supply chain commodities to meet expected needs. Still another activity is forecasting demand for transportation and assessing the impact of that forecast on the capacity and performance of the system against evidence-based historical data.

The PowerPoint for this presentation is available at <http://onlinepubs.trb.org/onlinepubs/conferences/2015/performance/Measurement/Tardif-2PS.pdf>.

PUBLIC-SECTOR SUPPLY CHAIN ANALYSIS FOR INVESTMENT DECISIONS

Marygrace Parker

Marygrace Parker described a study examining supply chains for different commodities associated with the I-95 corridor. Noting that more detailed information on the actual supply chains was covered in the breakout sessions, she focused her comments on the importance of public agencies understanding supply chains and some of the lessons learned from the study. Parker covered the following topics in her presentation:

- Parker reported that the pilot project was funded by the FHWA Office of Freight Management and Operations with support from the U.S. Department of Commerce Advisory Committee on Supply Chain Competitiveness and the I-95 Corridor Coalition. She recognized the support of Nicole Katsikides, Ed Strocko, and Caitlin Rayman from the Office of Freight and the principal investigators and their teams—Lance Grenzeback from Cambridge Systematics, Inc., and Joe Bryan from Parsons Brinckerhoff. She noted the I-95 Corridor Coalition was interested in examining supply chains that use portions of the I-95 corridor to better understand how the transportation system affects performance of the supply chains and how the supply chain analysis can be used for investment decisions. She said possible investment decisions included those related to improvements in infrastructure, operations, maintenance, ITS, and other related elements.

- Parker suggested it was important for public agencies to understand supply chains for a number of reasons. She noted that supply chains reflect the freight use of the transportation system. Stressing that supply chain performance is key to economic competitiveness, she noted that although performance is end-to-end and the sum of stages, improvements are typically made in individual stages that put local dynamics into a larger perspective. Moreover, she stated that understanding both the user view and the market view is important, as was understanding the role of public agencies.

- Parker noted that although supply chains are complex, they are also manageable. Shippers and carriers deal with complex supply chains daily and know the locations of “pain points” or bottlenecks. She suggested that addressing these pain points can make a supply chain more competitive.

- According to Parker, supply chain performance has a public role and a private role. She said she believed the public role is to operate the transportation networks as efficiently as possible. She noted that the public contribution occurs at many stages and from many jurisdictions, and that issues and bottlenecks are also shared between the public and the private sectors, as are the solutions. She highlighted the multiple sources of recent issues at U.S. ports, which included labor concerns, accommodating megaships, communication gaps, terminal capacity, and landside infrastructure.

She suggested that supply chains were fundamentally cooperative ventures between the public and private sectors and between the agencies responsible for different segments of the transportation system.

- Parker described the processed food supply chain examined in the project. She reported that the project documented how it is possible for public agencies to identify and understand supply chains and to measure supply chain performance. She said the analysis revealed the symptoms of concern with the supply chain, not the diagnosis and treatment. She suggested that solutions need to be cooperatively addressed, with the public and private sectors working together. Examples of multifaceted solutions may focus on adding infrastructure, improving operations, and developing new policies.

- Parker noted that the public contribution to supply chain performance crosses urban and rural areas, agencies, jurisdictions, modes, and sectors. She suggested that using a freight corridor approach could take advantage of corridor coalitions that support multiple players and conditions, as well as cooperative performance improvements. She noted that the freight corridor approach also provided a broad perspective on supply chains and more opportunities to leverage data acquisition. In addition, the freight corridor approach fits with the emergence of the GROW AMERICA multijurisdictional approach and megaregion multijurisdictional economies.

- Parker noted that the I-95 Corridor Coalition realized the importance of better understanding supply chains. She reported that the I-95 Corridor Coalition includes 16 states, including the District of Columbia. She said the combined corridor has a \$4.7 trillion economy—or 40% of the U.S. gross domestic product—21% of the nation’s road miles, and 35% of the nation’s vehicle miles traveled (VMT). She also noted that 5.3 billion tons of freight shipments occur annually in the multimodal corridor. She said two Canadian provinces, Quebec and New Brunswick, also contribute to the economic vitality of the corridor.

- Parker described earlier studies conducted by the I-95 Corridor Coalition examining supply chains and bottlenecks. The I-95 Corridor Mid-Atlantic Rail Study, conducted in the early 2000s, examined truck and rail options for transporting projected freight increases. Study participants included New Jersey, Pennsylvania, Delaware, Maryland, and Virginia, as well as rail partners CSX, Norfolk Southern, and AMTRAK. The project was supported by pooled funding from Coalition set-aside funds, the participating states, and the railroads. She suggested that key elements of the project included the participants, the data, the mix of funding sources, and the “sweat equity” from the partners. At the time, the best available data sources for use in the study included the Highway Performance Monitoring System, the Commodity Flow Survey, and the STB Rail Waybill.

- Parker reported that the study examined the types of commodities that might be diverted from truck to an improved rail system, as well as existing bottlenecks on the rail system. She noted that although each of the partners had different interests

and perspectives, they were able to work together to identify potential improvement projects. No specific funding was available for the projects, however. She said a follow-up project examined the costs and benefits of various projects.

- In closing, Parker suggested that public agencies do not need to understand every supply chain, just those that are most important to their area, corridor, or state. She noted that the methodology used in this study can be duplicated by others to learn about supply chains in their areas and to identify bottlenecks limiting the operation of those supply chains.

The PowerPoint for this presentation is available at <http://onlinepubs.trb.org/onlinepubs/conferences/2015/performance/Measurement/Parker-2PS.pdf>.

PERFORMANCE + TRANSPORTATION = ECONOMIC PROSPERITY

Page Siplon

Page Siplon discussed the importance and complexity of supply chains, described the factors influencing changes in supply chains, and provided examples of these changes. Siplon covered the following topics in his presentation:

- Siplon reported that TeamOne Logistics designs and manages workforce solutions to minimize the risk, cost, and complexity of logistics-enabled businesses. TeamOne Logistics has 850 employees and clients in 87 locations across 29 states.

- Siplon described the complexity of supply chains. He noted the importance of active relationships between the public and private sectors to improve the operations of these complex supply chains. He said supply chain reliability was a key factor for businesses and that public agencies could help enhance the reliability of the transportation system.

- Siplon discussed changes that are occurring in many of the factors influencing supply chain reliability. Specifically, technology, including drones and mobile devices, continues to change rapidly. He commented that the use of mobile communication devices was growing the fastest in China, South Africa, Japan, and other countries with emerging middle classes. He also noted that financial payments via mobile devices were increasing, with companies such as Apple emerging as leaders in payment processing. He suggested that technology innovations are being introduced by many diverse companies.

- Siplon described a simplified version of a supply chain and e-commerce using Vans shoes. The basic black Vans shoes may be made in China or Bangladesh, he said, shipped to the Port of Savannah via an ocean-going vessel, and distributed to stores by trucks. He said he thought Vans online “OFF THE WALL” cocreation platform, which allows consumers to customize their shoes, makes the supply chain

more complex. He suggested that many shoe companies, including Nike, generate a lot of revenue from these types of online customizing services.

- In general, Siplon said, logistics represent approximately 10% of the total cost of a product, with a higher percentage in the range of 30% to 40% for produce and pharmaceutical products. He noted that transportation represented about half the logistics cost and that moving goods by truck typically accounted for 80% of the transportation cost.

- Siplon discussed the importance of the last mile of delivery in the supply chain, noting it can often be the most expensive segment of the total trip. He suggested companies such as Amazon were driving innovation in last-mile delivery services. He also noted that some companies were using locker technologies to transfer the last-mile delivery cost back to the consumer.

- Siplon said Google was playing a major role in the development of autonomous vehicles and that the company had made 172 acquisitions since 2001, including leasing NASA hangers. He also noted that manufacturing was changing rapidly with 3-D printing and other new technologies.

- Siplon described changes in the construction industry, which continues to be an important economic indicator. He suggested that current construction methods are labor intensive and that research examining new approaches was under way. He described a prototype development in China that used 3-D concrete printing to construct 10 houses within a 24-hour period at a cost of \$5,000 per house. He noted that these types of changes in the construction industry would have major impacts on supply chains, with concrete powder replacing numerous building materials.

- Siplon described the influence of population growth in different areas of the country and on the supply chains serving those regions. Specifically, supply chains follow the growth states, including Florida, Georgia, California, Arizona, and Texas. He also noted that cargo theft is a problem in these areas. He suggested that approximately every 4 to 5 years a majority of companies face some type of national or human-made crisis and that almost 75% of these companies close or suffer a significant long-term impact.

- Siplon described a case study focusing on Xirallic, a mineral found primarily in Japan, which is used to make the glossy paint for motor vehicles. The recent disasters in Japan disrupted the supply chain for Xirallic, which resulted in the shutdown of some motor vehicle production lines in the United States. He suggested this example points out the importance of major companies knowing not only their supply chains but also their suppliers' supply chains.

- Siplon reported that the United States would continue to experience increases in freight shipments to meet the needs of a growing population. He noted that with each person requiring approximately 40 tons of goods per year, forecasts for an additional 100 million people in the United States by the year 2050 means 4 billion more tons of freight transported per year on overtaxed highway, rail, air, and waterway

networks. He suggested that the United States was underinvested in infrastructure for all transportation modes. He mentioned Panama and China as countries making significant investments in transportation infrastructure to improve supply chains.

- Siplon discussed the importance of the human infrastructure in education and training. He cited approximately 270,000 job openings a year in the logistics industry, with trucking, warehouse, and distribution labor combined representing approximately 90% of those openings. In addition, he said the logistics industry had not done a good job of presenting the employment opportunities in logistics, but that by 2020 the Millennial generation is forecast to make up approximately 40% of the workforce in the United States. He reported that the American Transportation Research Institute had estimated there will be a need for 100,000 new truck drivers a year for the next 10 years due to a combination of industry growth, retirement of current drivers, and drivers leaving for other jobs. He noted that to attract the Millennials, the trucking industry must become much more technology savvy.

- In conclusion, Siplon noted that numerous changes were occurring in the logistics industry and in supply chains. He suggested that change, especially change related to technology, would continue at a fast pace and that actively involving the private sector in the transportation planning process was important to address current and future needs.

The PowerPoint for this presentation is available at <http://onlinepubs.trb.org/onlinepubs/conferences/2015/performance/Measurement/Siplon-2PS.pdf>.

Mara Campbell, HERE, presided at this session.

DRIVING DECISIONS BREAKOUT SESSION

About Intermodal Investments and Operations

Garrett Pedersen, *Iowa Department of Transportation*

Machelle Watkins, *Missouri Department of Transportation*

Doug McLeod, *Florida Department of Transportation*

Lynnette Ciavarella, *Metra*

Michael Meyer, *Parsons Brinckerhoff*

The five speakers in this session discussed the development and use of freight and intermodal performance measures.

Garrett Pedersen of the Iowa DOT described the use of the value, condition, and performance (VCAP) freight project evaluation matrix to rank freight projects. He noted that projects are first ranked on three criteria: bottleneck occurrences (performance), incident cluster explorer rating (condition), and iTRAM vehicle hours traveled cost benefit (value). The rankings for these three criteria are summed for the initial VCAP rating. Projects are then evaluated based on their consistency with freight network optimization and proximity to freight-intensive facilities, and the adjusted VCAP is calculated. The final project rankings are based on the adjusted VCAP. The PowerPoint for this presentation is available at <http://onlinepubs.trb.org/onlinepubs/conferences/2015/performance measurement/Pedersen-2DD.pdf>.

Machelle Watkins of the Missouri DOT discussed the freight measures used by the department 10 years ago and the development and current use of a freight competitiveness index. She noted that previous general measures included annual port and rail freight tonnage, which were not very useful for planning purposes. She described the freight competitiveness index, which focuses on supply chains. She provided the example of shipping soy beans to New Orleans by truck and barge, finished motor vehicles to Los Angeles by rail and to Toronto by truck, and crop protection products (chemicals) to Los Angeles by trucks. The costs of making the same trips from competitor states are also calculated. The PowerPoint for this presentation is available at <http://onlinepubs.trb.org/onlinepubs/conferences/2015/performance measurement/Watkins-2DD.pdf>.

Doug McLeod of the Florida DOT discussed mobility measures for people and freight, focusing on the four dimensions of quantity, quality, accessibility, and capacity utilization. He highlighted examples of the Florida DOT matrix freight truck

measures, including truck ton miles traveled for the quantity dimension, truck average travel speed for the quality dimension, and truck backhaul tonnage for the utilization dimension. The PowerPoint for this presentation is available at <http://onlinepubs.trb.org/onlinepubs/conferences/2015/performance/Measurement/McLeod-2DD.pdf>.

Lynnette Ciavarella of Metra discussed the complex freight and passenger rail network serving the Chicago area. She noted that 10 freight railroads, along with Amtrak and Metra, operate in the Chicago terminal and that 25% of all freight railroad traffic in the country touches Chicago, including 46% of all intermodal units. She described the Chicago Region Environmental and Transportation Efficiency Program (CREATE), a \$3.7 billion public-private partnership designed to improve rail operations and traffic flow through Chicago by separating freight and commuter trains at six key junctions and eliminating 25 road-rail grade crossings. The number of delayed Metra trains has been reduced and on-time performance has improved as a result of the CREATE projects. The PowerPoint for this presentation is available at <http://onlinepubs.trb.org/onlinepubs/conferences/2015/performance/Measurement/Ciavarella-2DD.pdf>.

Mike Meyer of Parsons Brinckerhoff described some of the common questions local officials ask concerning freight and the link to performance measurement. The first question focused on the importance of freight to the public sector and why local policy makers should care about freight. The second question asked whether freight affects and competes with passenger transportation. The third question addressed how to identify bottlenecks in the transportation system, and the fourth question was what should be done to address these bottlenecks that will make a difference. He suggested that the appropriate performance measures to answer these questions focus on identifying locations to minimize bottlenecks, reduce conflicts in the transportation system, and improve access and economic development. He noted that the performance measures included in many freight plans address the number of trucks, ton-miles, and the value of commodities being transported, which are data that do not answer the questions important to local policy makers. He voiced concern that linking freight performance measures to the local level is not occurring. He then provided some takeaway points relating to performance measurement at the local level, which included realizing that everyone is still learning to develop and use performance measures, focusing on a few select system performance measures, setting realistic targets, and focusing on issues that can be addressed at the local level. The PowerPoint for this presentation is available at <http://onlinepubs.trb.org/onlinepubs/conferences/2015/performance/Measurement/Meyer-2DD.pdf>.

Jane D. Hayse, Atlanta Regional Commission, presided at this session.

TRACKING THE MOVES BREAKOUT SESSION

Breaking Freight Bottlenecks

Fluidity Metrics That Work

Jeffrey Short, *American Transportation Research Institute*

Anne-Severine Poupeleer, *Agentschap Wegen en Verkeer, Belgium*

Joseph Bryan, *Parsons Brinckerhoff*

Bill Eisele, *Texas A&M Transportation Institute*

Speakers in this breakout group discussed freight bottlenecks. Following the presentations, participants formed smaller groups to discuss factors contributing to bottlenecks, possible mitigation strategies, and additional research needs.

Jeffrey Short of the American Transportation Research Institute discussed the use of his agency's truck GPS database to measure speeds, travel times, and trip-time reliability and variability to identify truck bottlenecks. He noted that truck bottlenecks are typically found on limited-access highways during the weekday morning and afternoon peak periods. He presented maps highlighting the location of truck bottlenecks throughout the country and showed how insufficient capacity appears to be the major cause of truck bottlenecks, with interchanges, lane drops, and weaving patterns as frequent contributing factors. He also noted that the recovering economy, lower fuel prices, traffic incidents, and poor weather often aggravate already bad traffic conditions. The PowerPoint for this presentation is available at <http://onlinepubs.trb.org/onlinepubs/conferences/2015/performancemeasurement/Short-2TM.pdf>.

Anne-Severine Poupeleer of the Flemish Agency for Road and Traffic described the responsibilities and organization of the agency and the road network, traffic volumes, and modes. She described infrastructure and technology measures, road inspections, kilometer-based charging, and supertrucks. She highlighted different approaches to road inspections, including dynamic truck weighing. The PowerPoint for this presentation is available at <http://onlinepubs.trb.org/onlinepubs/conferences/2015/performancemeasurement/Poupeleer-2TM.pdf>.

