TR NEWS

NUMBER 270 SEPTEMBER–OCTOBER 2010

ASSET MANAGEMENT FOR A DURABLE INFRASTRUCTURE

3 INTRODUCTION

Asset Management at Work: Practical Perspectives on an Evolving Strategy

David L. Blake, Sue McNeil, and Kathryn A. Zimmerman

Whatever the infrastructure asset to be maintained, the principles of asset management can apply. Articles in this issue showcase a range of asset management experiences and successes, illustrating the principles at work in particular environments and offering practical insights into an evolving, proven, and valuable strategy.

4 Transportation Asset Management Timeline

6 Asset Management to Improve Highway Performance: Lessons from North Carolina and Tillamook County, Oregon

Patricia M. Bugas-Schramm and Lacy D. Love

The North Carolina Department of Transportation and Tillamook County Public Works in rural Oregon have worked to convert data about their activities, projects, and programs into information that decision makers can use in managing performance across a range of assets while minimizing cost and risk. Here are the challenges faced and the solutions that worked—which also have gained community support.

7 Transportation Asset Management: Definitions and Principles

Philip Tiewater and Kathryn A. Zimmerman

14 Applying Asset Management to the Interstate Highway System

16 Driving Asset Management Through Performance: Culture Change and Proven Results at the Missouri Department of Transportation

Mara K. Campbell

Missouri DOT has achieved significant improvements in pavement and other assets by implementing throughout the organization a performance management approach—data-driven, results-focused, accountability-based, and incorporating asset management practices. The system offers flexibility to adapt to customer needs and to an uncertain funding environment.

21 Developing Asset Management Programs for Airports

Marci A. Greenberger

22 Local Communities Adopting Asset Management: Initiatives, Models, and Results in Michigan and Wisconsin

Steve Warren

In Michigan and Wisconsin, statewide initiatives have encouraged local agencies to adopt an asset management approach to paved road conditions. Many local agencies are using asset management to educate decision makers and stakeholders about the basics of pavement deterioration and to explain the logic and sense of a mix-of-fixes preservation strategy.

28 Visualization of Transportation Assets with Geobrowsers: Cost-Effective Tools for Exploration, Interaction, and Decision Making

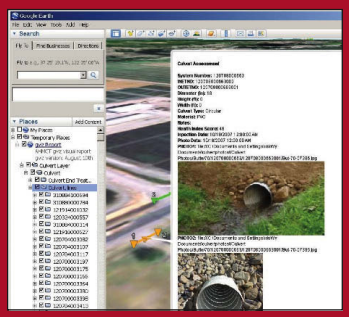
M. T. Darter, T. A. Lasky, and B. Ravani

Geobrowsers that use free or low-cost software have opened new opportunities for asset visualization, improving ease of use by transportation staff from diverse professional backgrounds, as well as by the public. Geographic visualization can assist in asset management by emphasizing exploration, interaction, and decision making.

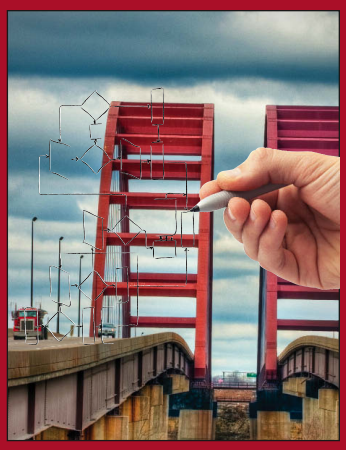
32 Asset Management Resources

3

22



28



COVER: As the nation's infrastructure ages, states and localities are putting asset management principles to work to improve the management and extend the service life of infrastructure assets. (Background photo: Missouri Department of Transportation)

TR NEWS

features articles on innovative and timely research and development activities in all modes of transportation. Brief news items of interest to the transportation community are also included, along with profiles of transportation professionals, meeting announcements, summaries of new publications, and news of Transportation Research Board activities.

***TR News* is produced by the Transportation Research Board Publications Office**
Javy Awan, Editor and Publications Director
Lea Mae Rice, Assistant Editor
Jennifer J. Weeks, Photo Researcher
Juanita Green, Production Manager
Michelle Wandres, Graphic Designer

TR News (ISSN 0738-6826) is issued bimonthly by the Transportation Research Board, National Research Council, 500 Fifth Street, NW, Washington, DC 20001. Internet address: www.TRB.org.

Editorial Correspondence: By mail to the Publications Office, Transportation Research Board, 500 Fifth Street, NW, Washington, DC 20001, by telephone 202-334-2972, by fax 202-334-3495, or by e-mail jawan@nas.edu.

Subscriptions: North America: 1 year $55; single issue $10. Overseas: 1 year $80; single issue $14. Inquiries or communications concerning new subscriptions, subscription problems, or single-copy sales should be addressed to the Business Office at the address below, or telephone 202-334-3216, fax 202-334-2519. Periodicals postage paid at Washington, D.C.

Postmaster: Send changes of address to *TR News*, Transportation Research Board, 500 Fifth Street, NW, Washington, DC 20001.

33 POINT OF VIEW
The Right Fix at the Right Time
Kirk T. Steudle
For nearly two decades, Michigan DOT has applied an asset management approach to investing in its infrastructure, and local transportation partners have worked to do the same for almost 10 years. The state agency's director reviews the practical lessons and the benefits, as the legislature considers funding allocations in adverse economic times.

