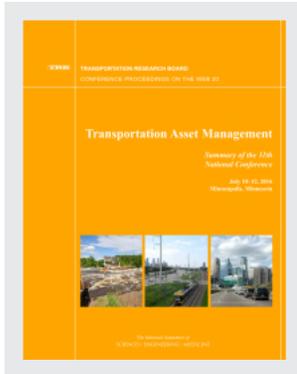


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0 pages | 8.5 x 11 | PAPERBACK

ISBN 978-0-309-48378-0 | DOI 10.17226/25242

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SUGGESTED CITATION

National Academies of Sciences, Engineering, and Medicine 2016. *Transportation Asset Management: Summary of the 11th National Conference*. Washington, DC: The National Academies Press. <https://doi.org/10.17226/25242>.

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CONFERENCE PROCEEDINGS ON THE WEB 20

Transportation Asset Management

Summary of the 11th National Conference

Katherine F. Turnbull
Texas A&M Transportation Institute
Rapporteur

July 10–12, 2016
Minneapolis, Minnesota

Organized by the
Transportation Research Board

Supported by the
Federal Highway Administration
Federal Transit Administration

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TRANSPORTATION RESEARCH BOARD
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2016
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This report has been reviewed by a group other than the authors according to the procedures approved by a Report Review Committee consisting of members of the National Academy of Sciences, the National Academy of Engineering, and the National Academy of Medicine.

This conference was supported by the Federal Highway Administration and the Federal Transit Administration.

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Acknowledgments

This meeting summary was prepared by Katherine F. Turnbull, Texas A&M Transportation Institute, as a factual summary of what occurred at the conference. The Conference Planning Committee's role was limited to planning the meeting. The statements made are those of the author and individual meeting participants and do not necessarily represent the views of all conference participants, the planning committee, or the National Academies of Sciences, Engineering, and Medicine.

This report has been reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise. 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.

The Transportation Research Board thanks the following individuals for their review of the draft of this report to ensure that it meets institutional standards for quality and objectivity: Michael Johnson, California Department of Transportation; Samuel Labi, Purdue University; Sue McNeil, University of Delaware; and Scott Richrath, Spy Pond Partners, LLC. The review comments and draft manuscript remain confidential to protect the integrity of the process. Although these four reviewers provided many constructive comments and suggestions, they did not see the final draft of the summary. The review of this summary was overseen by Susan Hanson of Clark University (emerita). Karen Febey, TRB Senior Report Review Officer, managed the review process.

Acronyms and Abbreviations

DOT	department of transportation
FAST Act	Fixing America’s Surface Transportation Act
FHWA	Federal Highway Administration
GIS	geographic information system
lidar	light detection and ranging
MAP-21	Moving Ahead for Progress in the 21st Century Act
MARTA	Metropolitan Atlanta Rapid Transit Authority
ROI	return on investment
TRB	Transportation Research Board
U.S. DOT	U.S. Department of Transportation
UTC	University Transportation Center
V2I	vehicle-to-infrastructure
V2V	vehicle-to-vehicle
VMT	vehicle miles traveled

Contents

Conference Overview	1
<i>Katie Zimmerman and Katherine Turnbull</i>	
Opening Session	
Panelists' Comments and Responses to Questions	3
<i>Frank Hornstein, Tom Everett, Paul Trombino III, and David Springstead</i>	
Closing Session	
Overarching Topics and Research Needs	11
<i>Scott Richrath, Matthew Hardy, David Schrank, Brad Allen, Laura Zale, and Rob Kafalenos</i>	

Conference Overview

Katie Zimmerman, *Applied Pavement Technology, Inc., and Conference Planning Committee Chair*

Katherine Turnbull, *Texas A&M Transportation Institute and Conference Rapporteur*

The 11th National Conference on Transportation Asset Management was held in Minneapolis, Minnesota, on July 10–12, 2016. Organized by the Transportation Research Board (TRB) of the National Academies of Sciences, Engineering, and Medicine, the conference was supported by the Federal Highway Administration (FHWA), the Federal Transit Administration, and the Transportation Asset Management Pooled Fund project. It was hosted by the Minnesota Department of Transportation (DOT).

The conference featured opening and closing sessions, 30 breakout sessions in five functional and two cross-cutting virtual tracks, a poster session, and four workshops. A peer exchange on implementing transportation asset management sponsored by the American Association of State Highway and Transportation Officials and FHWA, as well as joint TRB committee meetings and other related activities, was also held in conjunction with the conference.

The 448 on-site participants came from 48 states, the District of Columbia, Puerto Rico, and international locations. In addition, 65 sites participated in the conference via live streaming, bringing the total number to at least 513 participants. Participants represented federal, state, metropolitan, and local transportation and transit agencies, as well as consulting firms, universities, and research institutions.

Speakers at the conference highlighted the advancements and improvements being made in transportation asset management programs at the state, regional, metropolitan, and local levels. Information on the innovative approaches being used by transit and other modes was interwoven throughout the conference. These approaches are addressing emerging issues, local needs, and federal requirements to ensure the best use of limited resources for transportation and transit investment decisions.

Asset management programs are addressing climate change and extreme weather events, engaging diverse stakeholders in ongoing conversations, and using more robust and timely data. Programs are expanding to include risk assessments, vulnerability evaluations, and return on investment (ROI) analyses. Asset management is also being considered from a regional perspective in some areas.