Joseph Bryan of Parsons Brinckerhoff discussed the I-95 Corridor Coalition Freight Fluidity Measures Pilot Project, focusing on the supply chain transporting automotive parts from Chatham, Ontario, to the General Motors assembly plant in Spring Hill, Tennessee. He noted that the performance measures and metrics included transit time, measured by travel time in days or hours; reliability, measured by the 95% travel time in days or hours; and cost, measured in dollars. Another performance measure was safety, measured by fatality and injury rates. A final performance measure was risk, measured both by disruptions (caused by

storms, labor, infrastructure failure, and political forces) and by capacity expansion delays (caused by physical constraints and regulatory limitations and delays). He described the types of risks, the risk management process, and how bottlenecks were performance vulnerabilities intertwined with risk management. The PowerPoint for this presentation is available at <http://onlinepubs.trb.org/onlinepubs/conferences/2015/performance/Measurement/Bryan-2TM.pdf>.

Bill Eisele of the Texas A&M Transportation Institute defined freight fluidity and reviewed freight fluidity components, data sources, and methodology. He noted that data sources typically focus on performance (transit times and speeds, dwell times, supply chain resiliency, and associated costs) and quantity (volumes, weight, and value). He described a project sponsored by the Maryland State Highway Administration examining freight fluidity in the I-95 corridor. The PowerPoint for this presentation is available at <http://onlinepubs.trb.org/onlinepubs/conferences/2015/performance/Measurement/Eisele-2TM.pdf>.

Kitty Hancock, Virginia Polytechnic Institute and State University, presided at this session.

UNTANGLING THE DATA WEB BREAKOUT SESSION

Moving Data to Help Move People

Dominick Tribone, *Massachusetts Bay Transit Authority*

Donna Anderson, *Chicago Regional Transportation Authority*

Louis Cripps, *Denver Regional Transportation District*

Chris Pangilinan, *New York City Transit*

Speakers in this breakout session discussed the use of performance measurement at the Massachusetts Bay Transit Authority (MBTA), the Chicago Regional Transportation Authority (RTA), the Denver Regional Transportation District (RTD), and New York City Transit (NYCT). Topics covered included customer-focused performance measures, developing performance measures for multiple providers, and using new technologies for data collection and analysis.

Dominick Tribone of MBTA described the evolution of transit customer information systems over the past 20 years and the provision of the real-time status of transit vehicles to customers and for performance management. He summarized the MBTA framework for using data from the General Transit Feed Specification, which provides real-time vehicle feeds to measure performance related to schedule adherence, travel times, headways, dwell times, passenger wait times, and passenger travel times. He noted that the real-time information is provided to MBTA customers through smart phone apps and other technologies. It is also used as input to performance measures, which are provided to MBTA management and customers. The PowerPoint for this presentation is available at <http://onlinepubs.trb.org/onlinepubs/conferences/2015/performance/Measurement/Tribone-2DW.pdf>.

Donna Anderson of RTA discussed the development of performance measures for transit operators in the Chicago area. She noted that RTA is responsible for transit oversight, funding, and planning, with the three operating agencies (the Chicago Transit Authority, Metro Commuter Rail, and Pac Suburban Bus) providing service. She reviewed the collaborative process used by RTA to develop measures focusing on service coverage, service efficiency and effectiveness, service delivery, service maintenance and capital investment, and service-level solvency. She said she thought the process and results have been well received by the agencies, providing a positive focus on current operations and ongoing challenges. The PowerPoint for this presentation is available at <http://onlinepubs.trb.org/onlinepubs/conferences/2015/performance/Measurement/Anderson-2DW.pdf>.

Louis Cripps of the Denver RTD described analyses conducted by his agency to assess the relationships between the condition of RTD assets and the experience of RTD customers, as well as the RTD Asset Management Plan and the methods used

to monitor the condition of different assets. He noted that the analysis of passenger delay hours, cost per mile, and other data indicates that the “end of life” performance of assets negatively affects RTD customers. The PowerPoint for this presentation is available at <http://onlinepubs.trb.org/onlinepubs/conferences/2015/performance/Measurement/Cripps-2DW.pdf>.

Chris Pangilinan of NYCT highlighted the use of performance measurement at NYCT for operating, planning, and strategic decisions and the link between strategic planning efforts at NYCT and performance measurement. He presented examples of using real-time data and operations-level performance measures to make real-time changes in service, including holding trains and skipping stops, and how planning-level performance measure assessment focuses on wait times and on-time performance. He also presented an example from San Francisco of a strategic-level performance measure that addresses access to jobs by transit within a 30-minute radius. The PowerPoint for this presentation is available at <http://onlinepubs.trb.org/onlinepubs/conferences/2015/performance/Measurement/Cripps-2DW.pdf>.

Amy Van Doren, Marin Transit, presided at this session.

STATE OF THE PRACTICE BREAKOUT SESSION

Intermodal or Multimodal

It's About People and Freight

Krista Nordback, *Portland State University*

Gregory L. Slater, *Maryland State Highway Administration*

Nina Verzosa, *CDM Smith*

Corinne Donahue, *CDM Smith*

The speakers in this breakout session discussed performance measures for bicycle and walking trips, mobility projects, and transit services.

Krista Nordback of Portland State University discussed estimating bicycle miles traveled and pedestrian miles traveled in Washington State. She noted that measuring bicycling and walking was important for project and policy decisions, facility design, planning, economic impact analyses, public health assessments, and developing and operating safe facilities. She reviewed the state traffic monitoring program, the use of permanent and short-duration counters, and the calculations for determining annual average daily traffic and VMT. She presented an approach for assessing number of bicycle miles traveled, pedestrian miles traveled, annual average daily bicyclists, and annual average daily pedestrians. She reported that in 2012, the one permanent bicycle counter in the state was in Seattle. Currently, there are five permanent bicycle counters and four permanent bicycle and pedestrian counters in the Seattle area and one permanent bicycle counter in Spokane, as well as almost 40 short-duration counters located throughout the state. Manual counts are conducted at 50 locations in Seattle four times a year. One year of bicycle data on the Fremont Bridge in Seattle was presented. Different approaches for estimating bicycle miles traveled and pedestrian miles traveled were described, including sample-based, aggregate demand modeling, and travel surveys. The PowerPoint for this presentation is available at <http://onlinepubs.trb.org/onlinepubs/conferences/2015/performancemeasurement/Cripps-2DW.pdf>.

Greg Slater of the Maryland State Highway Administration (SHA) discussed the department's performance-based approach for improving mobility, reliability, and multimodalism. He described the decision-making framework and performance measurement at SHA. He noted that performance measurement and data-driven decisions are used at all levels within SHA and that there is an increased focus on operations, system efficiency and reliability, freight movement and the economy, and communicating performance to diverse stakeholders. He described the development and use of the SHA Annual Mobility Report, the Mobility and Economic Dashboard,

and the Reliability Roadmap. Slater also discussed the use of performance measures in the SHA freeway and arterial congestion management programs and in before-and-after studies on key projects. The PowerPoint for this presentation is available at <http://onlinepubs.trb.org/onlinepubs/conferences/2015/performance/Program.pdf>.

Nina Verzosa and Corinne Donahue of CDM Smith discussed transit performance management in Florida and a study sponsored by the Florida DOT that identified practices in evaluating transit performance. Verzosa noted that the Florida DOT has been a national leader in transit performance measures since the 1970s. She described the Florida Transit Information System–Integrated National Transit Database Analysis System, which combines individual National Transit Database files from multiple years into a single, standardized database with customized tools for quick and easy data retrieval, visualization, and analysis. This database, which includes peer comparison features and is available for use at no cost, is currently accessed by over 1,000 unique users in 10 countries. The Florida DOT has used three categories of transit performance measures (general performance indicators, effectiveness measures, and efficiency measures) since 1988. Donahue described a recent study that focused on developing a toolbox of performance measures, documenting measures used by Florida transit agencies, and identifying measures to meet MAP-21 requirements. The project included a review of relevant literature, case studies of six transit agencies throughout the country, and surveys of transit agencies in Florida. The recommended performance measurement categories in the toolbox include service effectiveness, service efficiency, labor productivity, safety and security, and vehicle use and asset management. The PowerPoint for this presentation is available at <http://onlinepubs.trb.org/onlinepubs/conferences/2015/performance/Donahue-Verzosa-2SP.pdf>.

Penelope Weinberger, American Association of State Highway and Transportation Officials, presided at this session.

INTEGRATING PLENARY SESSION

What Have We Learned? What Are the Gaps?

Patricia G. Hendren, *Spy Pond Partners, LLC*

Mara Campbell, *HERE*

Tim Lomax, *Texas A&M Transportation Institute*

Matthew Haubrich, *Iowa DOT*

This session featured the breakout session track leaders summarizing key themes from presentations during the first day of the conference. The track leaders covered the following points in their presentations:

DRIVING DECISIONS

Patricia G. Hendren

Patricia Hendren of Spy Pond Partners, LLC, discussed key themes from the Driving Decisions Breakout Sessions. She noted that the breakout sessions were organized to provide participants with actionable ideas and concepts that could be used to close the gap between the information provided to decision makers and what those decision makers want and need.

- The first theme presented by Hendren was the importance of turning data into information. She stressed the critical role agency analysts play in this process as their work is essential for identifying performance issues, addressing data quality issues, combining various data sets to uncover new insights, and translating vast amounts of data into useful information. She noted that agency leadership has an important role to play in explaining the purpose of specific performance measures, ensuring guidance on data analysis is sufficient, and providing overall direction for the analysis. She suggested that new skills may also be needed to help turn data into graphics and visual story telling.

- The second theme discussed by Hendren was the importance of reaching out to frontline employees and obtaining their understanding of and buy-in for performance measurement. She noted that engaging frontline employees in the performance management process was not easy, but it was key to a successful program. She reviewed examples provided by speakers in the track sessions, including talking to frontline employees on a regular basis, providing structured opportunities for

input from frontline employees, and connecting agency goals to daily tasks. For example, at the Southeastern Pennsylvania Transportation Authority, the maintenance supervisor accompanied the on-street supervisor to observe the importance of vehicle maintenance on a day with very heavy ridership. This interaction helped maintenance personnel realize the importance of their daily work keeping Southeastern Pennsylvania Transportation Authority vehicles maintained to meet agency goals. She suggested another approach was developing friendly competition among different agency groups, such as providing lunch for the escalator repair crew whose unit performs the best.

- The third theme presented by Hendren was realizing that it takes time to integrate the use of performance measurement into transportation agencies. She noted that although some agencies are further along in the development and use of performance measures, all groups still have progress to make. She commented that speakers highlighted the importance of learning by doing, adjusting measures as needed, and expanding programs as appropriate.

TRACKING THE MOVES

Mara Campbell

Mara Campbell of HERE discussed three key themes from the Tracking the Moves Breakout Sessions and how the objective of the track was to provide information on performance indicators for freight and people movement, as well as available data and analytic tools. She first summarized the definition of intermodal insanity presented in one of the sessions as doing the same thing over and over and expecting different results. This definition could also be applied to some aspects of performance measurement when the same data and analysis techniques are used but different results are expected. She noted that using different data and analysis methods may be needed to address changes in policies, priorities, and the transportation system.

- The first theme summarized by Campbell was the need to first identify the public policy questions being addressed and then consider the appropriate performance measure and data. She highlighted examples of public policy questions related to freight focusing on providing economic development opportunities and improving system performance.

- The second theme presented by Campbell focused on embracing the fact that the data needed for freight mobility and intermodal performance measures may never be perfect, but it was still important to tell the freight and intermodal story with available data.

- The need for ongoing dialog and cooperation between the public and private sectors on freight mobility performance measures was the third theme discussed by Campbell. She noted that a more robust dialog with the private sector would be

beneficial to identify their needs and future plans. She suggested that promoting active partnerships among the public and private sectors was needed to improve freight mobility in the country.

UNTANGLING THE DATA WEB

Tim Lomax

Tim Lomax of Texas A&M Transportation Institute discussed three themes from the first day of the Data Web Breakout Sessions. The first theme focused on measures and data. He noted that speakers highlighted the fact that although data quality is improving, the confidence in decisions cannot exceed the confidence in the data. He stressed the importance of understanding the strengths and limitations of available data and presenting them in appropriate ways.

- The need for partnerships, collaboration, and agreed-upon processes in collecting and analyzing data was the second theme highlighted by Lomax. He noted that many performance measures rely on data from sources external to a transportation agency, such as those on employment levels, gasoline prices, and population. He suggested that finding the right data partner is important for successful performance measurement programs.

- The third theme discussed by Lomax was using data for decision making, including the importance of understanding why the data are needed, how they are applied, and how they are communicated to decision makers. Lomax encouraged participants to use the communicatingperformance.com website developed as part of an NCHRP project, which presents good examples of communicating performance measurement to a wide range of stakeholders.

STATE OF THE PRACTICE

Matthew Haubrich

Matthew Haubrich of Iowa DOT described two themes from the State of the Practice Breakout Sessions.

- The first theme was the importance of distinguishing between goals and targets in performance management. He noted that one of the breakout sessions focused on target setting and provided examples of setting realistic performance targets, rather than aspirational goals that may be included in long-range plans.

- The second theme discussed by Haubrich related to developing and applying user-oriented performance measures. He noted that many measures developed by state DOTs focus on the condition of pavements, bridges, and other infrastructure. He

WHAT HAVE WE LEARNED? WHAT ARE THE GAPS?

suggested that performance measures that address how users perceive these elements, how they measure the performance of the transportation system, and how they make decisions related to using the system would be beneficial.

Joseph L. Schofer, Northwestern University, and Daniela Bremmer, Washington State Department of Transportation, presided at this session.

UNTANGLING THE DATA WEB PLENARY SESSION

Utilizing Advances in Data and Technology to Support Performance Management

Paul Trombino III, *Iowa Department of Transportation*

Heather Rothenberg, *Sam Schwartz Engineering*

Peeter Kivestu, *Teradata*

TRANSFORMING A DEPARTMENT OF TRANSPORTATION INTO AN INFORMATION AGENCY

Paul Trombino III

Paul Trombino discussed the development and use of different databases at the Iowa DOT for performance measurement and other related efforts. He described the development of supply chains for freight commodities in the state using these databases. Trombino covered the following topics in his presentation:

- Trombino noted that the Iowa DOT is examining how people and products are moving inside and outside the state. The analysis of these factors includes identifying major origins and destinations and points of consumption, which can help the department make better decisions for investments. He noted that emerging global markets for agricultural produce and manufactured goods from Iowa include Asia and Africa.
- Trombino discussed the changing roles of state DOTs. Noting the fusion of information occurring in transportation, he suggested that state DOTs are becoming sources and facilitators of information, as well as infrastructure owners and operators. He further suggested that information will be more important than infrastructure in the future roles of transportation agencies.
- Trombino discussed the difference between transportation and transport, and why it was important for public agencies to consider all the traditional transport modes (road, rail, water, and air) as well as pipelines. He stressed the importance of having data on all modes.
- Trombino described how manufacturing and agriculture were major elements of the Iowa economy and discussed changes in manufacturing, which historically has been a vertical process. He cited the example of automobile manufacturers that

made most vehicle components themselves or relied on a few nearby suppliers. Now vehicle parts come from their suppliers around the globe, and all sizes of manufacturers—small, medium, and large—are important.

- Trombino explained the importance of both physical supply chains and digital supply chains. He suggested that the digital supply chain may be more important to manufacturers in urban and rural areas to manage numerous suppliers and importers. He noted that 75% of 500 businesses surveyed in Iowa indicated they did not have full visibility of their supply chains, which he suggested represented a major risk and a potential cost. In addition, 30% responded that they were unsure where they rate in their suppliers' priorities, which he also noted represented a risk. He stressed the importance of transportation system availability 24 hours a day, 7 days a week, 365 days a year.

- Trombino described the Iowa economy, reporting that the gross state product is approximately \$165 billion. He repeated that Iowa is a production state and said that approximately 69% of the cost of products is transportation related. He further noted that approximately 84% of Iowa exporters are small- to medium-sized companies.