ALSO IN THIS ISSUE:

37 Calendar

38 Research Pays Off
Get on the Bus: Connecting Small Communities on Montana's Hi-Line
David Kack

40 Profiles
Bridge design engineer Barney T. Martin, Jr., and civil engineering professor and consultant Reginald R. Souleyrette

42 News Briefs
War of 1812 ship, green initiatives, online shopping's effects, and European traffic

44 TRB Highlights
Cooperative Research Programs News, 44

46 Bookshelf

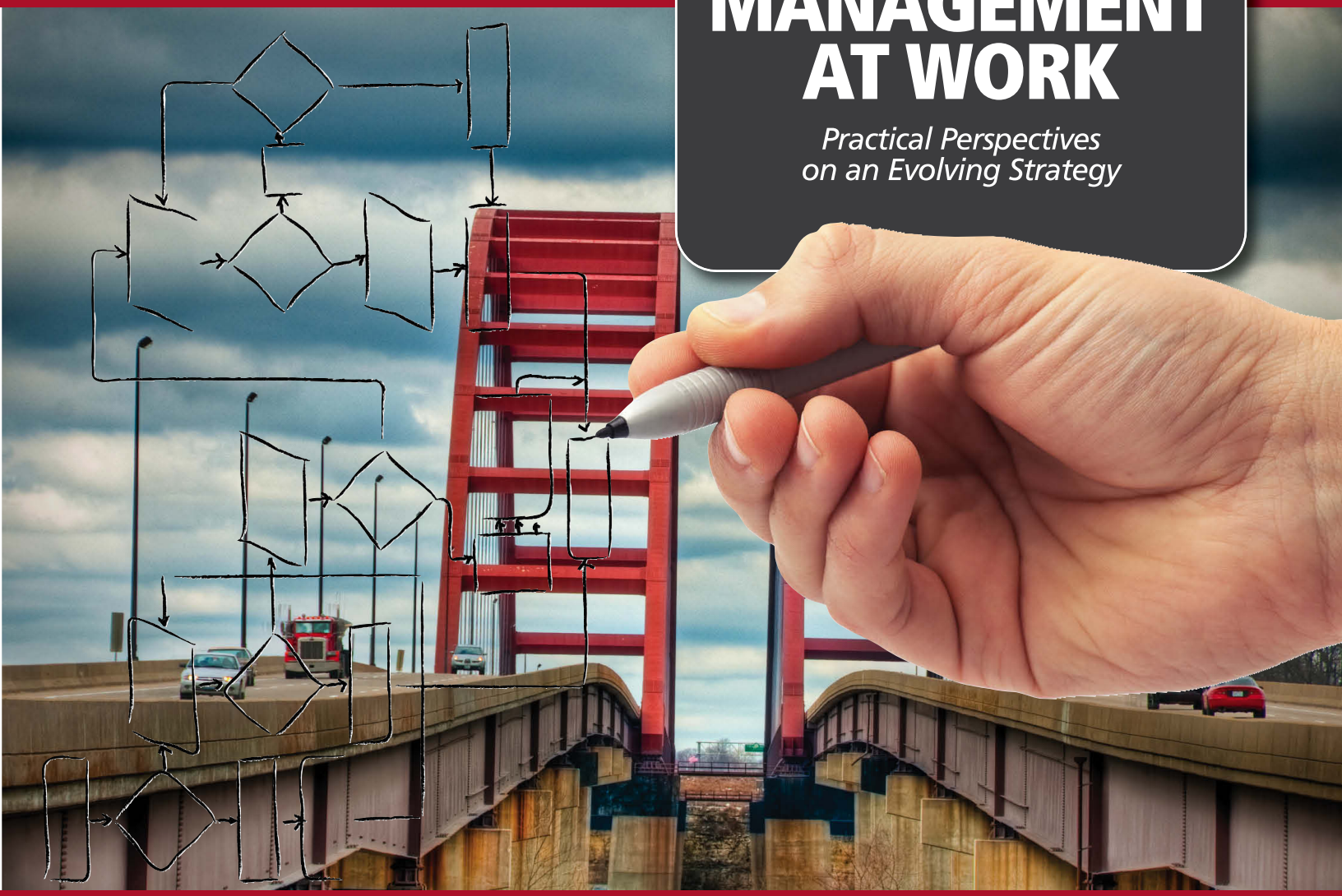
COMING NEXT ISSUE

The Transportation Research Board celebrates its 90th Anniversary in 2011, and the November–December 2010 *TR News* will inaugurate the occasion with a feature article by past Executive Director Thomas B. Deen, reviewing the organization's history and characteristics but focusing on developments and trends in the past 15 years. Supplementary features and sidebars include selected major milestones in TRB's evolution, a look forward to the next 10 years and TRB's centennial, summary comments from some of TRB's significant players, and a review of the first 5 years of the Airport Cooperative Research Program. Other features present state department of transportation experiences with public communication through social networking media, policy lessons for today from medieval bridge builders, and more.