Although numerous advancements are occurring, speakers noted that many of the keys to successful asset management programs remain the same. These factors include top leadership support, establishing a strong basic foundation, involving

TRANSPORTATION ASSET MANAGEMENT

personnel from throughout an agency, and transparency with policy makers and the public.

Conference participants also discussed issues that would benefit from further research and technology transfer activities. These topics will be used by the Transportation Asset Management Pooled Fund project to develop research problem statements for the National Cooperative Highway Research Program and other programs. The topics will also be used in the development of the 12th National Conference on Transportation Asset Management to be held in 2018.

This summary highlights the key elements from the conference. Comments from speakers in the opening session are presented first. The five track leaders' comments on the discussion of the topics addressed in the breakout sessions are summarized in the closing session. The PowerPoint presentations used by speakers and video recordings can be accessed online through the links embedded in the final program at <http://onlinepubs.trb.org/onlinepubs/Conferences/2016/AssetMgt/Recordings.pdf>. Scroll to the presentation of interest and click on the title.

OPENING SESSION

Panelists' Comments and Responses to Questions

Frank Hornstein, *Minnesota House of Representatives*

Tom Everett, *Office of Infrastructure, Federal Highway Administration*

Paul Trombino III, *Iowa Department of Transportation*

David Springstead, *Metropolitan Atlanta Rapid Transit Authority*

PANELISTS' COMMENTS

Frank Hornstein welcomed conference participants to the Minneapolis–Saint Paul metropolitan area and Minnesota. He commended the agency staff, consultants, and other groups in attendance for maintaining the transportation system and discussed the importance of communicating with elected officials and politicians.

Hornstein commented that asset management is often overlooked due to the short-term focus of most politicians today, as well as the fiscal constraints facing state and local governments. He noted that gaining support for increased funding for transportation by raising the motor fuel tax, authorizing a metropolitan sales tax for transit, or other options is very difficult. He suggested that funding for asset management can be especially challenging because it is less visible to the public and politicians than adding freeway lanes or other major projects.

Hornstein noted that he uses information from the Minnesota DOT's *Pavement Condition and Performance Report* in speeches and written materials. In this report, Minnesota DOT expects state highway pavement conditions to resume a long-term decline by the end of the decade, with pavements worse than the targets. Working together to present information to the public and policy makers at all levels to make the case for additional funding for transportation is an important issue. He suggested the need to generate urgency around the issue with the public.

Hornstein noted that although the Minnesota legislature has approved some short-term transportation funding measures during the past few sessions, the long-term revenue problem has not been addressed. He suggested that obtaining adequate funding for asset management represents an ongoing concern. He further suggested that communicating the benefits of asset management to policy makers and the public should be a high priority for agencies.

TRANSPORTATION ASSET MANAGEMENT

Tom Everett provided a welcome from FHWA, which has cosponsored all 11 transportation asset management conferences. He commented that the conferences provide a great opportunity to learn from the presentations and to interact with other participants, and he encouraged participants to share their experiences and ideas with others.

Everett described the importance of transportation asset management to FHWA and noted that Congress has tasked FHWA with providing stewardship and oversight to the Federal-Aid Highway program. Billions of dollars have been invested in this system over the decades. Ensuring the wise use of public funds is part of FHWA's responsibilities. Furthermore, he said the public also has an interest in how funds are expended and expects transparency in decision making, as well as a transportation system that meets their needs.

Everett noted that the Moving Ahead for Progress in the 21st Century Act (MAP-21) changed the Federal-Aid program to a performance-based program. He suggested that asset management is key to a performance-based program. Performance measures and targets are the destinations, and asset management is the vehicle to reach those destinations. He mentioned that MAP-21 also required states to develop risk-based asset management plans for pavements and bridges on the National Highway System. The Fixing America's Surface Transportation (FAST) Act did not change that requirement. A "Notice of Proposed Rulemaking" on the infrastructure condition proposed rule was published in February 2015, and over 50 entities provided numerous comments on it. Everett said a final rule has been developed and should be published in the *Federal Register* in the fall of 2016.

Everett reported that even without the final rule, 40 state DOTs were already developing asset management plans to meet the requirements. He reviewed the following definition of asset management used in the rule: "a strategic and systematic process of operating, maintaining, and improving physical assets, with a focus on both engineering and economic analyses based upon quality information, to identify a structured sequence of maintenance, preservation, repair, rehabilitation, and replacement actions that will achieve and sustain a desired state of good repair over the life cycle of the asset at minimum practical costs." He stressed the importance of the six key segments in this definition.

Everett noted that all agencies face the same challenge of how best to invest limited resources to achieve the greatest ROI. Factors that need to be considered include the purchasing power of the dollar, the aging infrastructure, increased demand on the system, increased project complexity, and the need for resiliency.

Everett described some of the activities conducted by FHWA to support the development of state performance-based asset management plans. Available National Highway Institute courses include "Introduction to Transportation Asset Management" and "Developing a Transportation Asset Management Plan." A web-based National Highway Institute course on "Introduction to Asset Management

PANELISTS' COMMENTS AND RESPONSES TO QUESTIONS

Plans” is also available. FHWA consultants can provide on-site assistance with data and gap analyses. The FHWA Asset Management website contains a wealth of information and will be further enhanced after the final rule is published.