- Trombino discussed the importance of examining the economic value of the transportation system. He noted that the traditional measure of the economic value of transportation has been construction jobs; however, transportation contributes much more, including economic development, mobility, and quality of life. He suggested that the more the world connects digitally, the more demand there is to connect physically by using the transportation system.

- The supply chain design initiative undertaken by the Iowa DOT and the Iowa Economic Development Authority uses the private-sector practice of supply chain design overlaid on the state to identify ways to lower transportation costs for businesses and to promote economic growth. Trombino commented that it might also be possible to lower the public-sector investment in the transportation system as part of the process.

- Trombino suggested that commodity flow data are more valuable than data on vehicle volumes or the percentage of trucks. He said knowing the type of truck and commodity is important to better understand their needs from the transportation system. He noted that commercial vehicles are basically treated as equal in the transportation system today, even when they carry commodities of much different values and time sensitivities. Furthermore, there is a need to understand the regulatory impacts on freight movements, along with the infrastructure needs.

- Trombino described the development of a robust database on the 48 freight commodities that are transported in Iowa. Origin–destination data are available by county to other Iowa counties, to the United States, and to 40 other countries. The data include the mode (truck, rail, water, and air) and the baseline cost. He noted that public-sector data and purchased private and commercial data sets are included in the database, which may be more robust than those used by companies because it includes all commodities moving by all modes.

- Trombino described the proof-of-concept supply chain design being developed for eight companies in the state. The results will benefit the companies and the Iowa DOT by identifying improvements needed to address system constraints. He noted the database can be used to develop a supply chain design for companies considering moving to Iowa or homegrown start-up businesses.

- Trombino highlighted examples of available data, including truck-dominated freight flows in five surrounding states. He noted that the baseline cost to move products in Iowa was 21%, which is on the high side due to the large amount of agricultural products transported in the state. A scenario optimizing the transportation system was also developed that resulted in reducing the transportation cost of a product from 21% to 14%, with the difference reflecting approximately \$11.5 billion in savings to businesses in the state. He suggested that although achieving the optimized scenario was unlikely, some improvements might be possible. Furthermore, other analyses can be conducted with the data, including network optimization, rate of return, and identifying multiple company clusters.

- Trombino highlighted an analysis examining the potential to expand cross-docking facilities in the state that showed cost savings to businesses and to the Iowa DOT. A second analysis focused on increasing intermodal facilities and addressing the container shortage in the state, which also resulted in cost savings.

- Trombino said developing a supply chain on energy was the next project and that the numerous changes occurring in the energy sector were affecting transportation in Iowa. Trombino reported that in response to a shortage in the state, a supply chain for propane was developed last year that was used to identify policy changes and system improvement to enhance the transport and delivery of propane in Iowa.

- In closing, Trombino discussed the future of transportation and economics and stressed the importance of knowing the products, customers, modes, origins and destinations, and costs. He said having data on these elements results in better transportation investments. He stressed the importance of having high-quality machine-ready data and a data structure to support them. People make travel choices based on safety, economic, and mobility decisions, and having information on these topics is important. The key goal in the Iowa DOT strategic plan focuses on performance management.

HELD HOSTAGE BY YOUR DATA: WHAT DOES “DATA-DRIVEN” DECISION MAKING REALLY MEAN?

Heather Rothenberg

Heather Rothenberg discussed data for analyzing safety performance measures. She suggested that the experience gained from safety data was relevant to performance measurement in general. She acknowledged the assistance of Jocelyn Lewis of Booz Allen Hamilton in developing the presentation. Rothenberg covered the following topics:



FIGURE 5 Levels of safety data. (SOURCE: Sam Schwartz Engineering.)

- Rothenberg discussed the three levels of safety data illustrated in Figure 5. She noted that data at the top level focus on overall safety performance that is used at the national and state levels. Examples of data and measures at this level include total fatalities and fatalities per VMT. Data for problem area identification was the second level discussed by Rothenberg, and the third level was data for identifying appropriate countermeasures to address the critical safety problems.

- Rothenberg noted that the number of fatalities has historically been used as the key performance measure for overall roadway safety, a measure that has been used partly because the Fatality Analysis Reporting System maintained by the National Highway Traffic Safety Administration (NHTSA) provides a uniform national database. Standardized definitions of events such as a crash-related fatality (defined as a death resulting from crash-related injuries occurring within 30 days of a crash) further support the use of these measures. She said one of the limitations of using fatalities as a performance measure is that they are relatively rare occurrences at a corridor, roadway, or intersection level.

- Rothenberg reported that although serious injuries represent a more recent safety performance measure being used in many areas, there is no national database for serious injuries resulting from traffic crashes. Each state is responsible for collecting crash reports from on-site police officers, and these reports are submitted to a state database. Furthermore, there is no consistent definition of serious injury, except the voluntary use of the NHTSA modal minimum uniform crash criteria. She suggested that another limitation is that law enforcement personnel are being asked to make medical assessments. Although serious injuries are more common than fatalities, she noted that small factors could potentially be the difference between a serious injury and a fatality.

- Rothenberg discussed the use of traffic safety performance measures at the national level, including how the most recent performance measures from NHTSA were released in 2008 and 2013. She also noted that NHTSA released an Interim Final Rule that related these measures to MAP-21 programs. She reviewed core outcome measures, which include the number of fatalities, the number of serious injuries, and fatalities per VMT. Additional outcome measures address fatalities for the specific problem areas of speeding, seat belt use, impaired driving, motorcyclists, pedestrians, and young drivers. She reported that the core behavior measures are citations and arrests related to speeding, seat belt use, and impaired driving, and that the activity measure is observed seat belt use.

- Rothenberg discussed Figure 6, which presents the national performance management measures included in the Highway Safety Improvement Program notice of proposed rule making (NPRM) issued by FHWA in March 2014. She noted the proposed rule implements the MAP-21 requirements that states must report the number of fatalities and serious injuries and their rate per VMT. The rule provides states with the option of reporting the difference in these measures between urbanized and nonurbanized areas.

- Rothenberg reported that states must identify safety problem areas as part of the strategic highway safety plan (SHSP) required by FHWA, the highway safety plan required by NHTSA, and the commercial vehicle safety plan required by the Federal Motor Carrier Safety Administration. She noted that in theory, state personnel working on these plans should be using the same data and should be developing common themes and approaches across the plans to leverage available resources. Safety data are also used in state long-range transportation plans, state transportation improvement plans (STIPs), and metropolitan planning organization (MPO) transportation improvement plans.

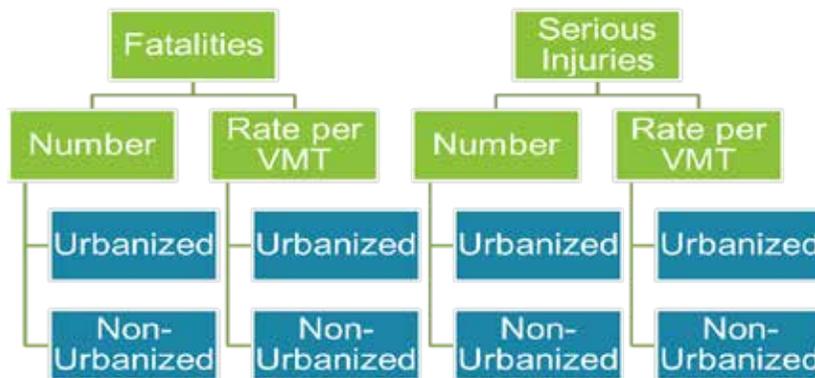


FIGURE 6 National performance management measures from the Highway Safety Improvement Program NPRM issued by FHWA in March 2014. (SOURCE: FHWA.)



FIGURE 7 Identification and implementation of safety countermeasures.
(SOURCE: FHWA *Safety Focused Decision Making Guide*.)

- Rothenberg reviewed key elements of a SHSP and presented examples from different states. She commented that SHSPs are data-driven, multiyear comprehensive plans that establish statewide goals, objectives, and key emphasis areas. SHSPs identify a state’s key safety needs and guide investment decisions toward strategies and countermeasures with the most potential to save lives and prevent injuries. The Utah SHSP uses fatalities to identify problem and priority areas to focus resources, and the Washington State SHSP uses fatalities and serious injuries to identify priority areas. She said a project must be in an identified problem area in a SHSP for a state to use Highway Safety Improvement Program funding.

- Rothenberg discussed Figure 7 from the FHWA *Safety Focused Decision Making Guide*, which presents the process for the third level of countermeasure identification and implementation. She reviewed the steps, which include identifying potential projects and programs to address a specific problem area, selecting the appropriate projects and programs, predicting the safety outcomes, and implementing the projects and programs. She noted that the desired outcome is to achieve the state and local safety targets. As illustrated in Figure 7, she said collecting and analyzing data were an important part of each step. She also highlighted the feedback loop to modify projects and programs as needed if the desired outcomes were not being realized.

- Rothenberg suggested there was not a good understanding of how implemented countermeasures affect safety in the problem areas and how improvements in the problem areas affect overall safety performance. Furthermore, the inability to assess the impacts of safety countermeasures was partly the result of being held hostage by data. Rothenberg identified factors associated with being held hostage by data, including relying on the “best available” data rather than striving for the best data, using old data because they are available, and confusing data causation with correlation. Other factors cited by Rothenberg were making decisions on data presented out of context and aiming for standardization and uniformity rather than customization.

- Rothenberg discussed the trade-offs with best available data versus best data. She noted that agencies have the best available data already. She suggested that getting the best data takes resources and that obtaining support and approval to invest in data can be difficult. She commented that it is hard to quantify the impact investing in traffic data systems has on reducing fatalities and serious injuries.

Rothenberg discussed the difficulty of determining causation, correlation, or neither with limited or inaccurate data. She used an example from Massachusetts focusing on the number of traffic speeding citations issued on an annual basis. She noted that the decline in the number of citations issued in 2005 might initially be attributed to programs or other activities aimed at reducing speeding in the state. She suggested, however, that a 2004 report from Northeastern University on racial and gender profiling by police in the state may have also influenced the decline in citations. Partly as a result of the study, police officers were required to complete an extra form when issuing a speeding ticket that included information on the race and gender of the individual receiving the citation. A decrease in speeding citations could be associated with the additional paperwork and its potential ramifications rather than an actual decrease in speeding. She said she thought this example highlighted the importance of understanding the data and situation.

- Rothenberg reported that most agencies are generally using crash data that are 1 to 2 years old due to the length of time it takes to record and transfer data, run data quality checks, close out a year, and complete other activities. She reviewed the schedule for the Fatality Analysis Reporting System, noting that the preliminary database is available to the public in the fall following the calendar year of data collection, with the final database available 1 year later. Based on this schedule, the final fatality database for 2012 is available in late 2014. She suggested that even when data are provided to the central depository faster from police departments using handheld tablets or other devices, they are not necessarily available to the public any sooner.

- Rothenberg suggested that although data visualization techniques, including infographics, dashboards, and heat maps, were great for presenting information in an easily understandable way, it was important to consider the context. She described the example of a map showing reductions in traffic fatalities in every state except North Dakota, which was experiencing an economic boom from oil and gas development, while most other states were experiencing a recession. Factors influencing the increase in fatalities included the dominance of rural roads in the state, new residents unfamiliar with driving on rural roads and in winter conditions, and residents with more disposable income. She noted another challenge with this type of presentation is that it does not provide a future outlook. For example, it does not convey that people will begin driving more as the economy recovers in other states and that it will be a challenge to continue reducing fatalities.

- Rothenberg suggested that although standardizing data was important, standardization should not occur at the cost of customization. She noted that being

able to compare similar data and performance measures across locations was important. At the same time, using data that were meaningful at a city, county, MPO, and state level was also important.

- Rothenberg stressed the importance of investing in safety data systems, not just in safety countermeasures. She acknowledged the difficulty of gaining support from policy makers to fund safety data collection and analysis. She also noted the need to examine the universe and cycle of performance measures rather than relying so heavily on fatalities and other traditional measures. She suggested that expanding the use of available data systems was important. NHTSA has identified six data sets for use in a traffic records program, including crash data, driver data, vehicle data, roadway data, citation adjudication data, and injury surveillance data. Some states, including Massachusetts, link crash and hospital data to better understand the actual injury outcomes of crashes. She suggested that more could be done in the area to develop meaningful performance measures associated with injury severity and other related factors.

- Rothenberg suggested that expanding the use of available data sources would also be beneficial. She cited an example from a state that was able to use a video log and related data initially collected for analyzing pavement conditions on roadways for safety analysis purposes. The focus should be on creating data systems that meet decision-making needs, not making decisions based on what can be found with existing data. In closing, she said this approach requires human, fiscal, and information technology resources, but that it was needed to improve safety data.

The PowerPoint for this presentation is available at <http://onlinepubs.trb.org/onlinepubs/conferences/2015/performance/measurements/Rothenberg-3PS.pdf>.

WHAT DOES USER EXPERIENCE HAVE TO DO WITH BIG DATA?

Peeter Kivestu

Peeter Kivestu discussed the use of data analytics to measure and ultimately transform the user experience in transportation. He described innovations in the airline industry resulting from deregulation and highlighted examples of data-driven analytics used in transportation. Kivestu covered the following topics in his presentation:

- Kivestu described different experiences for motorists, transit riders, and other user groups. He noted that real-time information on freeway congestion, the arrival of transit vehicles, and other transportation services is available online and on smart phones, with some applications inviting user interaction.

- Kivestu suggested that the purchase experience is a major part of the overall transportation user experience. He described the example of Hipmunk founder Adam Goldstein (who knew little about airline data but was well equipped with knowledge of how to put data to work), whose company helps people to make travel arrangements. He also described Uber, which redefined the taxi business into a mobile-centric business that connects a network of providers and users, creating a different user experience. He raised the question of how user experiences can be incorporated into transportation agency investment decisions.

- Kivestu discussed the experience with deregulation of the airline industry. He described the tension in the airline system at the time and how data analytics were used to address key issues. He compared that experience to the current situation with the surface transportation system and provided suggestions on how data analytics could help address these issues. Deregulation created tension between competing airline business models. Prior to deregulation, there were only two types of airfares: coach and first class. Since deregulation, there have been 35 years of continued decline in real average airfares. He suggested that deregulation resulted in dramatic price innovation in the airline industry. According to Kivestu, new low-fare airlines, price competition, intense financial pressure, and airlines fighting for survival all contributed to this change.

- Kivestu noted that the legacy airlines had extensive historical booking data that were used to identify which customers were likely to purchase tickets and when. The use of detailed booking history by flight was turned into pricing insights, a practice that became known as revenue management in the airline industry. Other innovations included frequent-flyer programs and other loyalty initiatives. At the time, booking data were considered “unimaginably big data” by most airlines; this conception of the difficulty of managing large amounts of data provided the opportunity for someone to take the lead.

- Kivestu described some of the current tensions in the transportation system, including funding limitations, deteriorating infrastructure, and rising consumer expectations. He elaborated these basic tensions as conflicts between private versus public funding, new roadway construction versus maintaining existing facilities, and increasing transit services versus building more roadways. He suggested that a better understanding is needed of how much consumers are willing to pay for different transportation services and under what circumstances they are willing to pay.

- Kivestu suggested that the pilot and demonstration projects focusing on high-occupancy toll (HOT) lanes and toll roads can provide important data on user preferences. He further suggested that insights on consumer preferences can be obtained if the data are captured systematically and managed strategically.

- Kivestu described the Stockholm Congestion Pricing project as an example of learning from available data. He highlighted key points made by Jonas Eliasson, Director of the Centre for Transport Studies at the Royal Institute of Technology in

Sweden, who noted that analysis of the project data found that travel patterns were much less stable than often thought and that not all trips and customers are the same. The subtleties of different travel patterns could be explored in the data. The raw traffic data details behind these patterns are the “unimaginable big data” of today.

- Kivestu described the extensive change in airline route networks resulting from the deregulation of the airline system that led to more and better options for consumers. Before deregulation, airline networks were oriented around point-to-point services. Deregulation resulted in a change to aligning route networks around hubs. He suggested that although the hub concept was not new, using hubs to increase service and to provide a robust airline network was new.

- Kivestu said American Airlines, one of the first airlines to change to a hub-based network, began new service from smaller cities to one of its major hubs. He noted that developing and undertaking this type of system requires extensive origin and destination data. The result was greater connectivity, new flights, new customers, higher load factors, and competitive growth.