INTRODUCTION

ASSET MANAGEMENT AT WORK

Practical Perspectives on an Evolving Strategy



DAVID L. BLAKE, SUE McNEIL, AND KATHRYN A. ZIMMERMAN

Blake is Project Manager, PBS&J, Florida's Turnpike Enterprise, Ocoee. McNeil is Professor, Department of Civil and Environmental Engineering, University of Delaware, Newark; Chair of the National Cooperative Highway Research Program Project Panel on Consequences of Delayed Maintenance; and Cochair, National Research Council Committee on Performance Measurement for Transportation Systems: Fourth U.S. and International Conference. Zimmerman is President, Applied Pavement Technology, Inc., Urbana, Illinois; and Chair, TRB Transportation Asset Management Committee.

Asset management is a term widely used in transportation agencies worldwide. Most people associate the term with pavements and bridges. These assets are the major funding issue for most transportation agencies, but asset management addresses more than bridges and pavements, with applications ranging from signs and culverts to buildings and communication towers. Whatever infrastructure asset needs to be maintained, the principles of asset management can apply.

Every asset management process involves four fundamental components:

- **Asset inventory.** Maintaining an accurate inventory of infrastructure assets is the critical first step.
- **Performance measures.** Measures are established to relate an asset's level of performance to an accepted standard.
- **Analysis.** Forecasting, comparing, and prioritizing performance measures yields recommendations for the maintenance, rehabilitation, or replacement of assets.
- **Decision making.** Recommendations from the analysis are incorporated into policy decisions.

How organizations implement these components varies greatly. For example, Florida's Turnpike Enterprise Asset Management System, or TEAMS, links financial management systems, work order applications, and maintenance programs via the Internet; the Michigan Department of Transportation

The Innerbelt Bridge in Cleveland, Ohio, undergoes inspection. Asset management in practice—such as comprehensive bridge maintenance plans—can prevent asset failures and costly replacements.

PHOTO: OHIO DEPARTMENT OF TRANSPORTATION

(DOT) assigns teams and committees throughout all its divisions to implement asset management; and the Queensland Department of Main Roads in Australia incorporates scenario analysis tools and risk assessments into its asset management framework.

Since 1999, when the Federal Highway Administration created the Office of Asset Management, the asset management phenomenon has spread throughout the transportation industry. As it evolves as a strategy, asset management can complement performance management and performance measurement. Performance management is the holistic management of the transportation network, including freight and congestion; performance measurement supports management activities; asset management informs decisions about how to manage the hard assets.

This issue of *TR News* showcases a range of asset management experiences and successes. One article describes how performance measures were established in North Carolina and in Tillamook County, Oregon, to create an asset management culture for decision making. Another article focuses on the importance of leadership in effecting Missouri DOT's successful transition to—and implementation of—an asset management system, guided by the mantra, "Better, faster, and

TRANSPORTATION ASSET MANAGEMENT TIMELINE

1996

1st National Asset Management Conference, "Advancing the State of the Art into the 21st Century Through Public–Private Dialogue," Washington, D.C.

1997

AASHTO creates Transportation Asset Management Task Force

2nd National Asset Management Conference, "21st Century Asset Management," Albany, N.Y.

1998

AASHTO adopts Asset Management Strategic Plan

1999

New Zealand Asset Management Support publishes *International Infrastructure Management Manual*

Government Accounting Standards Board implements Statement 34, requiring state and local governments to report the "conditions and costs of capital assets"

FHWA creates Office of Asset Management

3rd National Asset Management Conference, "Asset Management Peer Exchange," Scottsdale, Ariz.

2000

TRB establishes Asset Management Task Force

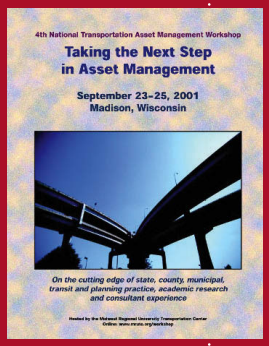
2001

4th National Asset Management Conference, "Taking the Next Step," Madison, Wis.

2002

AASHTO publishes *Transportation Asset Management Guide*, produced under NCHRP Project 20-24(11), Asset Management Guidance for Transportation Agencies

2001



2005

PHOTO: FHWA

A 2005 international scan included a demonstration of the sidewalk asset management program in Brisbane, Australia.

cheaper." A third article points out how asset management and its benefits can be extended beyond the state DOT level into local communities. New, affordable technology to visualize asset management information more effectively and improve decision making is described in a fourth article. Finally, in a Point of View, a state DOT director traces the practical lessons and the favorable policy responses to a statewide implementation of asset management, now undergoing a new test during difficult economic times.

Although each article presents a different perspective, all illustrate asset management principles at work within their particular environments. From how to implement asset management within an organization—including leadership's role—to documenting the results of improved asset management and visualizing the power of asset management, the articles in this issue of *TR News* offer practical insights into an evolving, proven, and valuable strategy. Whether at a small, local municipality or at a state DOT, the organizational implementation of asset management principles can improve the management—and extend the service life—of infrastructure assets.

Photo: North Carolina Department of Transportation

Although bridges and highways are the two primary applications of asset management, the principles also apply to signs, culverts, and other structures.

Editor's Note: Appreciation is expressed to TRB Senior Program Officer Charles Fay for his contributions in working with a special subcommittee of authors and reviewers, chaired by Sue McNeil, in developing this issue of *TR News*.

2003

5th National Asset Management Conference, "Moving from Theory to Practice," Atlanta, Ga., and Seattle, Wash.