Everett concluded by highlighting activities conference participants could undertake, including identifying personnel within their agencies involved in asset management, communicating with FHWA division staff in each state, and learning from others at this conference. He also encouraged participants to stay engaged after the final rule is published and to continue their participation in conferences and information sharing.

Paul Trombino noted that risk management can be thought of as controlling and constraining risks. Government agencies are often risk averse, which can stifle innovation and creativity and inhibit the decision-making process. He suggested that public agencies have to be “risk advantageous” or willing to take risks, including risks associated with the long-term management of assets, to ensure that unwise investments are avoided. It is important to have a process for risk management, but the process should not be so overly constraining that it inhibits innovation and creativity in delivering the products that sustain the transportation system.

Trombino suggested that it was important to consider asset management from the customer’s point of view. The people who use a transportation asset are the customers, not the asset itself. He stressed the importance of thinking from a customer’s perspective.

There is a need to move beyond MAP-21 and to consider performance-based organizations, not just performance-based asset management programs. Performance management is an organizational issue that requires organizational change. Trombino noted that just adding performance metrics does not necessarily change the way an agency performs and how well decisions are made concerning assets.

Trombino described the evolution of asset management at the Iowa DOT by saying that asset management was one of the first strategic topics discussed internally when he became director in May 2011. Those discussions began an organizational shift at the department to a new vision focusing on performance measurement, organizational improvement, and research. Improving the organizational decisionmaking process was an important part of the new focus to transforming the department into a performance-based organization. He suggested that if performance management is not addressed at the organizational level, it will be difficult to deal with at the program level.

Trombino reported that the Iowa legislature increased the state gasoline tax by \$0.10 a gallon in 2015. He noted the challenge of making decisions on what is affordable when the entire system is not affordable. Asset management defines the process for making good investments in the system. He stressed the importance of having a good process for determining investments in the system regardless of the amount of available funding. Asset management provides that process.

TRANSPORTATION ASSET MANAGEMENT

It is important to communicate the state DOT's decision-making process to policy makers and the public. Trombino suggested that providing information on performance management, asset management, and the overall transportation system from an engineering and economic perspective to policy makers and the public was key to increasing transparency and promoting a robust, open decision-making process. He further suggested that this approach allows transportation agencies to take short-term and long-term risks.

In closing, Trombino described introducing asset management to the seven-member Iowa Transportation Commission, including explaining the short-term and long-term views of the system and the decision-making process. He noted that the annual update and discussion, which occurs in February or March, is highly valued by commission members. Trombino stressed the benefits of engaging decision makers in the asset management process.

David Springstead provided a perspective from one of the many transit agencies actively using asset management. He stressed his passion for asset management, being fiscally responsible with public funds, building highly functional collaborative teams, pursuing positive outcomes, and making real impacts.

Springstead suggested that conference participants had an obligation as transportation professionals to produce accurate and meaningful information for making investment decisions that result in positive outcomes for the public. The conference provided the opportunity for participants to collaborate, share experiences, and learn. He challenged participants to share with colleagues the information on best practices, as well as new tools and techniques to help advance the use of asset management.

Cross-jurisdictional and cross-modal aspects of asset management are important means to better leverage and maximize resources. Springstead said he thought most conference participants would agree that a solution in which the city, the region, and the state have a fully collaborative and transparent decision-making process anchored on reliable and predictable data would result in optimized investments. He further suggested that most people would agree that investments among modes and jurisdictions within a metropolitan planning organization's boundaries should be leveraged to maximize public benefits. An example he cited of these types of opportunities was obtaining enough right-of-way as part of a new freeway interchange to accommodate a future passenger rail line. Many areas of the country have outbuilt the capacity to maintain the system, so it is important to consider operation, maintenance, and capital renewal costs in capital improvement programs. In addition, Springstead noted that many assets financed over a 30-year period do not last that long, especially advanced technology projects.

Springstead suggested that transportation agencies all face major infrastructure needs with limited resources. Further, there are competing interests for those limited

PANELISTS' COMMENTS AND RESPONSES TO QUESTIONS

resources. Rather than continuing along the same course, he discussed the need for innovation and strategic thinking. There is a need to reduce operations and maintenance costs and to be strategic about capital investments. He provided an analogy to owning a home: a homeowner has a mortgage and must make ongoing repairs and improvements. He also noted that neighbors help each other, pooling resources and expertise to make improvements, just as transportation agencies should.

Springstead made the case for collaboration, for leveraging assets and funding, and for focusing on maximizing the benefits to the public. Jurisdictional boundaries do not matter to the traveling public and to freight movers. The goals should be to provide a seamless, reliable, and safe mode of transportation to the public and to promote the economic vitality of a city, region, state, and country. These goals require collaboration and collective planning. Springstead noted that although there are complex issues in meeting these goals, they are achievable. Transportation planners should focus on identifying agency needs, obtaining accurate and timely data, establishing a method to prioritize projects, establishing a plan and a project delivery mechanism, and establishing targets and measures. Targets and measures are important to measure success and help propel programs forward.