- Kivestu commented that one factor influencing the tension in the surface transportation system today may be that it is not structured as a completely connected network and hence is not working to its full potential. Because the airlines needed to address congestion, lack of connectivity, and better return on investments, the hub system was a more robust system for them. He suggested that a network approach based on origin–destination data may help address these issues in surface transportation and result in an improved transportation system and user experiences.

- Without commenting on their viability, Kivestu highlighted three examples of network approaches being considered in congested travel corridors. The first example was the Transit Coalition Future plan for the SR-91 freeway corridor in the Los Angeles area. Elements of the plan included filling HOT lane gaps, improving direct access to HOT lanes, and adding toll lanes. Other elements are direct access ramps to transit stations, rapid express buses on HOT lanes, and closing rail gaps with a target of 30-minute rail service. This approach, which represents a private–public partnership for road, rail, and transit in the corridor, is a way of building out “hub connectivity” and improving service.

- The second example presented by Kivestu was the Anaheim Regional Transportation Intermodal Center, which serves AMTRAK and Metrolink commuter rail services and Orange County Transportation, Anaheim Resort Transit, and Megabus. The center has access to SR-57 and is directly accessible for bicycles from the Santa Ana River Trail. Future connections from the center are proposed for the streetcar to the Anaheim Resort and Platinum Triangle, the California High-Speed Rail, and the California–Nevada Maglev.

- Kivestu said the two reasons for building transportation hubs were to serve origin and destination traffic and to serve transfer traffic. He said the use of hubs

should continue to grow and that although knowing the initial demand is important, creating new traffic flows is also important. One lesson from the airline industry described by Kivestu was that the Dallas-Fort Worth airport and other airports, which were created to serve origin and destination traffic, also serve high volumes of transfer traffic. Transfer traffic accounts for approximately one-third of all passenger traffic at Dallas-Fort Worth.

- The third example of a network approach discussed by Kivestu was the regional mobility hub concept being developed in the greater Toronto region. The system of connected mobility hubs focuses on transit services, high-density development, and excellence in customer service. He suggested that these mobility hubs mirror the global airline network concept, serving as origins, destinations, and transfer points. The mobility hub concept is also intended to serve as a guidepost for high-density land use, thus encouraging robust demand growth around places where hubs can serve and grow.

- Kivestu used the Singapore Land Transport Authority as an example of an agency that was rich in operational data but at one time lacking in ability to use the data for analytic purposes. The agency wanted to plan for road, rail, bus, taxi, and private-vehicle networks, but its IT system was not designed to support the needed analytics. The solution was to integrate data from disparate operational systems and repurpose it for network design, goal management, audits, and many other uses. He elaborated on how that information is now readily available for analyzing historical key performance indicators and travel patterns, new measures of user experience, and efficiency levels and resource use, as well as providing support for modeling strategic plans.

- Kivestu discussed customer innovation as a final transformation emerging from airline deregulation. Before deregulation, the airlines did not distinguish between a customer who traveled once a week and customers who traveled once in their lifetime. American Airlines was the first airline to establish a mileage-based frequent-flyer program, which changed the competitive airline landscape. He suggested it captivated customers because it offered an economic benefit as well as an emotional connection to trips to exotic destinations. The airlines integrated available information on customers' trips and used it to add new value for customers. The results included better differentiation for high-value customers and opportunities for targeted marketing. Over time, partners have added value for customers and the carrier. Frequent-flyer programs have since become revenue generators for the airlines, as well as an endless source of new opportunities that emerge from analysis of the customer data.

- Kivestu described the smart card payment system implemented by the Nishi-Nippon Railroad Company in Japan, which operates a large railway network and provides local and long-distance bus service. Nishi-Nippon was experiencing changing customer demographics, which it decided to address by launching the

Nimoca smart card for use in fare payment and retail shopping. The system provides customer analyses for participating stores, including the details of daily purchases, allowing the stores to conduct more effective marketing and improve customer services.

- Kivestu said he thought these examples highlighted the wealth of data currently being collected from transit, toll road, HOT lane, and airline users, as well as retail customers. Furthermore, there are additional opportunities to leverage these data to benefit users and operators of the transportation system. Data on price and capacity can help determine a fair price for a fair service and lead to other innovations; at the same time, experimentation is needed to validate with data the price points and models that are acceptable to customers in terms of travel time, reliability, and available choices. Capacity and service need to be understood in terms of the origin–destination flow impacts, because not all trip purposes are the same and not all customers have similar needs.

- Kivestu suggested that the ability of any enterprise to answer key questions relates to metrics and context and that analytics are important to transportation agencies for creating metrics and then understanding them based on context, especially context in detail. Transportation agencies have access to three sources of data: available internal data, external data that could be obtained, and data that users will provide. He said integrating these data sets provides a powerful tool for performance management and enhancing customer experience.

The PowerPoint for this presentation is available at <http://onlinepubs.trb.org/onlinepubs/conferences/2015/performance/measurements/Kivestu-3PS.pdf>.

Gregory I. Slater, Maryland State Highway Administration, presided at this session.

DRIVING DECISIONS BREAKOUT SESSION

Getting Decision Makers to Use New, Big, and Different Data

Alice Mathew, *South African National Roads Agency Limited*

Jamie Henson, *District of Columbia Department of Transportation*

Yvonne Carney, *Washington Metropolitan Area Transit Authority*

Monique de los Rios-Urban, *Maricopa Association of Governments*

Speakers in this session discussed the use of different data sources, analysis methods, and communication techniques to assist decision makers.

Alice Mathew of the South African National Roads Agency Limited discussed the roadway system in South Africa and the use of performance management, asset management, freeway operations management, and tolling. She described the use of the agency's road survey vehicles to collect and analyze data on pavements and roadway conditions, the process for visual assessments of bridges, and the process for obtaining and analyzing vehicle volumes. The PowerPoint for this presentation is available at <http://onlinepubs.trb.org/onlinepubs/conferences/2015/performance measurement/Mathews-3DD.pdf>.

Jamie Henson of the District of Columbia DOT discussed a recent study considering a new streetcar system in a major bus corridor in the District. Exclusive lanes for transit were considered in the corridor, which has four major bus routes carrying approximately 75,000 daily bus riders. The analysis evaluated level of service, person throughput, and other factors for different alternatives. A broader set of performance measures was ultimately examined, including travel time, dwell time, trip-time reliability, headway adherence, vehicle level of service, and volume changes. The PowerPoint for this presentation is available at <http://onlinepubs.trb.org/onlinepubs/conferences/2015/performance measurement/Henson-3DD.pdf>.

Yvonne Carney of the Washington Metropolitan Area Transit Authority discussed enhancing tools for decision makers at Metro through the Vital Signs initiative, which focused on key performance measures. Information on the major drivers of on-time performance and the process for turning data into action was presented. She noted that Metro collects a lot of data, but turning them into information for making decisions has been challenging. The use of data on delay incidents and railcar availability for rail reliability and on-time performance measures was highlighted. The PowerPoint for this presentation is available at <http://onlinepubs.trb.org/onlinepubs/conferences/2015/performance measurement/Carney-3DD.pdf>.

Monique de los Rios-Urban of the Maricopa Association of Governments described the use of multiple data sources, including the National Performance Management Research Data Set (NPMRDS), the Arizona DOT Freeway Management System, and the HERE Analytic Traffic Patterns database. The coverage provided by the different sources was compared, and examples of performance measures on the MAGni[↑]ude Transportation Dashboard were presented. The PowerPoint for this presentation is available at <http://onlinepubs.trb.org/onlinepubs/conferences/2015/performance/Measurement/Rios-Urban-3DD.pdf>.

Patricia G. Hendren, Spy Pond Partners, LLC, presided at this session.

TRACKING THE MOVES BREAKOUT SESSION

Working Smarter, Not Harder, with Data

Nicole Katsikides, *Federal Highway Administration*

Terri Johnson, *HERE North America*

Marygrace Parker, *I-95 Corridor Coalition*

Joseph Bryan, *Parsons Brinckerhoff*

Ned Mitchell, *U.S. Army Corps of Engineers*

Speakers in this breakout session highlighted the use of data from different sources to analyze real-time traffic and predictive traffic conditions, supply chains, freight movements, and marine transportation.

Nicole Katsikides of FHWA described freight data available from the Freight Analysis Framework and NPMRDS. She presented examples of using data to analyze travel speeds, congestion levels, bottlenecks, and truck trips generated by the oil and gas drilling in North Dakota and automotive parts manufacturing in southern Ontario. She also highlighted the proof-of-concept pilot projects focusing on designing and implementing freight demand modeling and data collection to enhance decision making. These pilot projects were funded through the second Strategic Highway Research Program Capacity Project C20: Implementation Assistance Program. The PowerPoint for this presentation is available at <http://onlinepubs.trb.org/onlinepubs/conferences/2015/performance/Measurement/Katsikides-3TM.pdf>.

Terri Johnson of HERE North America described the navigation maps and traffic data available from HERE and highlighted applications related to performance measurement. She presented examples of multimodal traveler applications, traffic analyses, before-and-after analyses, public transit routings, and project benefit analyses. The PowerPoint for this presentation is available at <http://onlinepubs.trb.org/onlinepubs/conferences/2015/performance/Measurement/Program.pdf>.

Marygrace Parker of the I-95 Corridor Coalition and Joe Bryan of Parsons Brinckerhoff discussed the multimodal supply-chain case studies sponsored by the I-95 Corridor Coalition, the FHWA Office of Freight Management, and the U.S. Department of Commerce Advisory Committee on Supply Chain Competitiveness. They highlighted the data sources and general results from the five case studies focusing on automobile parts, retail consumer goods, electronics, agricultural produce, and processed food. The PowerPoint for this presentation is available at <http://onlinepubs.trb.org/onlinepubs/conferences/2015/performance/Measurement/Parker-3TM.pdf>.

Ned Mitchell of the U.S. Army Corps of Engineers described data sources and performance measures for the marine transportation system. He summarized the intermodal freight system in the country, public and private data sources, and

performance measure applications. The data spectrum ranges from reported, but not observed, data; data directly observed in transit; and data from continuous system monitoring. He presented applications using data from the U.S. Army Corps of Engineers Automatic Identification System, including travel and dwell times at ports and on the inland waterway system. The PowerPoint for this presentation is available at <http://onlinepubs.trb.org/onlinepubs/conferences/2015/performancemeasurement/Mitchell-3TM.pdf>.

Hugh Louch, Cambridge Systematics, Inc., presided at this session.

UNTANGLING THE DATA WEB BREAKOUT SESSION

Using Your Data for Good Rather Than Evil

Kevin Heaslip, *Virginia Polytechnic Institute and State University*

ZhiQiang Chen, *University of Missouri–Kansas City*

Michael Pack, *University of Maryland*

The speakers in this breakout session discussed the use of data from new sources to enhance performance management and asset management.

Kevin Heaslip of Virginia Polytechnic Institute and State University discussed the use of big data to support asset-management decision making. He reviewed the categories of asset management and the AASHTO 14 steps to implementing asset management. He described an extensive data collection effort in Utah using mobile LiDAR to inventory 5,860 centerline miles of roadways. Data available from the inventory include pavement characteristics and conditions, pavement markings, sign types and conditions, and bridge deflection and cracking, as well as an inventory of reflectors, guardrails, medians, and rumble strips. He described the integration of the data with the Utah DOT's GIS system, online UPLAN, and online OPEN DATA. He highlighted some of the challenges with the project, including postprocessing large amounts of data, keeping maps up-to-date, and updating the data. Future steps included examining the data to better understand infrastructure degradation and to forecast the useful life of different infrastructure elements. The PowerPoint for this presentation is available at <http://onlinepubs.trb.org/onlinepubs/conferences/2015/performance/Heaslip-3DW.pdf>.

ZhiQiang Chen of the University of Missouri–Kansas City discussed the use of crowdsourcing to report, assess, and manage pedestrian pavement conditions. He described current pedestrian pavement visual and automated inspection techniques and different types of crowdsourcing, including transportation examples. He outlined a collaborative mobile–cloud computing approach using smart phone apps and highlighted the system design, operational flow, and evaluation process. The PowerPoint for this presentation is available at <http://onlinepubs.trb.org/onlinepubs/conferences/2015/performance/Program.pdf>.

Michael Pack of the University of Maryland's Center for Advanced Transportation Technology Laboratory discussed the evolution and capabilities of vehicle probe data from private vendors. He described the development and use of different applications using data procured from INRIX on I-95 in 2008. The marketplace for vehicle probe

data has expanded, with INRIX, HERE, and TomTom providing data on I-95 in 2014. Possible concerns with using multiple private vendors include differences in data feeds, formats, and intervals. He discussed some of the opportunities, including intelligent data blending, with using multiple probe data providers, NPMRDS, and other sources. The PowerPoint for this presentation is available at <http://onlinepubs.trb.org/onlinepubs/conferences/2015/performance/Measurement/Pack-3DW.pdf>.

William G. Johnson, Colorado Department of Transportation, presided at this session.

STATE OF THE PRACTICE BREAKOUT SESSION

The “Data Pickle”

Do We Measure This or That?

Wenjing Pu, *Metropolitan Washington Council of Governments*

Mike Lewis, *Colorado Department of Transportation*

David Winter, *Federal Highway Administration*

Speakers in this breakout session presented examples of data sources and performance measures used at the MPO, state, and national levels.

Wenjing Pu of the Metropolitan Washington Council of Governments (MWCOCG) described the challenges of developing performance measures for the National Capital Region Transportation Planning Board and other multistate MPOs. These challenges include different legal and institutional authority, different processes for project development and selection, and different priorities among the partner states. Examples of common data for congestion measures used by the National Capital Region Transportation Planning Board include INRIX, HERE, and TomTom data and NPMRDS for the I-95 Corridor Coalition Vehicle Probe Project. He presented information available on the MWCOCG congestion dashboard webpage, including the travel time index, the planning time index, and the top 10 bottlenecks in the region. The PowerPoint for this presentation is available at <http://onlinepubs.trb.org/onlinepubs/conferences/2015/performance measurement/Pu-3SP.pdf>.

Mike Lewis, presently with the Colorado DOT and previously Director of the Rhode Island DOT, discussed applying performance management for investment reporting at the Rhode Island DOT. He described the transportation funding constraints facing the state and the use of performance measures related to bridge, pavement, and maintenance conditions to highlight the need for additional investments. The PowerPoint for this presentation is available at <http://onlinepubs.trb.org/onlinepubs/conferences/2015/performance measurement/Lewis-3SP.pdf>.

David Winter of FHWA discussed national-level performance measurement. He described measures using the Highway Performance Monitoring System (HPMS) data, including those focusing on annual average daily traffic, Interstate pavement smoothness, and the international roughness index. He highlighted examples of presenting information developed by the Data Visualization Center and explained the elements of FHWA’s All Road Network of Linear Referenced Data. The PowerPoint for this presentation is available at <http://onlinepubs.trb.org/onlinepubs/conferences/2015/performance measurement/Winter-3SP.pdf>.

David Putz, Iowa Department of Transportation, presided at this session.

PRACTICE MAKES PERFECT PLENARY SESSION

State of the Practice and Opportunities

Christos Xenophontos, *Rhode Island Department of Transportation*

Alan Colegate, *Main Roads Western Australia*

Peter Stephanos, *Federal Highway Administration*

MOVING A STATE DEPARTMENT OF TRANSPORTATION TO EXCELLENCE WITH PERFORMANCE MEASURES

Christos Xenophontos

Christos Xenophontos provided an overview of the Rhode Island DOT and the use of performance management at the department. He described the AASHTO state performance management model and discussed examples of organizational performance management in other states. Xenophontos covered the following topics in his presentation:

- Xenophontos said the Rhode Island DOT is responsible for designing, constructing, and maintaining the surface transportation infrastructure serving the needs of Rhode Island residents and visitors. The state-owned system includes 3,300 lane miles of highways and roadways, 1,154 bridges, approximately 60 miles of bike and pedestrian paths, and five train stations associated with the commuter rail service in the state. The Rhode Island DOT currently employs approximately 700 people, which is fewer than the 1,800 employees when he joined the agency. The Rhode Island DOT's capital budget expenditures are approximately \$260 million, and the highway operations budget is near \$90 million.
- Xenophontos described the factors influencing the use of performance management at the Rhode Island DOT. The workforce reduction resulted in a need to improve organizational and operational efficiencies. As a result, the Rhode Island DOT focused on becoming a performance-based organization. Other factors described by Xenophontos as influencing the change to performance management included a 2011 Governor's initiative for all state agencies to embrace performance management and the passage of MAP-21, which included requirements related to national performance measurements.
- Xenophontos discussed some of the milestones in the transformation of the Rhode Island DOT into a performance measurement-focused organization, including a FHWA-sponsored best practices scan tour to the Missouri and North Carolina DOTs in 2008. After this scan tour, the Rhode Island DOT staff were directed to

initiate performance management. An education phase, which Xenophontos reported still continues, was undertaken. He noted that the passage of MAP-21 allowed the Rhode Island DOT to establish an Office of Performance Management with dedicated resources. The primary functions of the office include collecting, analyzing, and trending the data needed for performance management. The Rhode Island DOT developed a partnership with the University of Rhode Island College of Business. In addition to system performance, the Office of Performance Management was tasked with examining organizational management and achieving organization excellence; the office is the only certified performance management office in the Rhode Island government.