AASHTO establishes Transportation Asset Management Subcommittee

AASHTO launches Transportation Asset Management Today, a community-of-practice website (http:/ assetmanagement. transportation.org)

2004

TRB establishes Transportation Asset Management Committee

AASHTO publishes Revised Asset Management Strategic Plan

2005

Transportation Asset Management International Scan: Australia, Canada, England, and New Zealand; FHWA publishes report (FHWA-PL-05-019)

TRB publishes NCHRP Report 545, *Analytical Tools for Asset Management*, developed under NCHRP Project 20-57

6th National Asset Management Conference, "Making Asset Management Work in Your Organization," Kansas City, Mo.

2006

EPA and FHWA sign Memorandum of Understanding on Asset Management

U.S. Domestic Scan Pilot: Asset Management, conducted under NCHRP Project 20-68(01); FHWA publishes scan report

2007

7th National Asset Management Conference, "New Directions in Transportation Asset Management and Economic Analysis," New Orleans, La.

2009

8th National Asset Management Conference, "Putting the Asset Management Pieces Together," Portland, Ore.

TRB publishes NCHRP Report 632, *An Asset Management Framework for the Interstate Highway System*, developed under NCHRP Project 20-74

Photo: FHWA

A U.S. domestic scan examined an instrumented van that collects pavement condition data for the Grand Valley Metropolitan Council, Grand Rapids, Michigan.

Asset Management to Improve Highway Performance

Lessons from North Carolina and Tillamook County, Oregon

PATRICIA M. BUGAS-SCHRAMM AND LACY D. LOVE

Bugas-Schramm is President, PBS Consulting, Inc., Portland, Oregon. Love is Director of Asset Management, North Carolina Department of Transportation, Raleigh.

The 2009 economic recession raised challenges for the states, regions, and the 39,000 local governments that manage the nation's transportation network. The North Carolina Department of Transportation (DOT) and Tillamook County Public Works in Tillamook, Oregon, have met the challenge to reduce costs and identify critical investments with simplified ways to report performance and manage risk.

Both agencies have worked to convert data about their activities, projects, and programs into information that decision makers can use in managing performance across a range of assets while minimizing cost and risk. In both cases, the ability to simplify key information and build teams for performance reporting has guided agency use of resources and has built community understanding of the challenges involved in preserving transportation assets.

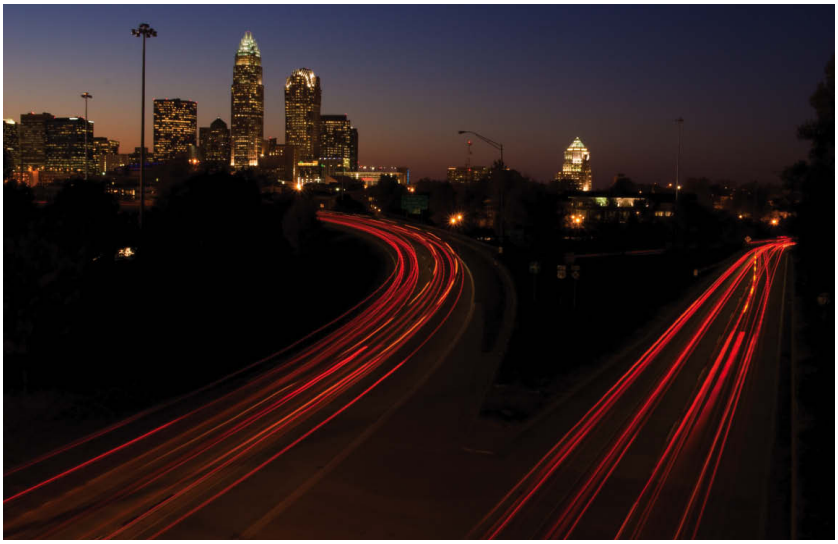


Photo: Dreamstime

The North Carolina Department of Transportation (DOT) maintains roads for urban and suburban commuters (above, Charlotte), as well as rural county networks.

Photo: North Carolina DOT

Road crews work on clearing debris from I-40 in western North Carolina after a 2009 rockslide. The state's roads traverse a variety of terrain, from mountainous to coastal.

Lay of the Land

North Carolina DOT maintains one of the largest state transportation systems in the nation—more than 79,000 miles of highways, second only to Texas DOT. Moreover, North Carolina DOT is one of only a few state highway agencies that maintain county road systems in addition to the Interstates and primary highways.

The state is geographically diverse, with coastal barrier islands in the east and mountain ranges in the west. Most of the state's 9.5 million residents live in the region between, near the state's major cities and the industries that drive its economy. With massive changes in such economic mainstays as tobacco, textiles, furniture, and agricultural products, a historically rural and agricultural state is in transition, with more citizens living in urban and suburban settings and commuting to work.

North Carolina DOT's Division of Highways (DOH) is responsible for the planning and design of the system and coordinates construction, maintenance, and operations through 14 field divisions with

support offices in all 100 counties. Like many other state highway agencies, the department depends on fuel taxes and user fees, along with the federal Highway Trust Fund, to support its programs; highway maintenance and operations must compete for funds with other programs and transportation modes.

Historically, requests to the department's leadership and to the legislature for funds were based more on trends in allocations than on needs. In the 1980s and 1990s, the department was unable to quantify its needs or to communicate effectively with the legislature, the public, and its own leadership about the level of service that was being provided or about the level of service that could be provided with additional funds.