In closing, Springstead stressed the need for a fully collaborative and transparent decision-making process based on reliable and predictable data and the importance of collaboration among stakeholders. Community investment districts provide a good example of collaboration among stakeholders. He further suggested that the message from the federal level was that needs and priorities should be managed at the regional and state level, not at the federal level. MAP-21 and the FAST Act focus decision making at those levels based on the development of required plans. He encouraged conference participants to share ideas, collaborate, and plan to solve issues to optimize the benefits to the public.

RESPONSES TO QUESTIONS

The panelists responded to the following questions as part of the opening session.

Current legislation has accelerated the rate at which asset management is being used in transportation agencies. How do you see asset management developing in the next several years, and what do you think will be instrumental to making that happen?

Everett suggested that initial decisions on resource allocation represent a simple form of asset management. The sophistication of the tools and techniques used in asset management has improved over time. When FHWA began allocating funding for transportation projects, the states and FHWA also began applying asset management. The FHWA asset management rule will likely shape the future

TRANSPORTATION ASSET MANAGEMENT

direction of asset management, but states already know what needs to be done to manage assets. He noted that the rule will include compliance dates. Everett cited several factors that will influence the future direction of asset management, including the demand from policy makers for data-based, performance-based decision making; reduced funding; increased demand on the transportation system; and the availability of more sophisticated tools. For example, he noted that the advances in bridge management were impressive. Risk factors, including financial risk as well as focusing on strategic investments and preservation, will also influence the future direction of asset management. He noted the importance of leadership and commitment at all levels within transportation agencies to help advance asset management.

Trombino stressed the importance of having the right data. He suggested that changes in the data being used in asset management will allow agencies to analyze the economic benefits and the ROI from transportation projects.

Springstead suggested that focusing on a simple, functional, and effective asset management system was a good way to begin. Sophistication can come later. He stressed that building a strong foundation first was important.

Why do you think some organizations are moving faster than others to adopt asset management? What do you think are some of the key drivers that exist in the organizations that have been quick to adopt asset management?

Trombino responded that some agencies not embracing asset management view it as a compliance issue rather than a means of improving their decision-making process and fostering better investments. Organizations focused more on change are embracing performance-based asset management. He noted that although having data management systems is important, data management is not asset management. That is, having data to manage the system is not the same as assessing the best investment strategies for the future. Trombino noted that different skills and different organizational goals are needed for performance-based asset management. He suggested that asset management for pavement and bridges is easier than for other assets, including information technology, which is more challenging.

Everett commented on the importance of leadership and commitment for successful asset management programs at an agency. The support of the top executives is critical to advancing asset management, including the development of more sophisticated tools and approaches.

PANELISTS' COMMENTS AND RESPONSES TO QUESTIONS

Springstead noted the importance of ensuring that operations and maintenance personnel and the capital programming staff are fully engaged. All groups responsible for funding, allocating resources, operating, and maintaining the system need to be involved in the asset management process. There is a need to promote the right culture and to communicate success stories, cost savings, and effectiveness. Springstead agreed that leadership from the top of an agency is important, but he also stressed the need to cultivate the involvement of personnel throughout an organization.

What should regionalized asset management look like? Are there strategies an agency could adopt to optimize its program while benefitting the region as a whole?

Springstead suggested that the first step is ensuring that your own program is in order, including having accurate and timely data. Sharing your priorities and issues with other regional partners is a second step. Variations in data between agencies appear to be a common problem in many areas. Agencies use different data collection methods, analysis techniques, and report formats. He noted that coordinating data collection and analysis, including establishing a common baseline, would benefit all agencies and help advance regional asset management.

According to Springstead, it is also critical to include the right people or regional coordinating teams to ensure trust and professionalism; moreover, all agencies must benefit. Getting organized and clearly arranging data in a common platform are key. Focusing on the highest risks to the region that supports the economic engines of the cities and the state is also important, as is focusing on a common goal that benefits all agencies and the region as a whole.

What steps do you think transportation agencies need to take to become more resilient when dealing with uncertainties such as extreme weather events?

Trombino responded that most state DOTs have to deal with some type of extreme weather event. He recounted the story of becoming the Iowa DOT director in May 2011 just before the worst flood in the history of the state. The situation illustrated the importance of flooding to the transportation system, with segments of the Interstate system underwater, and how the agency responded to an extreme weather event. He reported that a risk review was conducted to better understand the vulnerable segments of the system and to better prepare for future events by using a balanced approach focused on the most important segments of the system. The risk review also pointed out the need to include personnel from all departments and levels in examining risks and developing asset management plans.

TRANSPORTATION ASSET MANAGEMENT

Trombino further noted that because much of the highway system in Iowa was constructed in floodplains, flooding is going to occur. There is only so much the department can do to protect the system, depending on the type and extent of extreme weather. He described two nontraditional approaches that can assist in better preparing the system for extreme weather events. The first approach is forecasting the potential for future floods to assist in making decisions on critical infrastructure investments. The second approach is investing in improvements to the tributaries feeding the major rivers in the state to reduce potential flood impacts. It may be challenging to justify these types of investments, which might include revitalizing vegetation by using traditional transportation funding; however, the potential benefits enhance the ability to respond to future floods and long-term water quality and water flow. Trombino stressed the importance of taking a balanced approach to dealing with extreme weather events.