- Xenophontos said the Rhode Island DOT examined approaches and models in use at other state DOTs and information available from AASHTO, TRB, and FHWA. He indicated that AASHTO's interest in performance management could be traced back to the formation of the Standing Committee on Quality in 1992. He noted that the Standing Committee on Performance Management (SCOPM) was established in 2008 to enhance coordination with other AASHTO committees and subcommittees, as well as with federal agencies and other professional organizations. The SCOPM charter focused on providing state DOTs with the expertise and resources to support performance-based management and to create a results-driven environment to maximize the performance of both transportation systems and organizations.

- Xenophontos described the state performance management model developed by SCOPM. In addition to AASHTO, other organizations and agencies agreeing with the model were the Association of Metropolitan Planning Organizations, the American Public Transportation Association, FHWA, and FTA. He said the model included three focus areas: organizational management; systems performance; and federal policy, regulations, and programs.

- Xenophontos noted that a variety of information, books, and reports were compiled and reviewed as part of the educational process at the Rhode Island DOT. Topics covered included developing and using vision, mission, and value statements, as well as guiding principles. Other topics examined were organizational platforms and developing strategic multiyear plans, tactical annual plans, and long-range plans. Information on organizational and system goals, goal areas, goal statements, and objectives and tactics was also included. Finally, he noted that information on performance measurements, performance reporting, and messaging was collected and reviewed.

- Xenophontos discussed the Colorado DOT mission and vision statements. The Colorado DOT mission is “to provide the best multimodal transportation system for Colorado that most effectively and safely moves people, goods, and information.”

The vision is “to enhance the quality of life and the environment of the citizens of Colorado by creating an integrated transportation system that focuses on safely moving people and goods by offering convenient linkages among modal choices.” He

stressed that communicating an agency’s mission and vision internally and externally was important, and employees need to embrace an agency’s mission and vision and understand how they contribute to accomplishing the mission and vision.

- Xenophontos noted that many organizations identify their key values as part of a strategic plan process. He highlighted the Massachusetts DOT values presented in Figure 8 as a good example. He also reviewed FHWA value statements. He stressed the importance of involving employees throughout the agency in the development process. He also noted that once adopted, values need to be communicated, practiced, and cultivated as part of the organizational culture.

- Xenophontos described some of the different quality management systems available for use, including total quality management, balanced scorecards, Baldrige, and ISO 9000. These systems help organizations ensure they are meeting the needs of their stakeholders and customers, as well as meeting statutory and regulatory requirements.

- Xenophontos cited the New York State DOT Forward Four as a good example of the use of guiding principles. As illustrated in Figure 9, the four guiding principles are preservation first, system not projects, maximize return on investment, and make it sustainable. He highlighted examples of strategic multiyear plans from the Washington State DOT, the California DOT (Caltrans), the Virginia DOT, and the Minnesota DOT.

- Xenophontos said organizational goals are strategic objectives outlining expected outcomes and cited the Wisconsin DOT’s organizational goals, which focus on mobility, accountability, preservation, safety, and service (MAPSS). He described the links between the Wisconsin DOT’s organizational goals, performance measurement, targets, the MAPSS dashboards, and performance reporting. The

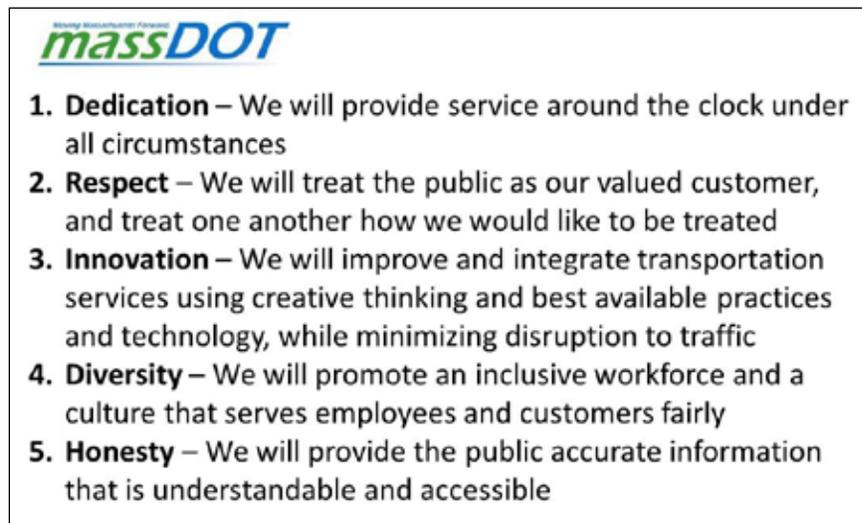


FIGURE 8 Massachusetts DOT statement of values. (SOURCE: Massachusetts DOT.)



FIGURE 9 New York State DOT Forward Four guiding principles.
(SOURCE: New York State DOT.)

Washington State DOT’s Gray Notebook and the Missouri DOT’s Tracker have been in use for over 10 years. He also cited the Illinois DOT’s Annual Plan, the U.S. DOT’s Annual Performance Plan, and the North Carolina and Rhode Island DOTs’ dashboards for performance reporting. He suggested that performance reporting allows agencies to tell their stories and provides transparency and accountability. Performance reporting also empowered Rhode Island DOT employees and informed stakeholders, as seen by the importance of the agency’s “PM3” approach: performance measurement, management, and messaging. He suggested that messaging should be tailored to specific customers and that identifying the information to share and the best methods to use was important.

- Xenophontos described a recent example of messaging at the Rhode Island DOT. He reported that over the past 5 years, the agency spent an average of \$10.4 million on winter maintenance, of which approximately 52% was for materials, including salt. He noted that the Maintenance Division was an early adopter of performance measurement. The division examined the use of salt and other materials per inch of snow. A key result from this analysis was retrofitting a portion of the winter operations fleet to use a closed-loop system to reduce salt usage in winter storms. The tracking that was done through performance management allowed the Rhode Island DOT to make the business case for the closed-loop system.

- In closing, Xenophontos said he thought performance management makes sense for state DOTs. Both organizational and system excellence can be achieved through performance management. He noted a wealth of resources is available to the transportation community on performance management, including a transportation pooled-fund project. The purpose of the project was to research and assess training and educational needs of contributing members, to develop and deliver training, and

to facilitate the sharing and retention of performance management best practices. More information on the pooled-fund project is available at <http://www.pooledfund.org/Details/Solicitation/1394>.

The PowerPoint for this presentation is available at <http://onlinepubs.trb.org/onlinepubs/conferences/2015/performance measurement/Xenophontos-4PS.pdf>.

MEASUREMENT-DRIVEN OPERATIONS MANAGEMENT

Alan Colegate

Alan Colegate described the transportation system in the state of Western Australia (WA). He discussed the challenges facing WA and Main Roads. He summarized the methods used by Main Roads to measure and communicate performance measures to the government, customers, and the public. He noted that all costs are provided in U.S. dollars. Colegate covered the following topics in his presentation:

- Colegate provided an overview of WA and the transportation system in the state. WA comprises 1.5 million square miles, accounting for one-third of Australia. With a population of approximately 2.5 million people, it is one of the fastest-growing states in Australia. Approximately 70% of the population lives in and around the capital city of Perth. As a result, much of WA is sparsely populated. The natural resources in the northern part of WA are a major part of the Australian economy, with raw materials exported to countries throughout the world.

- Colegate noted that the World Bank has characterized transport as the ultimate enabler, so by serving other sectors of a nation's economy, transport and roads support the achievement of national goals. He reported that the road network was important in Australia. He commented that although transport makes the greatest contribution to the Australian economy, it was also seen by the public and policy makers as needing improvement to address congestion and growing demands.

- There are three levels of government in Australia: federal, state, and local. Colegate reported that the national government does not own any road assets, although it provides funding for large infrastructure projects that contribute to national economic outcomes. He stated there are approximately 510,000 miles of roads in Australia, with 43% sealed or paved roads. He noted that in 2014, approximately \$13 billion was spent on roads throughout Australia.

- Colegate said road transport accounts for 70% of domestic passenger travel, with use anticipated to increase by 2.5% per year. Further, 80% of nonbulk freight transport was carried by trucks on the road system, and freight traffic was forecast to increase by 80% by 2031. Colegate noted that traffic congestion was increasing on WA roads, with congestion currently estimated to cost \$12 billion and increasing to \$53 billion by 2031.

- Colegate reported that local governments were responsible for the majority of roadway miles in Australia. He noted that WA was responsible for approximately 11,000 miles of roadways, and local jurisdictions were responsible for 81,000 miles. WA Main Roads was also responsible for managing 1,300 sets of traffic signals and maintaining 2,000 timber and concrete bridges, numerous traffic signs, and pavement markings. Although the roads under WA control represent only 12% of the total public road network, they carry over 60% of the total traffic and freight volumes. There are only a few toll roads in Australia, and none in WA. The potential of introducing heavy vehicle charges was being considered on a new highway segment in the state.

- Colegate described the WA transport organizational structure. The transport agencies (Main Roads and the Public Transport Authority) were brought together under one chief executive officer a few years ago, but they maintain their autonomy in day-to-day operations. He suggested that the structure promoted coordination and cooperation among the agencies, focusing on providing integrated transport solutions for WA.

- Colegate noted that Main Roads is responsible for one of the largest geographically spread road networks in the world. He commented that Main Roads has provided infrastructure and has operated the state roadway system for almost 90 years. The assets of Main Roads are valued at approximately US\$36 billion, representing almost 30% of the state's total asset base. Main Roads invests approximately US\$1.8 billion annually in the transport system and has close to 1,000 employees in 10 regional centers across the state. According to Colegate, it is important to demonstrate and communicate to policy makers and the public how the agency adds value to the people and businesses in the state.

- Colegate described some of the internal and external factors driving the future direction of Main Roads. WA's growth in population is expected to continue. Population growth peaked at approximately 3% in 2013 but recently had stabilized at close to 2%, with most of the growth occurring in the greater metropolitan Perth area. He noted that WA was also experiencing an increase in the number of motor vehicles, accompanied by an increase in VMT.

- Other factors influencing WA cited by Colegate included increased freight volumes through the state's ports and on the road network, the need to develop integrated multimodal approaches to address congestion, and rapidly evolving automated and connected vehicle systems. He noted that the truck platooning trials were of interest to Main Roads, as resource companies are already operating mining vehicles in the northern part of WA remotely from control centers almost 3,000 miles away in Perth. Another factor influencing Main Roads is limited funding, especially related to addressing maintenance needs and preserving assets.

- Colegate described Main Roads' new strategic direction, "Keeping WA Moving," which focuses on addressing the issues cited. He said rather than a mission, vision, or purpose statement, Main Roads developed an aspiration, which defines what the agency is trying to achieve and its ideal future direction. The Main Roads

aspiration is “To provide world class outcomes for the customer through a safe, reliable, and sustainable road-based transport system.”

- Colegate described the four strategic areas of focus for accomplishing the aspiration: customers, movement, safety, and sustainability. He noted that the focus on customers included enhancing Main Roads’ understanding of customer needs to deliver a transport network centered on what they value. Examples of this strategic focus area include providing a transport network, not just a roadway network; using data to better understand and communicate with customers; and providing real-time information to improve the total transport experience. He suggested that success in this area included clearly defined customer segments and improved feedback on the efficiency and reliability of the network.

- Colegate reported that the focus on movement is to achieve a balanced approach that improved the mobility of people and the efficiency of freight. Other characteristics of this strategic area included economic benefits from improved productivity, corridor management, and improving the environment for bicycling and walking. It also involved using data to make informed and smart choices, examining ITS applications in transit, enhancing intermodal connections and access to natural resources, and security. Measures of success were increased freight throughput at strategic locations, reduced congestion and increased use of road space, reduced incidents, and increased use of transit and alternative modes.

- Colegate discussed the focus on sustainability, which uses Main Roads’ existing network and innovative revenue sources to contribute to achieving connected and healthy communities. The outcome of this focus area is to develop a sustainable transport network that meets social, economic, and environmental needs. The attributes focus on improving use of the existing infrastructure, reducing carbon emissions and the impact of noise, and creating high-quality public spaces that enrich communities and encourage transportation options that improve people’s health. He noted that it also focused on creating new funding and financing opportunities, including potential financing from the capital opportunities created by Main Roads.

- Colegate reported that the focus on safety included supporting the delivery of improved safety outcomes for all users of the transport network. He said WA continued to lag behind other states in safety performance. The desired outcomes in safety performance included reducing fatalities and serious injuries, as well as promoting transformational change through integrating a holistic approach to transport safety with shared responsibility for a safe system based on the four cornerstones of safe road users, safe roads and roadsides, safe speeds, and safe vehicles. He stressed that improving the safety of vulnerable road users was a key element and that measures of success focused on reductions in fatalities and serious injuries for motorists and vulnerable road users.

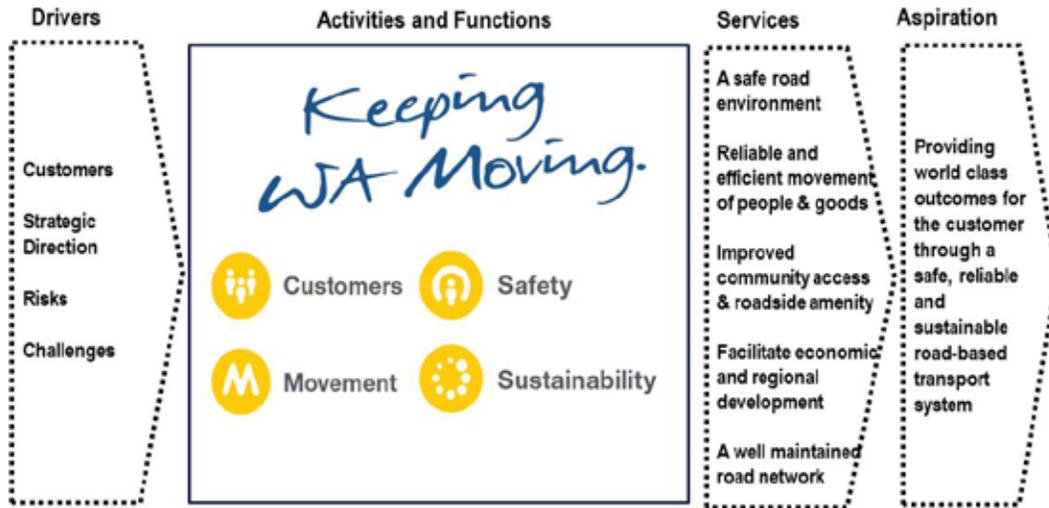


FIGURE 10 Main Roads' Western Australia business planning model.
(SOURCE: Main Roads Western Australia.)

- According to Colegate, the Main Roads business planning model illustrated in Figure 10 is being used to link the strategic direction to the actual services provided. The drivers—customers, strategic direction, risks, and challenges—feed into the activities and functions in the four focus areas, which link to the services provided by the agency. He noted that the services also link to the overarching WA government goals and the different Main Roads programs.