Condition Reports

In 1997, the North Carolina General Assembly passed legislation requiring the department to report the state's maintenance needs based on data, not on historical trends. The department developed a method for assessing the maintenance condition of the state's highway system and, in 1998, produced its first maintenance condition report on the state highway system.

To determine what to measure and how to establish levels of service, North Carolina DOT held workshops to gain the input and engage the expertise of

Photo: North Carolina DOT

As the state's historically rural landscape becomes more urban, changing road use and infrastructure needs present a challenge to North Carolina DOT.

Transportation Asset Management
Definitions and Principles

PHILIP TIEWATER AND KATHRYN A. ZIMMERMAN

As transportation asset management (TAM) has evolved over the years, so has its definition. Most of today's definitions reflect a strategic, performance-based process for making decisions about the allocation of investments and resources; considerations include multiple assets, alternative funding strategies, risk, and an asset's economic and engineering characteristics throughout its life.

Most TAM definitions encompass the following principles:

◆ **Strategic objectives are specified.** Strategic direction is important for any organization. An organization can create the best opportunity for achieving its strategic goals by aligning its resource allocation decisions and improvement programs with those goals.

◆ **Decisions are based on measures of performance.** In a TAM environment, performance measures (PMs) are integral—they track various aspects of agency performance and provide the data that decision makers need for the effective management of transportation assets:

- *PMs measure progress toward strategic goals*. TAM assists agencies in aligning day-to-day decisions with strategic goals. PMs provide a means of monitoring progress, so that improvements can be made when warranted, and resources can be allocated appropriately.
- *PMs link agency decisions to stakeholder priorities.* TAM decisions consider the needs of various stakeholders; PMs help keep these priorities before the organization and provide a means of reporting on progress.

◆ **Assets are managed from a long-term perspective**. Transportation assets represent a significant investment; TAM makes the preservation of asset value a priority. Agencies must manage each asset throughout its entire life cycle, focusing on long-term strategies instead of short-term gains.

◆ **Decisions are data driven.** Investment and resource allocation decisions depend on the availability of reliable data that indicate current conditions and that can project performance under alternative scenarios.

◆ **Risk is considered in the decision process.** Understanding the probability of asset failure and the consequences—as well as the reliability of the data used for decision making—are fundamental aspects of TAM.

◆ **TAM is a dynamic process.** Agencies do not need to wait until they have complete data sets or sophisticated decision processes to adopt TAM principles. Agencies should begin with the premise that as the data improve and the organizational culture changes, the resulting decisions will improve. In turn, as data availability and decision processes improve, TAM activities should be reassessed and improved.

Tiewater is Founder and Principal, ELM Consulting, LLC, Wayne, Pennsylvania. Zimmerman is President, Applied Pavement Technology, Inc., Urbana, Illinois, and Chair, TRB Transportation Asset Management Committee.

PHOTO: NORTH CAROLINA DOT

In 2005, North Carolina DOT's Department of Highways hosted a workshop with the Federal Highway Administration, initiating a focus on performance measures and goals.

its field engineers. The workshops accomplished three main objectives:

- To give the field engineers an opportunity to help develop the process;
- To gain buy-in from the field managers, who would have to collect the data; and
- To help the central staff finalize the methodology.

The 1998 workshops created the foundation for the performance measures and performance targets that now are central to the department's asset management efforts.

At first, North Carolina DOT conducted assessments of highway assets every other year and reported the condition and funding needs to the General Assembly. These early efforts helped quantify needs to stakeholders, developed credibility with the legislature, and provided justification for shifting more dollars to maintenance and operations.

Shift in Leadership

Although the findings succeeded in securing funds to maintain assets, the agency needed other data to adjust work plans to address the deficiencies identified. The collected data were only accurate enough for reasonable assumptions about the condition of the network statewide, but not at the county or district levels.

At the same time, North Carolina DOT was undergoing a shift in leadership at the central offices and in the field divisions. Almost all of the senior managers hired during the boom years of Interstate construction were retiring. The new managers introduced a fresh perspective on maintenance and were open to new ideas and concepts to improve management of the highway infrastructure.

The agency established the position of pavement preservation engineer, implemented a modern maintenance management system, conducted customer surveys, refined its maintenance quality assessments, developed a long-range transportation plan, and established an Office of Asset Management, among its many initiatives. The Federal Highway Administration's (FHWA's) national and division offices provided technical support and assistance; the division office added an asset management specialist.

Achieving Measurable Results

The new DOH leadership was not satisfied with continuing past practices but sought a shift from a reactive approach to focus on outcomes, with clearly defined goals and objectives, flexibility, and accountability. In 2005, in partnership with the FHWA division office, the department held a 2-day workshop to develop strategies for implementing a performance-based culture with established goals, performance targets, and measures. A steering committee of senior DOH managers provided guidance and direction.

The workshop focused on the core operational business areas, to develop performance measures and performance targets for key outcomes that should be measured. Focus groups of about six members, including representatives of the central office, field staff, and FHWA, examined functional areas of DOH Operations.

The overarching goal was to create an environment in which the central and field engineers and field managers could manage their operations more like a business, to achieve measurable results. The managers would gain flexibility, control in decision making, and opportunities to use their management skills. The changes aimed at a more efficient and uniformly maintained and operated highway system, with a higher level of service.