Springstead added the importance of considering resiliency in the capital program. Examining all aspects of a project, from the location through design and into operation, is key to a resilience system. For example, the cost of real estate is influenced by numerous factors. Property in a floodplain may be less expensive, but future flooding may cause operational problems and structural damage to facilities, resulting in increased costs. Checking all the touch points of a proposed asset will help with its long-term resilience. He noted that the Metropolitan Atlanta Rapid Transit Authority (MARTA) uses the term “stresses” rather than “resilience” in examining environmental factors that may affect the life of an asset. Trombino also suggested it was important to prioritize funding for the resilience of key infrastructure and to establish standard operating procedures for other assets, such as bus route detours for roads that are likely to flood in major rainstorms.

CLOSING SESSION

Overarching Topics and Research Needs

In the closing session, the leaders for the track and cross-cutting virtual sessions highlighted examples from their sessions related to several overarching topics and summarized gaps identified in the sessions that would benefit from further research and technology transfer.

SPEAKERS

The session leaders were as follows:

- Scott Richrath, Spy Pond Partners: “How-To”: Technical Sessions to Advance the State of Practice Track,
- Matthew Hardy, American Association of State Highway and Transportation Officials: Connecting Risk and Asset Management Track,
- David Schrank, Texas A&M Transportation Institute: Data, Performance Measurement, and Target-Setting Track,
- Brad Allen, Applied Pavement Technology, Inc.: Moving Beyond Map-21 Track,
- Laura Zale, Southeastern Pennsylvania Transportation Authority: Transportation Asset Management Implementation Track and Transit Asset Management Sessions, and
- Rob Kafalenos, Federal Highway Administration: Improving Resilience to Climate Change and Extreme Weather Events Sessions.

TOPICS

Evidence That Asset Management Is Evolving

Scott Richrath noted that speakers in the “How-To” track provided examples of the evolution of asset management. An initial application of asset management in many states focused on the idea of “worst to first” in addressing roads in the poorest condition first. Ranking individual projects was the next step in the progression of asset management. Single-year analysis or optimization of projects represents another step, followed by multiyear optimization.

Richrath described the transit asset management gap assessment at the Connecticut DOT. A traditional practice is to focus on the largest gaps, but the

TRANSPORTATION ASSET MANAGEMENT

process in Connecticut focused on reaching agreement among staff on the most important gaps. The New Mexico DOT is using an asset management plan to explain the evolution of asset management in New Mexico. One of the district engineers has become an advocate and a spokesperson for asset management within the department. Richrath noted that the district had evolved from using a very basic spreadsheet for their limited asset management plan to a more sophisticated process.

Matthew Hardy provided examples from the “Connecting Risk and Asset Management” track. He suggested that the discussion of risk itself represents an evolution of asset management. Risk management adds another dimension to the asset management forecasting process. Further, risk needs to be considered as another element in the overall allocation process. He suggested that risk has evolved to encompass more than just threats (such as climate change and extreme weather events) and now includes aspects of uncertainty, variability, and opportunities. These ideas are included in the final report of NCHRP Project 8-93, *Managing Risk Across the Enterprise: A Guide for State Departments of Transportation* (http://onlinepubs.trb.org/onlinepubs/nchrp/docs/NCHRP08-93_FullGuide.pdf).

David Schrank highlighted some of the common topics related to the evolution of asset management from the “Data, Performance Measurement, and Target-Setting” track. He described the evolving data collection technologies and methods used in asset management, including light detection and ranging (lidar), aerial photography, cloud computing, and hand-held devices. He noted that these technologies are now common in discussions of asset management data collection.

Schrank noted that the increase in diverse stakeholders involved in asset management, including elected officials and agency decision makers, represented another example of the evolution of asset management. The focus on quality assurance and quality control with data from a wide range of sources also represented the evolving nature of asset management. He further suggested that the need to address the resilience of transportation investments is pushing asset management. Finally, he commented that analysis needs and wants are outpacing the ability to collect and analyze data.

Brad Allen described some of the themes from the “Moving Beyond MAP-21” track. He noted that the need for communication within agencies, between agencies, and with external stakeholders was a leading theme. There is a changing focus from simply providing information to stakeholders to engaging them in ongoing dialogues and listening to their needs. Examples he cited of this change included the implementation by the Metropolitan Transportation Commission in the San Francisco Bay Area of customer-based performance measures for all aspects of the capital program. Condition data were linked to customer-based performance measures to calculate approximately \$6.8 billion in user benefits from the investment in

OVERARCHING TOPICS AND RESEARCH NEEDS

preservation projects, an amount larger than the benefits realized by capacity projects. Allen also noted the dialogue occurring between Minnesota DOT and the Minnesota legislature to ensure that sustainable transportation funding is provided to maintain the state's transportation infrastructure. Developing a framework linking project-level investments directly to the statewide transportation mission and goals and ensuring clearly defined objectives and measures are major parts of this process.

Laura Zale commented that the evolving state of the practice was a common theme in the "Transportation Asset Management Implementation" track in the "Transit Asset Management" sessions. Speakers described numerous activities that were moving asset management forward. In comparison to the topics discussed at the conference 2 years ago, progress is being made quickly, both in the type of work being conducted and the diversity of the attendees at the conference. She suggested that regulatory compliance, although very important, was not the driving factor behind the development of asset management. She commented that many transit agencies and state DOTs were conducting similar activities 20 to 30 years ago as part of good business practices. These practices are evolving and becoming more sophisticated. Zale noted that one of the comments at the closing session at the 2014 conference was the need for a common vernacular with asset management and that this concern has been resolved with consensus on common terms.