- Colegate described the methods used to measure and communicate performance. Reporting requirements in WA were based on legislation that directs agencies to develop and use efficiency and effectiveness indicators for the defined services and outcomes. The agencies are required to include the results in their annual report to the government, and the indicators had to be relevant, appropriate, and free from bias. Further, Main Roads must demonstrate that the indicators are used to influence and manage its business and performance. He said each indicator must be approved by the WA Head Treasury and that the Auditor General must give an opinion on each indicator, which is considered to be of equal weight and value as the opinion of an auditor. He noted that noncompliance is serious and results in reports to the government.

- Colegate said agencies in WA have been required to comply with reporting requirements since 1984. In 2006, there was a transition from output-based reporting to outcome-based reporting. He noted that agencies are required to report key performance indicators for effectiveness (relating to conditions that affect outcomes) and efficiency (relating to the resources required to provide each of the services). Main Roads has various performance review and evaluation initiatives that are undertaken monthly, quarterly, biannually, and annually. In addition, the Main Roads

Corporate Score Card, which is the cornerstone of this evaluation process, includes measures from the business plan and outcome-based performance measures used to report to Parliament and the community. He said further that the Score Card allows Main Roads to align the performance measures with government goals; customer and stakeholder expectations; and Main Roads' strategic direction, corporate business plan elements, and programs and services. He reported that the integrated approach allows one set of measures to be used in evaluating diverse views. He noted that measures and metrics continue to be evaluated to ensure relevancy.

- Colegate described some of the methods used to communicate the Score Card information. The Score Card is available online and is moving to a web-based application. He also noted that the Main Roads Corporate Executive releases a quarterly special communique outlining progress that is limited to two pages and focuses on the four areas of finances, delivery, customers, and people and safety. An annual report is used for external stakeholders.

The PowerPoint for this presentation is available at <http://onlinepubs.trb.org/onlinepubs/conferences/2015/performance/measurements/Colegate-4PS.pdf>.

COLLABORATING TOWARD SUCCESSFUL PERFORMANCE MANAGEMENT: FHWA AND THE STATES WORKING TOGETHER

Peter Stephanos

Pete Stephanos discussed FHWA's efforts to implement the MAP-21 performance measurement requirements, including assisting states and MPOs with their new responsibilities. He expanded on the comments made by Jeff Paniati in the opening session. Stephanos covered the following topics in his presentation:

- Stephanos noted the importance of FHWA, other federal agencies, state DOTs, MPOs, transit agencies, and local governments working together to implement the MAP-21 performance management requirements. He said he thought MAP-21 makes a transformational change from a federal surface transportation program focused on program delivery to one focused on performance outcomes.

- Stephanos reported that the framework for the new performance measurement requirements includes establishing national goals to focus on the Federal-Aid Highway Program, developing measures to track performance at the national level, setting targets at the state and MPO levels, documenting how states and MPOs are reaching those targets, and reporting on progress. A final requirement is to make all the information transparent to the public, providing a better understanding of transportation investment decisions.

- FHWA was implementing the MAP-21 requirements through the rule-making processes discussed by Paniati and presented in Table 1 (see page 7). Stephanos said further that FHWA has issued five NPRMs and that the comment period on all five has been closed. The one remaining NPRM on system performance measures, traffic congestion, freight movement, and on-road mobile source emissions is anticipated to be released later in the year. He noted that many thoughtful, meaningful, and useful comments have been received on the NPRMs, most of which should be finalized in late 2015 and 2016.

- Stephanos said FHWA has focused on maintaining a balance between consistency and flexibility in the development of the NPRMs while ensuring a reliable and credible national program. Flexibility is provided to ensure states and MPOs are not forced to take actions that are inconsistent with local priorities and can manage performance across multiple jurisdictions. Stephanos pointed out that improving data quality for reporting at the national level and for use in making local transportation investment decisions was also important. NPRMs include the use of national data sources to the extent possible while noting areas for improving data at all levels, including taking advantage of advancements in technology for data collection and analysis. He suggested there was a need to better link the federal investments to performance outcomes.

- Stephanos expanded on the need to manage performance measurement across multiple jurisdictions. He used the Philadelphia area covering portions of Pennsylvania, New Jersey, Maryland, and Delaware illustrated in Figure 11 as an example. He noted that in addition to the four states, the area includes four MPOs. The decisions made by individual states and MPOs affect travelers throughout the area. Furthermore, portions of the area are in EPA Non-Attainment and Maintenance categories, with further requirements. He suggested that ideally all these states and MPOs would work together to collectively set performance outcomes for the area and to identify how each agency will contribute to achieving those outcomes. An inefficient approach would be for each agency to work independently, identifying different priorities and performance measures. Stephanos reported that FHWA had been conducting workshops throughout the country to promote collaboration among agencies on performance measurement and investment decision making.

- Stephanos discussed the need to effectively use national data sources for reporting on national performance. He reviewed the pilot studies evaluating different pavement conditions and data sources, including state databases, the HPMS database, and field-collected data. The case studies also examined different methods, including the international roughness index–based approach, the composite condition approach, and the structural measurement approach. These approaches were examined for different corridors. The case study results for the I-90 corridor in Minnesota, Wisconsin, and South Dakota indicated that the data source made a difference. For example, he noted that the field data collection had the highest percentage of



FIGURE 11 Multiple jurisdictions in the Philadelphia region. (SOURCE: FHWA.)

pavement in good condition, with state data reflecting a similar, but slightly lower percentage in good condition, and HPMS data reflecting an even lower percentage in good condition.

- Stephanos reported that FHWA also reviewed NCHRP Project 20-24(82), which examined the differences in the HPMS database and state databases. The project results indicate apparent consistency between the HPMS and state data sets for pavement ride quality and pavement smoothness, but less consistency for other aspects of pavement conditions, including cracking and rutting. The NPRM included a proposal for defining good, fair, and poor conditions in a consistent and standardized manner.

- Stephanos described the assistance being provided by FHWA to states and MPOs with implementing MAP-21 requirements. The first area he covered was reporting on performance management. He noted that as a federal agency, the U.S. DOT is required to complete an annual performance and accountability report, which is available online. Two examples of performance measures in this report are the percentage of the National Highway System with pavement in good condition and the percentage of National Highway System bridges that are structurally deficient. He noted that although the targets in the report are being met, they were not established with state and MPO input. The targets will be reexamined in consultation with states and MPOs as part of the MAP-21 implementation process.

- Stephanos described the FHWA *Conditions and Performance Report*, which is developed and submitted to Congress every 2 years. The report includes information on system conditions, operational performance, safety, revenues and expenditures, and investment analyses. He noted there are two issues with the report. The first issue relates to the time lag between obtaining the data and completing the report approval process. Much of the information is 2 years old by the time the report is released. A second issue is the difficulty of associating performance with federal investments from the information contained in the report. He said he thought both issues should be addressed with implementation of the new rule making.

- Stephanos said the American Recovery and Reinvestment Act (ARRA) projects included performance-reporting requirements. Information on these projects is available on the ARRA website. This reporting was the first federal highway program that expected measurable outcomes, including the creation of jobs. Stephanos noted that under the ARRA program FHWA was not able to report the impact of these investments on system performance; however, this information will be possible after MAP-21 is implemented.

- Stephanos described the FHWA transportation performance management technical assistance program and training that are available or being developed. The FHWA transportation performance management (TPM) website includes information on noteworthy practices, training opportunities, and other information. The noteworthy practices highlight effective examples from states and MPOs to improve different elements of performance measurement. The FHWA *TPM Digest*, published every 2 months, highlights additional case studies and examples.

- Stephanos discussed the FHWA TPM technical assistance program, which includes three parts: technical assistance resources, on-site assistance and action planning, and national assessments and surveys. A TPM capability maturity model (CMM) is under development and will be presented at a pilot workshop at the conference. Other activities described by Stephanos included the development and distribution of a TPM *Implementation Guidebook* and the deployment of a TPM Toolbox that integrates the TPM CMM and the TPM *Implementation Guidebook*. He noted that workshops on these resources will begin in 2016.

- Stephanos described the division TPM readiness assessment and the national TPM implementation review efforts that will be carried out in 2015 and 2016, respectively. The purpose of the division TPM readiness assessment is to assess the abilities of division offices to oversee and provide support in the implementation of MAP-21 performance provisions. The national TPM implementation review is an external review to assess the degree to which state transportation agencies and MPOs have implemented MAP-21 performance provisions. These efforts are being conducted to identify best practices that can be shared and to identify needs for technical assistance and support.

- Stephanos said a frequent request to FHWA is to provide a way to make new public data files more accessible and that the FHWA-sponsored Data Palooza events focus on highlighting and sharing new data sources. He reviewed other activities under way, including FHWA's cloud testing for pavement and bridge data, partnering with other agencies to share data, the Data Visualization Center, and developing research data sets. Further, he commented that an effort is under way within FHWA to develop a data governance plan to enhance data consistency and standardization within the agency.

- In closing, Stephanos highlighted the existing and new TPM websites. Numerous resources, including infographics, trends, reports, and searchable databases, will be included in the new website, which should be online in 2016. A variety of information is available on the current website at <http://www.fhwa.dot.gov/tpm/>.

The PowerPoint for this presentation is available at <http://onlinepubs.trb.org/onlinepubs/conferences/2015/performance/Stephanos-4PS.pdf>.

Matthew Haubrich, Iowa Department of Transportation, presided at this session.

DRIVING DECISIONS BREAKOUT SESSION

World of Opportunity

Transportation's Future and Performance-Driven Decision Making

Julie Lorenz, *Burns & McDonnell*

Joe Crossett, *High Street Consulting Group*

Julie Lorenz of Burns & McDonnell and Joe Crossett of High Street Consulting Group presided at this interactive breakout session exploring the connections between changes in the transportation system and the performance measures needed to prepare for and manage those changes. The NCHRP Foresight 750 Series video and reports were used as the basis of the breakout session. Small group discussions focused on the following four topics:

- Technology: technology investments at the right time;
- Sociodemographics: the transportation impacts of shifting sociodemographics;
- Climate: how to prepare for extreme weather events; and
- Energy and fuels: future energy scenarios.

The following four future scenarios developed and examined in the Foresight projects were also discussed:

- Momentum: American population ages and becomes more diverse. Global trade booms. Domestic growth flattens.
- Global chaos: Worldwide financial instability restricts growth. Extreme weather increases, with negative impacts.
- Technology triumph: New technology radically changes transportation. The economy booms, and the United States becomes more self-reliant.
- Gentle footprint: The public demands low-impact choices. Regulations reduce consumption and increase government control.

Participants discussed the potential differences in the economy, technology, politics, society, and the environment under the various scenarios and how transportation might look in 2065. Participants also discussed possible changes in existing performance measures and new performance measures needed to prepare for the transportation system of 2065.

The PowerPoint for this presentation is available at <http://onlinepubs.trb.org/onlinepubs/conferences/2015/performance/Measurement/Lorenz-4DD.pdf>.

TRACKING THE MOVES BREAKOUT SESSION

“Transpo Talks”

Traffic Analytics and Visualization

Sreenath Gangula, *Washington State Department of Transportation*

Larry Redd, *Redd Engineering*

Lytang Kelley, *INRIX*

Peter Rafferty, *University of Wisconsin*

Scott Perley, *Iteris, Inc.*

Michael Pack, *University of Maryland*

Mara Campbell, *HERE*

In a takeoff of TED Talks, which are billed as a platform for “ideas worth spreading,” speakers in this session provided examples of traffic data analytics and visualization techniques to communicate performance measures with a range of stakeholders.

Sreenath Gangula of the Washington State DOT discussed the development and use of the agency’s 2014 *Corridor Capacity Report*, which was developed in partnership with MPOs and transit agencies in the state and the University of Washington. The *Corridor Capacity Report* appraises the legislature, stakeholders, and other groups on highway system conditions and multimodal capacity opportunities. It also supports the Washington State DOT’s Practical Solutions and performance-based planning initiatives. He presented the Dashboard of Indicators, which includes corridor-specific congestion indicators, demographic and economic indicators, multimodal performance measures, and statewide congestion indicators. He illustrated the detailed data available by corridors, including commute travel times by different modes, transit ridership, and park-and-ride lot use. The PowerPoint for this presentation is available at <http://onlinepubs.trb.org/onlinepubs/conferences/2015/performanceasurement/Gangula-4TM.pdf>.

Larry Redd of Redd Engineering discussed incorporating risk into asset management at the Colorado DOT. He summarized a project developing a method to portray and understand risk across the highway network. He described the steps in the process, which included developing a statewide risk register of the top 50 risk event types, spreading the risk scores across corridor types and specific corridors for all affected asset classes, and examining 17 corridors in more detail. He noted that risk management strategies were then developed for each corridor. The PowerPoint for this presentation is available at <http://onlinepubs.trb.org/onlinepubs/conferences/2015/performanceasurement/Redd-4TM.pdf>.

Lytang Kelley of INRIX discussed the products and services provided by INRIX, including those focusing on aggregating and packaging data that are meaningful and

useful to public agencies. Examples of available products include real-time traffic data and archived historical traffic data, which can be analyzed and presented in numerous ways. She described the partnership between INRIX and the University of Maryland to develop additional analytic tools available to the public sector. She highlighted that trip data can include the actual routes of vehicles and the types of vehicles and that there are different visualization techniques to display the data.

Peter Rafferty of the Traffic Operations and Safety Laboratory at the University of Wisconsin discussed the development and use of multistate mobility performance measures. He highlighted examples of corridor coalitions throughout the country and discussed the 2013 FHWA report *How to Improve Performance on Corridors of National Significance*. He presented examples of mobility measures on I-70 in the Mid-America region and I-90 in the western states. The PowerPoint for this presentation is available at <http://onlinepubs.trb.org/onlinepubs/conferences/2015/performance/Measurement/Rafferty-4TM.pdf>.

Scott Perley of Iteris, Inc., discussed the use of big data and data analytics to enhance performance measurement. He noted that the use of big data provides greater accuracy, reduces costs, and allows for deeper insights. He provided an overview of NPMRDS and approaches to fill data gaps in some areas and examples from the iPeMS Dashboard presenting different performance measures. The PowerPoint for this presentation is available at <http://onlinepubs.trb.org/onlinepubs/conferences/2015/performance/Measurement/Perley-4TM.pdf>.

Michael Pack of the Center for Advanced Transportation Technology Laboratory at the University of Maryland discussed the use of analytics and visualization to tell compelling stories related to performance measures. He suggested that visualization techniques can help make data easily accessible, usable, and understandable to a wide range of users. He presented examples of different visual analytics and stressed the importance of ethics in visualization, as information can easily be misrepresented. The PowerPoint for this presentation is available at <http://onlinepubs.trb.org/onlinepubs/conferences/2015/performance/Measurement/Pack-4TM.pdf>.

Mara Campbell of HERE discussed the products available from HERE Traffic and highlighted examples of turning big data into useful information. She noted that HERE Real-Time Traffic provides continuous dynamic traffic information, including real-time speeds and travel times. HERE Advanced Analytics includes traffic analytics based on historical data, NPMRDS, and typical traffic patterns based on historical data. HERE Predictive Traffic provides forecasted speeds and travel times up to 12 hours into the future. She presented an example of using HERE data for a before-and-after analysis assessing the impacts of a work zone and described the benefits of traffic analytics. The PowerPoint for this presentation is available at <http://onlinepubs.trb.org/onlinepubs/conferences/2015/performance/Measurement/Campbell-4TM.pdf>.

Brendan Nugent, Transport for New South Wales, presided at this session.

DATA WEB BREAKOUT SESSION

Data Business Planning

Anita Vandervalk, *Cambridge Systematics, Inc.*

Kristen Carnarius, *Metropolitan Transportation Commission*

Stanley Young, *University of Maryland*

Speakers in this session addressed using technology to enhance performance management at the state level, the MPO level, and on freeways and arterials.

Anita Vandervalk of Cambridge Systematics, Inc., discussed the Florida Mobility Performance Measures Program, highlighting data needs, data sources, measured data, modeled data, and future activities. The program covers the movement of people and goods by all modes. She reviewed the assessment of public and private data sources and the use of advanced technologies to collect and analyze data. The PowerPoint for this presentation is available at <http://onlinepubs.trb.org/onlinepubs/conferences/2015/performance measurement/Vandervalk-4DW.pdf>.