The focus groups reviewed a list of potential performance measures by functional area. Each group completed a template for each performance measure and submitted results to the steering committee (Table 1).

TABLE 1 Sample Worksheet for North Carolina Performance Measure

Element:	Pavement
Asset:	Pavement (structure or quality)
Activities:	Pavement condition rating
Condition Indicator:	Pavement condition survey rating ≥ 80
Performance Measure:	Percent of lane miles that meet condition indicator

LOS Category	LOS Description
A	85% or more of lane miles meet the condition indicator
B	80% to <85% of lane miles meet the condition indicator
C	75% to <80% of lane miles meet the condition indicator
D	60% to <75% of lane miles meet the condition indicator
F	<60% of lane miles meet the condition indicator

LOS = level of service.

TABLE 2 Sample of North Carolina Performance Measures

Asset	Performance Measure	Statewide Tier		Regional Tier		Subregional Tier	
		Target	LOS	Target	LOS	Target	LOS
Pavement	Pavement condition rating ≥ 80	85	A	80	B	75	C
Bridge Health Index	% of bridges in good condition	90	A	75	B	65	C
Ground-mounted signs	Visible and legible	92	A	85	B	85/77*	B/C*

*Higher score and LOS for regulatory and warning signs, lower for other signs.

The process developed 49 performance measures, like those shown in Table 2, to measure the success of DOH Operations in delivering transportation products and services. Because North Carolina DOT is responsible for the entire state highway system—except for municipal streets—three distinct classifications of highways were addressed:

- Statewide tier highways—Interstates and major primary routes;
- Regional tier highways—the remaining primary routes; and
- Subregional tier highways—the secondary road system.

PHOTO: LEA M. RICE

Highway NC-12, along the state's northeastern shore, is classified as a Statewide Tier Highway in the North Carolina Multimodal Investment Network.

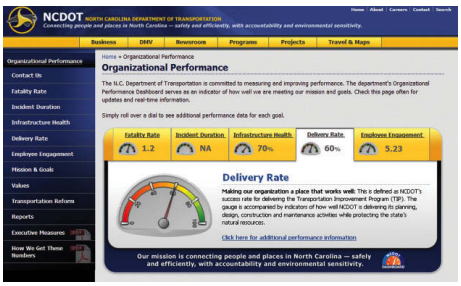
In establishing the performance targets for each performance measure, the work groups recognized that each class served a different purpose and required a different level of service.

Individual performance reviews were tied to measureable outcomes for the first time in 2009. Performance appraisals for all DOH managers were based in part on the performance and condition of the highway system, generated from the 2008 biannual highway assessment program. Areas that did not meet the performance target were highlighted, to draw field managers' attention to the deficiencies (Table 3).

What-If Work Plans

DOH Operations continues to refine the performance measures and the targets developed by the work groups. One discovery is that measuring a few important features in a focused effort sometimes can work better than measuring too many items and overwhelming the field managers. As a result, the department has reduced the number of performance measures to be evaluated during the 2010 assessment to approximately 30.

The department is taking advantage of its management systems to develop what-if work plans and resurfacing programs based on anticipated investment dollars and levels of service. The maintenance management system and the pavement management system quickly produce multiple what-if options, reducing the amount of analysis previously performed by central staff. The data support departmental 5-year work programs that are part of the transformation to a results-based organization. The department also has developed a public dashboard—a display of indicators and measures—on its website to inform and educate stakeholders about the performance results and assessments.[1]



North Carolina DOT's Organizational Performance Dashboard allows the public to access statistics on performance indicators, including infrastructure health, fatality rates, and delivery rate.

Measurements and Management

Department managers realize that the transition to a performance-based organization that relies on asset management principles will take time. The establishment of performance measures and performance targets is a major step. The adage, "What gets measured, gets managed," can spur an organization, a

[1] https://apps.dot.state.nc.us/dot/dashboard/.

TABLE 3 Sample of North Carolina Performance Results, 2008

Asset	Data Collection Method	2008 Target	State Avg. Score
Pavement	PCS	85	75
Bridge Health Index	NBIS	90	71
Ground-mounted signs	MCA	92	90

PCS = pavement condition survey; NBIS = National Bridge Inspection Standards; MCA = maintenance condition assessment.

Photos courtesy of Patricia Bugas-Schramm

Surfaces and bridges damaged by storms in Tillamook County, Oregon. Approximately 25 percent of the county's $4 million annual road budget goes to road surface management.

division, or an individual to achieve accountability.

At North Carolina DOT, managers are beginning to understand the importance of meeting performance targets, not only as an organization, but also as individuals. This makes the establishment of performance measures and the setting of performance targets a critical task.

The department continues to align its measures of success with the expectations of stakeholders, the legislature, and the administration. DOH Operations will revisit the performance measures and targets at the end of the 2010 assessment, engage the public's expectations, and calibrate engineering measurements with the public's wants and needs. Establishing an asset management culture that relies on appropriate performance measures is a long-term effort that can start with data already available from an agency's pavement and bridge reporting systems.

Confidence and Understanding

Tillamook County Public Works manages a small, rural 380-mile county road network that has a 2009 replacement value of $394 million. With a population of 25,845, the county is located on the west central coast of Oregon, in a wet climate—the average annual rainfall is 90 inches. Many severe hurricane-force wind and rain events have struck Tillamook County since 1996; eight of these were declared federal emergencies.