Zale reported that speakers provided examples of implementing asset management at their agencies and prioritizing projects based on customer values. Speakers described the changes made at transit agencies based on data from their asset management programs, including increasing state funding and maintaining assets in periods of limited funding.

Rob Kafalenos suggested that linking asset management with climate change and extreme weather events is best described as a work in progress. He noted that many state DOTs, metropolitan planning organizations, and transit agencies have been examining risks tied to extreme weather events, and some are beginning to include that risk information in their transportation asset management plans. Examples from the North Central Texas Council of Governments, MARTA, and state DOTs in Michigan, Minnesota, Maryland, and New York were presented in the breakout sessions. He noted that FHWA and the Federal Transit Administration have sponsored vulnerability assessment projects in different areas and that the results of some studies are beginning to filter into asset management plans and asset management systems.

Kafalenos highlighted the activities of the Michigan DOT, which included a vulnerability assessment project identifying critical roads, bridges, culverts, and pump stations. The vulnerability of these assets to future changes in temperature and precipitation patterns through the midcentury was examined. The potential impacts

TRANSPORTATION ASSET MANAGEMENT

on maintenance, operations, and construction activities were analyzed. Maps were developed highlighting the location of vulnerable assets. The information is being examined for use in the Michigan DOT asset management system.

Creation of Sustainable Asset Management Programs That Are Embedded in the Organizational Culture

Matthew Hardy suggested that risk is being embedded not only in the asset management planning process, but also as a change agent to reorganize and change the culture of transportation agencies. He noted that risk-informed transportation asset management processes can minimize the recovery time when a threat is realized. Although a risk analysis does not eliminate a threat, it helps prepare an agency for different types of risks. He commented that risk management is creating a more overall resilient and sustainable transportation system that is able to minimize, and possibly eliminate, system downtime. It is important to remember that resilience relates to more than just extreme weather events. Other risks and threats include financing and funding, crude oil railcar derailments, and cyber attacks.

Brad Allen highlighted that the requirements of MAP-21 and the FAST Act are being embedded into agencies. He described the development of four white papers and videos by the Asset Management Expert Task Group that were presented in one of the breakout sessions. One of the topics discussed was defining the elements to include in trade-off decisions. Different ways of making trade-off decisions to enhance transparency and credibility with external stakeholders were also discussed. Allen highlighted the implementation of standards at the Massachusetts Bay Transportation Authority and the Long Island Rail Road. Both agencies used standards from the transportation industry, as well as from other industries with strong asset management frameworks. The importance of executive leadership was stressed in these examples.

Laura Zale discussed two sessions that addressed implementation and, more specifically, implementing asset management in a sustainable manner. She noted that a recurring theme in the sessions was the importance of establishing a framework for asset management. Speakers addressed the different framework models and the importance of examining the needs of internal and external customers in identifying the best approach. The development of a data governance strategy to ensure that data are collected, stored, and analyzed correctly emerged as another theme. Keeping the process simple, especially initially, represented still another common theme in many of the presentations. Piloting some of the asset management elements was suggested as an effective way to introduce new concepts and approaches. Zale agreed that identifying champions and key support personnel was important for embedding asset management into an agency's culture.

OVERARCHING TOPICS AND RESEARCH NEEDS

Rob Kafalenos noted that speakers provided examples of how agencies are incorporating climate data into asset management programs and systems. One example presented, the Alaska Department of Transportation and Public Facilities geotech asset management program, focuses on rock and soil slopes, embankments and retaining walls, and material sites. The department maps the assets, conditions, and availability of materials near the National Highway System for upcoming projects. Future changes in the permafrost are also analyzed to assess possible long-term impacts on assets. He noted that the value of the geotech assets in Alaska is two or three times the value of bridges. Another example was the North Central Texas Council of Governments, which has assessed vulnerabilities linked to future temperature increases and more frequent and severe flooding in developing their long-range transportation plan. Concerns related to asset management and planning, resiliency, and sustainability are addressed. Asset management principles and performance data to rank projects are included. MARTA provides another example of using the asset management system to identify asset resilience concerns and to make investment and operation decisions based on those data.

Kafalenos reviewed some of the lessons learned highlighted by speakers. A first step to understanding future vulnerabilities is to talk with staff with the best knowledge of the assets, including maintenance and operations personnel. The importance of institutional knowledge was also noted by many speakers, including communicating across disciplines and across silos.

Scott Richrath suggested that one underlying theme was that change will occur and that agencies need to be prepared for change. One approach discussed was the use of a peer review process involving asset managers, project managers, traffic engineers, materials engineers, and deterioration experts to assess life-cycle costs and benefits. The importance of including stakeholders early in the process at Bay Area Rapid Transit was also highlighted, as was using change management to balance technical and organizational challenges at the Pennsylvania Turnpike and to instill an asset management philosophy.

David Schrank noted that the data available today are much more robust than just a few years ago. As a result, they are being used for many more applications and analyses. At the same time, agencies are becoming much more dependent on those data. Speakers voiced the need for sustainable data sources.