Kristen Carnarius of the Metropolitan Transportation Commission discussed reinventing the MPO performance-monitoring process by using interactive data visualization techniques. She described the Vital Signs project, which tracks the implementation of sustainability objectives in the San Francisco Bay Area and which also relies on extensive collaboration with the Association of Bay Area Governments, the Bay Area Air Quality Management District, and the San Francisco Bay Conservation and Development Commission. She also described the interactive Vital Signs website, which allows the public to monitor progress of different measures. The PowerPoint for this presentation is available at <http://onlinepubs.trb.org/onlinepubs/conferences/2015/performance measurement/Carnarius-4DW.pdf>.

Stanley Young of the University of Maryland discussed the I-95 vehicle probe project, the I-83 and I-81 multivendor freeway validation process, the arterial probe data quality study, and other recent projects examining the use of advanced technologies to monitor arterials. He presented the analyses from these projects and described some of the challenges with arterial performance measures. The PowerPoint for this presentation is available at <http://onlinepubs.trb.org/onlinepubs/conferences/2015/performance measurement/Young-4DW.pdf>.

Erik Sabina, Colorado Department of Transportation, presided at this session.

STATE OF THE PRACTICE BREAKOUT SESSION

Transportation Performance Measurement Capability Maturity Model Workshop

Michael Nesbitt, *Federal Highway Administration*

Karen Miller, *Missouri Department of Transportation*

Susanna Hughes-Reck, *Federal Highway Administration*

Patricia G. Hendren, *Spy Pond Partners, LLC*

The use of capability maturity models (CMMs) is an emerging best practice across multiple transportation disciplines. This breakout session was a workshop introducing the FHWA transportation performance management (TPM) CMM. The workshop was conducted by Michael Nesbitt, FHWA; Karen Miller, Missouri DOT; Susanna Hughes-Reck, FHWA; and Patricia G. Hendren, Spy Pond Partners, LLC. Modeled after the successful transportation systems management and operations CMM, the TPM CMM covers the people, processes, and technology and data aspects of implementing TPM. From a process perspective, this model aligns with (and uses terminology consistent with) existing guidance and agency practice for performance-based planning and programming.

The workshop included presentations, interactive polling, and roundtable discussions on the 10 TPM CMM model components. Examples of different applications were also presented. The 10 model components are

1. Strategic framework;
2. Target setting;
3. Performance-based planning;
4. Performance-based programming;
5. Monitoring and assessment;
6. Reporting and communication;
7. Performance measurement organization and culture;
8. External collaboration;
9. Data usability and analysis capabilities; and
10. Data management.

The PowerPoint for this presentation is available at <http://onlinepubs.trb.org/onlinepubs/conferences/2015/performance measurement/Nesbitt-4SP.pdf>.

Michael Nesbitt, Federal Highway Administration, presided at this session.

INTEGRATING TOWN HALL DISCUSSION PLENARY SESSION

Where Do We Stand and Where Are We Going with Performance-Based Management?

Patricia G. Hendren, *Spy Pond Partners, LLC*

Mara Campbell, *HERE*

Tim Lomax, *Texas A&M Transportation Institute*

Matthew Haubrich, *Iowa Department of Transportation*

Daniela Bremmer, *Washington State Department of Transportation*

This closing session featured conference participants highlighting their key take-away ideas from the conference, the breakout session track leaders summarizing major themes, and the conference planning committee cochair setting the stage for the next conference.

COMMENTS FROM CONFERENCE PARTICIPANTS

Conference participants were asked to identify one key idea, theme, or new information they learned from the conference. The following comments were made by conference participants:

- You cannot improve what you cannot measure.
- Words are words, explanations are explanations, promises are promises, but only performance is reality.
 - Defining the decisions we are trying to influence with improved data and performance measures is important.
 - Performance measurement is evolving as a discipline. We are moving beyond discussions defining measures to actually using performance measures and target setting in a meaningful way.
 - Once you begin collecting data, the data will get better.
 - Although data are important, the ability to communicate key points and messages is equally important.
 - We need to integrate asset and performance management: asset management to make decisions and performance management to evaluate those decisions.
 - Accept there is going to be insufficient funding to achieve the desired targets.

- We collect data and are data driven. We analyze the data for performance measures and become measurement-driven decision makers. Do not let dumb measures lead you to dumb decisions. Do not let bad data try to give you a good answer.
 - Understand that the data may not be perfect but may be the best available data.
 - It is important to tie investments back to savings or benefits that can be measured. Developing and using performance measures that permit cross-asset and cross-mode optimizations is also important.
 - Do not settle for the best available data, seek the best data.
 - It is important to focus on the consumer. People make safety, mobility, and economic decisions based on available data.
 - The reliability of a decision cannot exceed the reliability of the data.
 - Problems do not get better with time.
 - Bad news does not get better with time.
 - The discussion of intermodality was interesting.
 - The comment by one of the speakers that providing information will be more important for state DOTs in the future than providing infrastructure is an interesting perspective to consider.
 - We should realize that we are still early in the stages of using performance management and we need to allow time to grow and expand. For example, performance measures for freeway operations are different from those for arterial operations.
 - Transforming data into information and presenting it to policy makers to help with decisions is a key focus. Working backwards from the decision that needs to be made to the information and data needed to enlighten that decision may be a good approach.
 - The discussions of the different internal processes used at state DOTs for target setting were informative.
 - Engaging all levels of an agency in performance measurement is important for a successful program. Linking performance measures to responsibilities at each level and aligning them with the agency mission is part of this process.
 - Know your customer.
 - Understanding and breaking down silos within an agency are important for successful performance management programs.
 - Performance management involves both systems and organizations.
 - It is important to think across modes and consider intermodal connections. There is probably more capacity in the highway system that could be used by thinking strategically.
 - Speakers at the conference presented a number of examples that can be used to communicate and use performance measures in better ways.
 - Public agencies can learn from the approaches used in the private sector.

REPORTS FROM THE BREAKOUT TRACK LEADERS

The track leaders summarized the themes that emerged in the four sets of breakout sessions.

Driving Decisions

Patricia G. Hendren

Patricia G. Hendren, Spy Pond Partners, LLC, presented three key themes from the Driving Decisions Breakout Sessions.

- The first theme was that decision makers want more access to data. She noted that speakers in the breakout sessions presented a number of innovative data reduction, analysis, and retention techniques, including layering different data to analyze a wide range of characteristics and situations. She also noted that agencies will need to become much more comfortable with the open sharing of data. The concept of transportation agencies becoming information agencies or information managers was discussed by the speakers. Becoming information resources, rather than information gate keepers, was suggested by several speakers. She suggested that providing access to data helps reinforce the value of data and the need to allocate resources to collect, analyze, and retain data.

- The second theme described by Hendren focused on using data to manage, but more importantly to optimize, the transportation system. Examples included optimizing the freight system in Iowa; transit agencies managing on-time delivery service but optimizing the system by changing where the service is provided; and the Missouri DOT's optimizing its management of the mowing of the highway right-of-way by reducing the number of times the right-of-ways are mowed.

- Connecting and learning from others was the third theme highlighted by Hendren. She noted the numerous opportunities at the conference for networking and learning from others. She also encouraged participants to continue participating in TRB and other professional organizations.

Tracking the Moves

Mara Campbell

Mara Campbell of HERE presented three common themes from the Tracking the Moves Breakout Sessions the previous day: that the public policy being addressed matters in terms of data needs and analysis methods; that practitioners need to focus more on available data (as the data will never be perfect) and embrace big data; and that building relationships and collaborating with industry are important for transportation professionals. She reported that three takeaways from today were

watching industry trends, turning data into information and telling a story, and maximizing intermodal connections and the capabilities of each mode.

- In discussing the first theme, Campbell said industry trends will influence intermodal performance measures. She suggested that technologies, including connected and automated vehicles, will affect future business data needs and data availability. She noted that establishing policies on data ownership and use will be important in the future and will influence performance measurement.

- The second theme highlighted by Campbell was turning data into useful information and telling compelling stories that resonate with different customers. Examples of the use of infographics, visualization techniques, and other innovative approaches were presented by conference speakers. She said she thought creating the message you want customers to hear is the key element.

- The third theme presented by Campbell was connecting the modes effectively and seamlessly. She noted that intermodal connectivity is critical but not easy to accomplish. In addition, maximizing each mode and the intermodal connections will be even more important in the future. Campbell concluded her presentation by suggesting that although customers and the workforce are changing, the investment in transportation is not changing.

Data Web

Tim Lomax

Tim Lomax of the Texas A&M Transportation Institute discussed three key themes from the Data Web Breakout Sessions.

- The first theme focused on data and data access, with transportation agencies taking on new roles as facilitators, compilers, and storytellers. He suggested that numerous opportunities are available to find new partners and new methods to obtain needed data and that the MAP-21 requirements provide further openings to leverage innovative data partnerships and new measures. These new partnerships may also help build the trust needed to address possible data-sharing concerns.

- The second theme highlighted by Lomax was the real-time analysis of data. He noted that many speakers in the breakout sessions discussed the increasing availability of real-time data. He suggested that customers expect agencies to use real-time data to make immediate improvements in operating the transportation system, which is a challenge. This expectation reinforces the importance of data as a priority, and delivery on this expectation will build support for funding data collection and analysis.

- The third theme described by Lomax was the need to use data sources to communicate beyond transportation operations. He suggested that the role

transportation plays in supporting the economy and the quality of life in communities may not be as appreciated by the public and policy makers as it should be. Using available data to communicate the link between transportation investments and the quality of life in communities, schools, health care, and other factors is important. He noted that connecting data to performance measures, performance measures to actions, and actions to strategic plans are all important to engage internal and external stakeholders.

State of the Practice

Matthew Haubrich

Matthew Haubrich of the Iowa DOT presented four key themes emerging from the State of the Practice Breakout Sessions. In discussing the themes, he stressed the interconnections between the topics addressed in the four tracks, especially the close link between the driving decisions and the state-of-the-practice tracks. He commented that agencies are driving multimodal decisions today with available data obtained from diverse sources and technologies.

- One theme from the breakout sessions noted by Haubrich was the importance of communicating key messages about performance measures, including using storytelling. He noted that most people take the transportation system for granted. Transportation only gets noticed when there are problems. He suggested that data and analytics are needed for agencies to respond when something goes wrong with the transportation system and that being open, honest, and transparent if issues arise is important.

- Another theme Haubrich highlighted was transforming data into information for use by diverse stakeholders. He noted that different sources use different data collection frequencies, data definitions, and analysis methods. In addition, harmonizing disparate data sets will continue to be important. Uniformity may not always be appropriate, but realizing differences exist is important.

- The final theme discussed by Haubrich was the importance of reaching out to other states and other agencies for help in developing and using performance measurement. He stressed that assistance is available from TRB, AASHTO, other organizations, and local, state, and federal agencies.

CLOSING COMMENTS AND A LOOK FORWARD

Daniela Bremmer

Daniela Bremmer, Washington State Department of Transportation and cochair of the conference planning committee, provided the following closing comments:

- Bremmer thanked members of the conference planning committee and TRB staff for their hard work in organizing the conference. She also recognized and thanked FHWA and FTA for their sponsorship of the conference and acknowledged the 25 state DOTs participating with the pooled fund project supporting the conference. Bremmer noted that numerous partners are needed for a successful conference. With participants from 12 countries (including the United States), the exchange of ideas, sharing of expertise, and discussion of future directions were rich.

- Bremmer suggested that an appropriate theme for the next conference was *When Passion Propels Performance*. She noted many opportunities exist to improve the performance of the multimodal transportation system. The commitment of transportation professionals to maximize the benefits of performance measurement helps drive these improvements, and there are untapped opportunities with technology and big data to enhance performance measurement. She noted that professionals developing skill sets to apply big data to performance measurement will be important in the future.

- Bremmer highlighted the progress that has been made integrating performance measurement into transportation and transit agencies. She noted there is still a need to explore new methods to communicate with policy makers and the public. She also stressed the importance of continuing to develop and nurture partnerships with diverse public- and private-sector groups. In closing, Bremmer thanked attendees for their active participation in the conference and encouraged their ongoing involvement in advancing the use of performance measurement to enhance the transportation system.

Joseph L. Schofer, Northwestern University, presided at this session.

APPENDIX A

Posters

TRACKING THE MOVES

Calculating Vessel Travel Times on the Inland Marine Transportation System with Automatic Information System Data

Patricia DiJoseph and Ned Mitchell, U.S. Army Engineering Research and Development Center

Truck Freight Bottlenecks: Analysis and Integration into a Performance Management Program

Nicole Katsikides, FHWA Office of Freight Management and Operations, and Richard Margiotta, Cambridge Systematics, Inc.

Selecting the Right Data and Tools for Performance-Based Planning Under the Moving Ahead for Progress in the 21st Century Act (MAP-21)

Kyung-Hwa Kim, Atlanta Regional Commission

A Trip-Based Supply Chain Approach to Monitoring Long-Distance Truck Freight Travel

Christopher Lamm and Richard Margiotta, Cambridge Systematics, Inc.

Florida's Multimodal Mobility Performance Measures Approach

Doug McLeod, Florida DOT

Identifying Passenger and Freight Bottlenecks on Florida's Strategic Intermodal System

Praveen Pasumarthy, CDM Smith

Discovering the Space-Time Pattern Between Freight and Passenger Car Speeds Using the National Performance Measurement Research Data Set

Karl Petty and Scott Perley, Iteris, Inc.

Use of Multiple Data Sources for Freight Performance Measures

Tyrone Scorsone and Hui Chen, Cambridge Systematics, Inc.

DRIVING DECISIONS

Using Data for Better Operational Results

Frances Harrison, Spy Pond Partners, LLC, and Deb Miller, Surface Transportation Board

Asset Investment Management System

William G. Johnson and JoAnn Mattson, Colorado DOT

Mobility Performance Management: Maryland State Highway Administration's Performance-Based Approach for Improving Mobility, Reliability, and Multimodalism

Subrat Mahapatra and Gregory I. Slater, Maryland State Highway Administration

Using Data for Better Strategic Results

Deb Miller, Surface Transportation Board, and Frances Harrison, Spy Pond Partners, LLC

Performance-Based System Operations During Nonrecurring Events: Lessons Learned from Virginia

Ramkuma Venkatanarayana, Virginia Center for Transportation Innovation and Research, and Simona Babiceanu, University of Virginia

Using Performance Data to Assess Operations Project Benefits and Costs

Kenneth Voorhies and Anita Vandervalk, Cambridge Systematics, Inc.

Multiyear Waterway Network Maintenance Optimization Using Genetic Algorithms

Corey Winton and Ned Mitchell, U.S. Army Corps of Engineers

Arizona DOT: Needs-Based Maintenance Budget Allocation Model

Rob Zilay and Jeffrey Holabaugh, Dye Management Group, Inc.

STATE OF THE PRACTICE

Environmental Performance Measures for State DOTs

Jeffrey Ang-Olson, ICF International, and Joe Crossett, High Street Consulting Group

Performance Management by Assessing and Forecasting Bridge Condition: A Case Study from Iowa

Basak Aldemir Bektas, Iowa State University

Texas DOT's Portfolio Planning and Resource Planning Initiative

Lauren Garduno and Maureen Wakeland, Texas DOT

Using Vehicle Probe Data to Analyze Performance on the Boston Area MPO Roadways for the Congestion Management Process

Ryan Hicks and Scott Peterson, Boston Region MPO

Successful Models of Long-Range Transportation Plans: Incorporating Performance-Based Planning

Jody McCullough and Egan Smith, FHWA, and Michael Grant, ICF International

System Performance Measurement Applications in Rhode Island

Sudhir Murthy and Deanna Peabody, TrafInfo Communications, Inc.

The Impacts of Performance Measures Methodologies on Meaning and Interpretation

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

Real-World Problems, Real-World Answers: Probe Data Analytics in Action!

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

Implementation of Traffic Incident Management Performance Measures

Kelley Pecheux, Applied Engineering Management Corporation

System Performance Measures: Past, Present, and Future

Monali Shah, HERE

An Alternative Look at Arterial Performance Measures

Stanley Young and Reuben Juster, Center for Advanced Transportation Technology Laboratory, University of Maryland

UNTANGLING THE DATA WEB

Scaling Performance Management Platform to Billions of Data Points Using the Cloud: National Performance Management Research Data Set Example

Jane Berner, Iteris, Inc.