In the past 20 years, road programs have been reduced or eliminated, although the needs of the road system have increased. The $4 million annual road budget has remained unchanged for 10 years. Little preventive maintenance has occurred. Approximately 25 percent of the total budget is spent on road surface management. Three sources of funding support the county roads: federal forest timber receipts, the Oregon Motor Vehicle Fund, and state and federal grants primarily for bridge replacement and storm repairs. The U.S. Congress is phasing out the federal forest receipt funding, which generates approximately 40 percent of the county's road revenues.

Photo courtesy of Patricia Bugas-Schramm

An average rainfall of 90 inches per year in Tillamook County highlights the importance of preventive maintenance and of an asset-based management program.

Identifying Critical Assets

In January 2008, new county leadership moved quickly to adopt asset management principles for the road network and the services provided to the community. This initial effort produced the Tillamook County *Road Asset Management Plan 2008 Report,* identifying road asset information, the current level of services, and future service options.

The report drew on an assessment of the agency's service planning and business processes. Strategic goals and objectives were updated, along with the roles and responsibilities for managing infrastructure data. Cost accounting activities were categorized in terms of an asset's life-cycle cost, and links to financial reporting were established.

The plan includes detailed information for all major assets, including the inventory, replacement value, condition, and requirements to bring the system to a state of good repair, as shown in Table 4. This information has helped to identify critical assets and to establish service priorities.

Rating Pavements

Pavements are a critical asset. Tillamook County adopted the pavement rating method of the San Francisco Bay Area Metropolitan Transportation Commission (MTC), which applies the Pavement Condition Index (PCI) scale of 0 to 100; the ratings are sorted into categories from good to poor, as listed in Table 5.

TABLE 4 Sample Asset Inventories, Replacement Value, Condition, and Unmet Needs: Tillamook County

ASSET	INVENTORY	REPLACEMENT VALUE	CONDITION						TOTAL UNMET NEED
			VG	G	F	P	VP	TBD	
PAVEMENT									
Paved	283 centerline miles	$261,600,000		25%	15%	25%	35%		$37,000,000
Gravel	97 centerline miles	NA						x	NA
		$261,600,000							$37,000,000
STRUCTURES									
Bridges	96	$122,689,350		67%	20%	13%			TBD
Guardrails	10 miles	$1,152,395	39%	8%	8%	33%	10%	2%	$495,526
Levees	7	TBD						x	TBD
		$123,841,735							$495,526
STREET SIGNS									
Signs	4,641	$139,230	85%	14%		1%			$1,620
Delineators	457	$9,597						x	TBD
Posts	4,165	$70,805						x	TBD
		$219,632							

VG = very good; G = good; F = fair; P = poor; VP = very poor; TBD = to be determined; NA = not available.

The Integrated Road Information System developed by the Association of Oregon Counties includes a pavement management module to assist county agencies in managing their assets. Tillamook County had partial inventories of many road assets, with the condition of many assets—such as culverts—unknown or with the asset information not maintained. In 2008, guardrail, vehicle, bridge, and pavement information was added.

The MTC methodology allows comparison with the pavement conditions in other Oregon and West Coast jurisdictions. The paved road condition was benchmarked with that of adjoining Oregon coastal counties and with that of state routes (Table 6). The comparison indicated that the condition of Tillamook County roads was the worst in Oregon and that the most significant decline had occurred since 2001 (Figure 1).

TABLE 5 Average Network Condition, Tillamook County

Category	PCI Range	% of Network
Good	70–100	24.80
Satisfactory	50–69	15.00
Fair	25–49	24.70
Poor	0–24	35.50

PCI = Pavement Condition Index.

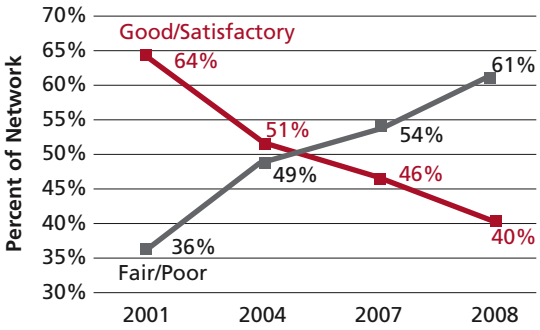


FIGURE 1 Pavement condition, Tillamook County, 2001–2008.

TABLE 6 Benchmarking Pavement Performance for Tillamook County

Asset or Service	Key Performance Indicator	Performance				Performance Target			
		Tillamook, 2007	Tillamook, 2008	Clatsop, 2007	Lincoln, 2007	Tillamook, 2008		State	
						Actual	Target	Actual	Target
Paved Roads	Pavement Condition Index (PCI): • Good > 70 • Satisfactory, 50–70 • Fair, 25–49 • Poor < 25	PCI = 48	PCI = 45	PCI = 75	PCI = 76	40% satisfactory or good	70% satisfactory or good	87% fair or better (PCI > 45)	78% fair or better (PCI > 45)

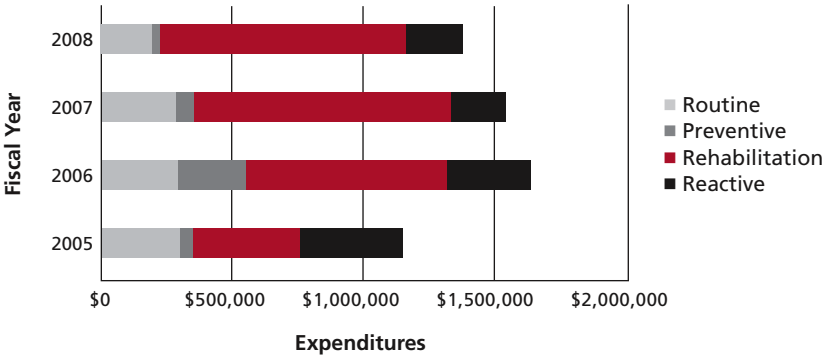


FIGURE 2 Road surface life-cycle management, Tillamook County.