Influence of Technology on How Decisions Are Made

David Schrank reported the theme of “collect data once and use them many times” was common at this conference and at other venues. He noted that collecting data is expensive, and ensuring that data will be used many times and fill many needs is

TRANSPORTATION ASSET MANAGEMENT

important. At the same time, there is the need to invest wisely with data collection and to match the costs associated with data to the costs of the assets. He noted that the geographic information system (GIS) industry may be changing some elements to better respond to the needs of transportation agencies.

Brad Allen noted that a scanning tour of different states on knowledge management was described in one session, and GIS as an emerging visualization communication tool was highlighted in another. He noted that participants discussed if simply integrating data and presenting them visually result in improved knowledge of the transportation system. A key takeaway, according to Allen, was that the relationships and communication among people within an organization are important for technology to be used to its fullest extent. He suggested that everyone within an organization is a decision maker. Ensuring that personnel understand their roles and the impact their jobs have on data quality or asset performance is important because it will contribute to their ability to make informed decisions. Communication from data collectors to analysts to managers to executives should be clear and provide an understanding of how their roles affect others' work. Allen cited Minnesota DOT's use of maps to present their statewide needs analysis to the legislature as a good example of communicating with stakeholders. The maps illustrated needs and projects by legislative districts, allowing senators and representatives to understand the benefits to their constituents that could be achieved by providing additional funds for transportation.

Laura Zale suggested that technology and software applications represented one of the evolving areas of asset management. She noted that a few years ago the focus was on feeding data into software programs and getting an answer. Today, there is more thoughtful use of software as an enabler. She noted that speakers in the implementation and transit sessions provided examples of using technology to shape their processes and to communicate with stakeholders.

Zale reported that some speakers highlighted the use of lidar to collect a wide range of data. Speakers noted that lidar provided more accurate data and eliminated the need for field data collection, increasing the safety of agency personnel. Other speakers described agency-developed computer, tablet, and smartphone applications. The Massachusetts DOT created a simple smartphone app to track roadway potholes. Data from the app are matched to pavement condition data to provide a more robust asset management data set. She noted that the success of the app helped gain support from other parts of the agency.

Zale highlighted other topics addressed by speakers, including proper data collection and data archiving methods. Personnel from the Pennsylvania DOT illustrated an example of converting a closet full of boxes with data into an 80,000-line database that is used by the department and 1,200 municipalities in the state for

OVERARCHING TOPICS AND RESEARCH NEEDS

assessing pavement conditions. Given the cost of collecting and maintaining data, some speakers stressed the importance of understanding what information you need and why you need it.

Rob Kafalenos noted that information on near-term and long-term changes in environmental conditions has become more available since the 2014 Asset Management Conference. This information can be used to help transportation agencies identify vulnerable assets and risks associated with different weather events. The results can be integrated into the decision-making process. He noted that available databases track changes in temperature and precipitation. The Army Corps of Engineers has a tool for estimating and plotting changes in sea level rise. Tools are also available for scoring and ranking vulnerabilities. Hydraulic engineering circulars provide assistance in understanding the potential impacts of future changes in precipitation.

Scott Richrath suggested that the rapid evolution of technology is challenging for public agencies and for research projects because the technologies may be outdated soon after they are implemented. He highlighted the “Rapid-Fire Round Table” session, which included presentations on the use of different technologies to support asset management and much discussion about techniques for project prioritization and optimization. He suggested that although technology can better inform decisions, it does not replace the decision-making process.

Matthew Hardy highlighted the risk analysis conducted by the Colorado DOT that evolved after the major floods a few years ago. The risk and vulnerability assessment is being applied along the length of the I-70 corridor to better inform future investment decisions.

Evidence That Data and Information Are Being Used to Speak to Multiple Audiences

Brad Allen described an example from the Indiana DOT of using technology to survey the public on the gasoline tax and other revenue sources for transportation. The survey results indicated that many people thought they were paying more in gasoline taxes than they actually were. This information was used by Indiana DOT to work with the state legislature to develop a long-term funding bill. The bill was built around taking care of existing facilities first by using available funding, and then funding additional projects by approaches identified through the survey.

Scott Richrath suggested there is a desire for a more transparent, data-driven, and objective process. He further suggested the need to recognize that the communication

TRANSPORTATION ASSET MANAGEMENT

and level of trust developed with stakeholders and partners through the process may be more valuable than the final ranked set of projects. As one speaker noted, “The journey is more important than the score.”

Laura Zale reported that the discussion of using data to communicate with all audiences covered a variety of topics. Participants talked about dashboards and the extensive data and work needed to feed what appears to be a simple application. Agency representatives cautioned about overaggregating data, which may result in not being able to tell the full story and to set performance measures. Other agency representatives discussed structuring field data to articulate the need for additional infrastructure funding.

Zale described a presentation on the ROI of asset management programs. The presentation covered the use of ROI for projects, but it was also noted that the life cycle of asset management systems may be shorter than the life cycle of the asset. She highlighted a Colorado DOT presentation on risk assessment of a retaining wall and geotechnical asset. That process was transferred to Minnesota DOT, highlighting the importance of sharing best practices and examples at conferences and through other mechanisms. Zale noted that transit agencies are sharing experiences on the development of asset hierarchies. Quantifying rail track and overhead catenary systems represents another topic of interest. She suggested there is an opportunity to leverage the strengths of different transit agencies working together as well as working with state DOTs.