Transition from Modeled to Measured Data for Calculation of Mobility Performance Measures

Hui Chen and Anita Vandervalk, Cambridge Systematics, Inc.

SaaS Data Fusion Tool for Railway Axle-Bearing Monitoring

Emaneule Fumeo and Stefano Terribile, University of Genoa, Italy

Conducting a Transportation Data Assessment to Support Performance Measurement Improvement

Frances Harrison, Spy Pond Partners, LLC, and Stan Burns and Ron Vibbert, Michigan DOT

Leveraging the National Performance Measurement Research Data Set

Scott Perley and Leon Raykin, Iteris, Inc.

Exploring Multisource ITS Data for Multimodal Arterial Performance Measurement

Shu Yang and Yao-Jan Wu, University of Arizona

APPENDIX B

List of Attendees

Mohammed Aldagheiri, Qassim University
Jose Aldayuz, Michael Baker International
Basak Aldemir Bektas, Iowa State University
Ellison Alegre, San Diego Association of Governments
Imad Aleithawe, Mississippi Department of Transportation
Angela Alexander, Georgia Department of Transportation
Brad Allen, New York State Department of Transportation
Karin Allen, Chicago Regional Transportation Authority
Al Alonzi, Federal Highway Administration
Adjo Amekudzi-Kennedy, Georgia Institute of Technology
Sandy Amores, Miami-Dade Transit
Donna Anderson, Chicago Regional Transportation Authority
Jeffrey Ang-Olson, ICF International
Stephen Arhin, Howard University
Don Arkle, Alabama Department of Transportation
Holly Arnold, Maryland Transit Administration
Charles Austin, Denver Regional Transportation District
Gemechisa Ayana, Denver Regional Transportation District
Craig Babowicz, Connecticut Department of Transportation
Rabinder Bains, Federal Transit Administration
Martin Batistelli, Los Angeles County Metropolitan Transportation Authority
David Beal, Bi-State Development Agency
Alan Becker, Denver Regional Transportation District
Deanna Belden, Minnesota Department of Transportation
Josh Bench-Bresher, South Dakota Department of Transportation
Nancy Bergeron, Transport Canada
Andre Bernard, French Ministry of Ecology and Transport
Jane Berner, Iteris, Inc.
Andrew Bickmore, Maine Department of Transportation
Richard Boadi, AMEC Foster Wheeler
Jennifer Brandenburg, North Carolina Department of Transportation
Daniela Bremmer, Washington State Department of Transportation
Michael Bridges, Consultant
Coco Briseno, California Department of Transportation
Dennis Brown, Rhode Island Department of Transportation
Matthew Brown, Stolfus & Associates, Inc.
Joseph Bryan, Parsons Brinckerhoff
Stan Burns, Utah Department of Transportation
Mark Burris, Texas A&M Transportation Institute

Stephanie Burris, Delaware Transit Corporation
David Burrows, Gannett Fleming
Jeffrey Busby, TransLink
Alex Calvillo, Oklahoma Department of Transportation
Mara K. Campbell, HERE
E. Dean Carlson, Carlson Associates
Kristen Carnarius, Metropolitan Transportation Commission
Yvonne Carney, Washington Metropolitan Area Transit Authority
Legna Carrasco, Miami-Dade Transit
Adrian Ray Chamberlain, Consultant
Jason Chapman, Louisiana Department of Transportation and Development
ZhiQiang Chen, University of Missouri–Kansas City
Linda Cherrington, Texas A&M Transportation Institute
Melanie Choy, Metropolitan Transportation Commission
Lynnette Ciavarella, Metra
Michael Cohen, Connecticut Department of Transportation
Alan Colegate, Main Roads Western Australia
David Cook, South Carolina Department of Transportation
Louis Cripps, Denver Regional Transportation District
John Crocker, JTC Analytics
Joe Crossett, High Street Consulting Group
Norene Curran, Denver Regional Transportation District
Brian Davis, Alabama Department of Transportation
Lauren Deaderick, U.S. Department of Transportation
Paul Degges, Tennessee Department of Transportation
Monique de los Rios-Urban, Maricopa Association of Governments, Phoenix
Michel Demarre, Colas S.A. Cedex
Christopher DeVerniero, Montana Department of Transportation
Patricia DiJoseph, U.S. Army Corps of Engineers
Corinne Donahue, CDM Smith
Paula Dowell, Cambridge Systematics, Inc.
Jim Edgerton, AgileAssets Inc.
Bill Eisele, Texas A&M Transportation Institute
Kurt Engler, AECOM
Shannon Fain, AirSage
James Fallon, Connecticut Department of Transportation
Jason Firman, Michigan Department of Transportation
Aimee Flannery, AEM Corporation
Susie Forde, Wisconsin Department of Transportation
Emanuele Fumeo, University of Genoa
Stephen Gaj, Federal Highway Administration
Sreenath Gangula, Washington State Department of Transportation
Kevin Gantt, South Carolina Department of Transportation
Moses Garcia, Texas Department of Transportation
Rebecca Geyer, North Dakota Department of Transportation

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Angela Gibson, Municipality of York Region
James Gillespie, Virginia Department of Transportation
John Giorgis, Federal Transit Administration
Gary Glasscock, VIA Metropolitan Transit
Michael Grant, ICF International
Yonel Grant, CH2M Hill
Royce Greaves, Opus International Consultants
Jonathan Groeger, Amec Foster Wheeler
Max Grogg, Federal Highway Administration
Steve Guenther, California Department of Transportation
Samet Gursel, Maryland Transit Administration
Bill Haas, Federal Highway Administration
Maureen Hammer, Virginia Department of Transportation
Kathleen Hancock, Virginia Polytechnic Institute and State University
Rami Harb, Atkins
Christopher Harris, Tennessee Department of Transportation
Frances Harrison, Spy Pond Partners, LLC
Matthew Haubrich, Iowa Department of Transportation
Jane D. Hayse, Atlanta Regional Commission
Kevin Heaslip, Virginia Polytechnic Institute and State University
Richard Heineman, Pennsylvania Department of Transportation
Patricia G. Hendren, Spy Pond Partners, LLC
Tim Henkel, Minnesota Department of Transportation
Elijah Henley, Federal Highway Administration
Michael Henry, Arkansas Department of Transportation
Jamie Henson, District of Columbia Department of Transportation
Ryan Hicks, Boston Region Metropolitan Planning Organization
Jeffrey Holabaugh, Dye Management Group, Inc.
Pat Hu, U.S. Department of Transportation
Jim Hubbell, Mid-America Regional Council
Ryan Huffman, Arapahoe County
Susanna Hughes-Reck, Federal Highway Administration
David Hurst, Dye Management Group
Tina Ignat, Metra Chicago
Liisa Itkonen, COMPASS
Amy Jackson-Grove, Federal Highway Administration
Ted Jamele, Transportation Research Board
Alex Jendzejec, Booz Allen Hamilton
Randy Jensen, Federal Highway Administration
Michael Johnson, California Department of Transportation
Terri Johnson, HERE North America
William G. Johnson, Colorado Department of Transportation
Jessie Jones, Arkansas Department of Transportation
Sudhir Joshi, New Jersey Department of Transportation
Jason Junge, Minnesota Department of Transportation
Reuben Juster, University of Maryland

Eirini Kastrouni, University of Maryland
 Nicole Katsikides, Federal Highway Administration
 Matthew Kaufman, UrbanTrans North America
 Robert Keller, LoadTrek
 Lytang Kelley, INRIX
 Michael Kelly, Arkansas Department of Transportation
 Martin Kidner, Wyoming Department of Transportation
 Michael Kies, Arizona Department of Transportation
 Kyung-Hwa Kim, Atlanta Regional Commission
 Peeter Kivestu, Teradata
 Peggi Knight, Iowa Department of Transportation
 LaFewt Knox, Alaska Railroad Corporation
 Sylvestre Janvier Kotchofa, Benin Road Fund
 Michael Krimmer, AEM Corporation
 Deborah LaCombe, Yakima Valley Council of Governments
 Caleb Lakey, Idaho Transportation Department
 Christopher Lamm, Cambridge Systematics, Inc.
 Randy Lamm, Los Angeles Metropolitan Transportation Authority
 Mai Q. Le, Transportation Research Board
 Randy Lee, Oklahoma Department of Transportation
 Nancy Lefler, VHB
 Shawnessy Leon, Alaska Railroad Corporation
 Michael Lester, AgileAssets
 James Lewis, New Jersey Department of Transportation
 Michael Lewis, Colorado Department of Transportation
 Timothy J. Lomax, Texas A&M Transportation Institute
 Denise Longley, Los Angeles Metropolitan Transportation Authority
 Julie Lorenz, Burns & McDonnell
 Hugh Louch, Cambridge Systematics, Inc.
 Dana Majors, Kansas Department of Transportation
 Cynthia Maloney, U.S. Department of Transportation
 Gayende Martin, Connecticut Department of Transportation
 Alice Mathew, South African National Roads Agency Limited
 Miwa Matsuo, Waseda University
 JoAnn Mattson, Colorado Department of Transportation
 John McCormick, Bay Area Rapid Transit
 Kenneth McDonald, Long Beach Transit
 Tim McDonald, Ohio Department of Transportation
 David McGraw, Desert Research Institute
 Chad McKeown, North Central Texas Council of Governments
 Doug McLeod, Florida Department of Transportation
 Michael Meyer, Parsons Brinckerhoff
 Bruce Millar, Transportation Research Board
 Deb Miller, Surface Transportation Board
 Karen Miller, Missouri Department of Transportation

LIST OF ATTENDEES

Sabya Mishra, University of Memphis
Kenneth Mitchell, U.S. Army Corps of Engineers
Leah Mooney, Chicago Transit Authority
John Moore, Kentucky Transportation Cabinet
Margaret Mordahl, Wyoming Department of Transportation
Sudhir Murthy, TraffInfo Communications, Inc.
Michael Nabhan, Denver Regional Transportation District
Kenneth Napper, Champaign-Urbana Mass Transit
Jean Nehme, Arizona Department of Transportation
Mark Nelson, Minnesota Department of Transportation
Michael Nesbitt, Federal Highway Administration
Joseph Nestler, Wisconsin Department of Transportation
Krista Nordback, Transportation Research and Education Center, Portland State University
Tracy Nowaczyk, Kentucky Transportation Cabinet
Brendan Nugent, Transport for New South Wales
Peter Ogonowski, CDM Smith
Rotimi Ogunsuyi, Federal Transit Administration
Olufunso Abiodun Ogunwunmi, Federal Road Safety Corps
Steven Olmsted, Arizona Department of Transportation
David Ooten, Oklahoma Department of Transportation
Michael Pack, University of Maryland
Thomas M. Palmerlee, Transportation Research Board
Chris Pangilinan, New York City Transit
Jeffrey Paniati, Federal Highway Administration
Jim Pappas, Delaware Department of Transportation
Hyun-A Park, Spy Pond Partners, LLC
Marygrace Parker, I-95 Corridor Coalition
Praveen Pasumarthy, CDM Smith
Deanna Peabody, TraffInfo Communications, Inc.
Kelley Pecheux, AEM Corporation
Garrett Pedersen, Iowa Department of Transportation
Scott Perley, Iteris, Inc.
Cory Pope, Utah Department of Transportation
Anne-Severine Poupeleer, Agentschap Wegen en Verkeer
John Preiss, Rhode Island Department of Transportation
Theodore Prince, Tiger Cool Express, LLC
Wenjing Pu, Metropolitan Washington Council of Governments
David Putz, Iowa Department of Transportation
Kevin Quinn, Maryland Transit Administration
Peter Rafferty, University of Wisconsin–Madison
Kavya Rajasekar, Colorado Department of Transportation
Brian Reagan, Missouri Department of Transportation
Larry Redd, Redd Engineering
Jonathan Regehr, University of Manitoba
Scott Richrath, Spy Pond Partners, LLC

Lori Richter, Wisconsin Department of Transportation
 Elizabeth Riklin, Federal Transit Administration
 William Robert, Spy Pond Partners, LLC
 Michael Robson, Fugro Roadware
 Robin Roeber, Chicago Transit Authority
 Heather Rothenberg, Sam Schwartz Engineering
 Nastaran Saadatmand, Federal Highway Administration
 Erik Sabina, Colorado Department of Transportation
 Michelle Scheuerman, Colorado Department of Transportation
 Margaret Schilling, Federal Transit Administration
 Joseph L. Schofer, Northwestern University
 Scott Schram, Iowa Department of Transportation
 David Schrank, Texas A&M Transportation Institute
 Laurie Schultz, South Dakota Department of Transportation
 Tyrone Scorsone, Cambridge Systematics, Inc.
 John Selmer, Iowa Department of Transportation
 Francine Shaw-Whitson, Federal Highway Administration
 Jeffrey Short, American Transportation Research Institute
 Shourya Shukla, Rolta Americas
 Page Siplon, TeamOne Logistics
 Gregory I. Slater, Maryland State Highway Administration
 Michael Smallcombe, Rolta Americas
 Mshadoni Smith, Federal Transit Administration
 Chris Sopp, Alaska Railroad
 Peter Stephanos, Federal Highway Administration
 Elizabeth Stolfus, Stolfus & Associates, Inc.
 Charles Stoll, San Diego Association of Governments
 Elizabeth Stolz, Ready4Wellness, LLC
 Lisa Streisfeld, Colorado Department of Transportation
 Mary Stringfellow, Federal Highway Administration
 Mark Suarez, Louisiana Department of Transportation and Development
 Jim Sutton, Denver Regional Transportation District
 Mark Swanlund, Federal Highway Administration
 Louis-Paul Tardif, Transport Canada
 Rob Tardif, Toronto Ministry of Transportation
 Shintaro Terabe, Tokyo University of Science
 Kevin Thornton, Arkansas Department of Transportation
 Kelly Travelbee, Michigan Department of Transportation
 Ted Trepanier, INRIX, Inc.
 Dominick Tribone, Massachusetts Bay Transportation Authority
 Paul Trombino III, Iowa Department of Transportation
 Katherine F. Turnbull, Texas A&M Transportation Institute
 Max Tyler, Colorado General Assembly
 Sharada Vadali, Texas A&M Transportation Institute
 Thomas Van, Federal Highway Administration

LIST OF ATTENDEES

Anita Vandervalk, Cambridge Systematics, Inc.
Amy Van Doren, Marin Transit
Mark Van Port Fleet, Michigan Department of Transportation
David Vautin, Metropolitan Transportation Commission
Allan Venema, Fugro Roadware
Ramkumar Venkatanarayana, Virginia Center for Transportation Innovation and Research
Marie Venner, Venner Consulting
Nina Verzosa, CDM Smith
Jonathan Wade, Denver Regional Transportation District
Maureen Wakeland, Texas Department of Transportation
Alexander Walcher, ASFINAG Bau Management
Jason Wallis, Colorado Department of Transportation
Agneta Wargsjo, Swedish Transport Administration
Machelle Watkins, Missouri Department of Transportation
Bryan Weimer, Arapahoe County
Penelope Weinberger, American Association of State Highway and Transportation Officials
Ermias Weldemicael, Colorado Department of Transportation
Luke Westlund, Denver Regional Transportation District
Karen White, Bureau of Transportation Statistics
Geoffrey Whitfield, Centers for Disease Control
Maceo Wiggins, Bay Area Rapid Transit
Lukasz Wilk, City of Edmonton
Andrew Williams, Ohio Department of Transportation
Dave Williams, Metro Atlanta Chamber
Keith Williams, Federal Highway Administration
Chris Williges, HDR Engineering, Inc.
Mark Wingate, Wyoming Department of Transportation
Robert Winick, Motion Maps, LLC
David Winter, Federal Highway Administration
Corey Winton, U.S. Army Corps of Engineers
Butch Wlaschin, Consultant
Richard Woo, Maryland Department of Transportation
David Wresinski, Michigan Department of Transportation
Yao-Jan Wu, University of Arizona
Christos Xenophontos, Rhode Island Department of Transportation
Connie Yew, Federal Highway Administration
Scott Young, Colorado Department of Transportation
Stanley Young, University of Maryland
Scott Zainhofsky, North Dakota Department of Transportation
Laura Zale, Southeastern Pennsylvania Transportation Authority
Douglas Zimmerman, Pennsylvania Department of Transportation
Kathryn Zimmerman, Applied Pavement Technology



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