Rob Kafalenos noted that in the resilience field, practitioners are using data to communicate potential concerns to multiple audiences. Scientists use climate models to communicate future changes in environmental conditions. Planners and engineers use models and data to identify current and future vulnerabilities. Asset managers can use this information to identify and rank risks and to prioritize funding. He reported that most of the presentations on this topic included the use of maps to illustrate the location of vulnerable assets and to communicate this information with diverse audiences. Although different disciplines use information in different ways, the use of GIS and mapping vulnerabilities provides a powerful tool, according to Kafalenos.

Brad Allen focused his comments on communicating with different audiences. He described the presentation of the Wyoming DOT that used safety data in asset management decisions. Another presentation focused on the four steps in data collection. The first step was understanding the need for the data, including who needs the data and how they will be used. Encouraging participation by the end users in developing the data collection plan was suggested.

Allen reviewed the final session in the track, which focused on clear and simple approaches to present information to convey the bottom-line message on asset

OVERARCHING TOPICS AND RESEARCH NEEDS

management to diverse stakeholders. An Ohio DOT video provided one example of providing basic information on the department's asset management program to the public. He stressed the importance of simple and clear communication and information that can be understood by more than just the transportation community.

Matthew Hardy noted the need to improve the overall communication of risk data and cited the Colorado DOT risk analysis as an excellent example of a comprehensive process. He suggested that presenting the results in a way that different stakeholders can understand them was important, including the use of the triple bottom line, which was discussed in a different session.

David Schrank suggested that the improved data from asset management programs are being used for multiple purposes, including planning, design, and operation. He noted that the focus on data-driven decision making is requiring more performance output variables. The importance of good data to tell a complete and accurate story was stressed by speakers. Schrank noted that the proliferation of agency websites with good information highlighted the trend of speaking to multiple audiences.

Gaps That Would Benefit from Further Research or Technology Transfer Activities

Scott Richrath identified three gaps from the “How-To” track. The first gap was that although many people think deterioration modeling is a difficult part of the asset management process, cost modeling is actually harder. He suggested that examining methods to enhance cost modeling would be beneficial. The second gap related to the importance of data and prioritizing data, analyzing the ROI of data, and conducting benefit–cost analyses on data. The third gap related to identifying the impact of maintenance and operational costs associated with major capital expansion projects. He noted that Minnesota DOT is currently piloting this approach.

Matthew Hardy also identified three gaps from the “Connecting Risk and Asset Management” track. The first gap focused on how transportation agencies can take advantage of risk opportunities. He noted that identifying case study examples would be beneficial. The second gap was the need for data scientists at transportation agencies. The Seattle, Washington, DOT is one example of an agency with a data scientist. The third gap was examining risk analysis from a holistic perspective. He noted this approach is being used by some agencies and is documented in the final report of NCHRP Project 8-93, *Managing Risk Across the Enterprise: A Guide for State Departments of Transportation*.

David Schrank identified communication techniques and breaking down internal barriers to data sharing as two gaps from the “Data, Performance Measurement, and

TRANSPORTATION ASSET MANAGEMENT

Target-Setting” track. He noted that the extensive effort that goes into collecting and analyzing data is not always matched with an equally extensive effort to communicate the results effectively to diverse agencies and stakeholders. Second, he noted that working to break down barriers to sharing data across departments and groups is still needed at some agencies.

Brad Allen described three gaps from the “Moving Beyond MAP-21” track. One gap was the advancement of performance measures to better link asset performance to customer or user benefits. Second, executive leadership was noted by many participants as a key element for successful asset management programs. He discussed the need to identify better methods to communicate the benefits of asset management to agency executives, to develop tools for promoting better internal alignment to support asset management, and to develop better communication strategies for use with stakeholders. A third gap was the need to develop a clearer vision among statewide visions, goals, transportation priorities, asset management plans, projects, and measures. Finally, Allen suggested that all these elements need to be expanded beyond public policy and law so they bear on projects and deliverable measures.

Laura Zale added one gap from the “Transportation Asset Management Implementation” track and “Transit Asset Management” sessions. She suggested the need to improve the tools to collect and analyze life-cycle trending data for items beyond rolling stock, pavement, and bridges to assist in making better investment decisions. She also noted that participants expressed interest in having a session at the 2018 conference on the impact of the new rulemaking on the state of the practice.

Rob Kafalenos described four gaps related to asset management and climate change and extreme weather events. First, he noted the need to improve methods to help asset managers integrate consideration of climate risk, along with other risks, into asset management. A second gap was the need for data on the resilience of assets. Making this information available electronically and seamlessly within and across agencies and jurisdictions was noted as important. Another gap was the need to track damages to transportation assets from extreme weather events. This information could be used to identify the impacts of different types of events for future planning and investments. The communication gap across state and city boundaries was discussed by speakers in some of the breakout groups. The need to improve communication across jurisdictional boundaries was identified as important by some participants, including those who noted that watersheds do not follow political boundaries. Finally, some participants suggested that not all state DOTs are comfortable discussing climate change risks. Finding ways to discuss changing conditions was suggested as important.



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