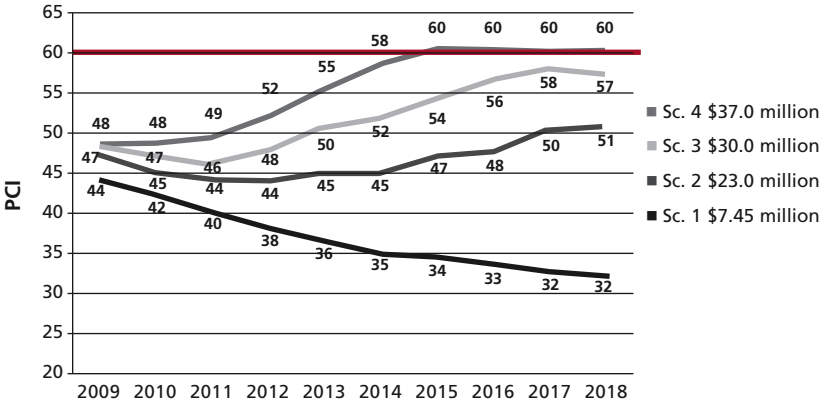


FIGURE 3 Pavement condition scenarios and expenditures, Tillamook County, 2009–2018. (Sc. = scenario.)

Preventive Maintenance

Activities were categorized to reflect the historical investment strategy by the type of treatment (Figure 2). Analysis of the pavement management activity costs showed that past expenditures lacked a preventive maintenance focus. The data enabled the agency to document the need to incorporate a preventive maintenance strategy consistent with the new focus on asset performance.

Tillamook County established a PCI target of 60—or satisfactory—which required a commitment to invest $37 million over 10 years (Figure 3). Nearly three-fourths (71 percent) of county roads are projected to reach a good condition—or a PCI of 70 or more—within 6 years and to maintain that condition for the next 4 years by incorporating more preventive maintenance treatments, along with traditional resurfacing activities.

Confidence Ratings

An annual performance report updates key information for each major asset class (Tables 7 and 8). The high-level description expresses the accuracy and reliability of the information, whether the data collection was ad hoc or repeated by trained personnel on a schedule, and the nature of the documentation, if any.

Bridges and pavements received optimal confidence ratings, for example, but signs received a moderate confidence rating. Skilled personnel have documented the processes for judging pavement, bridge, and sign conditions; however, sign condition was not entered consistently in the database. The data confidence levels helped build decision makers' trust and improved their understanding and application of the critical asset information.

Three-year trends for key performance indicators were published in the 2009 annual performance report, providing an overview of asset performance highlights, trends, and issues (Table 9).

Setting Priorities

Anticipating that the U.S. Congress would not renew federal forest receipts, in June 2008 the county convened a risk management team of county commis-

TABLE 7 Tillamook County Asset Information Confidence Level Definitions

	Confidence Level	Inventory Completeness	Condition Assessment Method and Frequency	Process and Documentation
1	No confidence	No inventory	No assessment method	No process
2	Low confidence	Partial	Estimates used to assess condition	Process not well documented
3	Moderate confidence	Inventory complete	Subjective process to estimate condition	Some documentation in place
4	High confidence	Inventory complete	Condition surveys conducted on a regular schedule by well-trained personnel	Well-documented process followed
5	Optimal confidence	Inventory complete	Condition survey on a regular schedule	Objective process followed; accuracy of data verified and well documented

sioners, road advisory committee members, other county department directors, and road department managers to set priorities. Meeting over six weeks, the team used the organizational assessment and road asset management plan to identify service priorities and the critical assets that would be needed.

The risk assessment identified the causes of asset or service failure, the likelihood of failure, and the impact on the community, the environment, and the economy. The review of the performance information, including the relative age, condition, and future performance of each asset group, traced out the challenges facing the county.

Participants interacted with a trained facilitator to display options and choices on a screen, to visualize the likelihood and consequence of risk. This collaboration developed a common understanding of the assets in the transportation network, the specific risks the county faced in managing the assets, and a unified approach to address the road funding crisis.

An important outcome was the identification of nonmandated road services that could be rescinded. For example, the county had assumed responsibility for nonstandard local access roads but now has transferred this back to the private land owners. The decisions about road priorities were communicated to the community.

The workshop included brainstorming for a risk contingency response plan; a detailed action plan was developed after the workshop (Table 10). A three-year improvement plan incorporated many of these decisions in reallocating resources to address extreme risks.

Photo courtesy of Patricia Bugas-Schramm

A risk management team was assembled in 2008 to consider Tillamook County's transportation assets, assess risks, and identify an approach to funding challenges.

The Case for Funding

Citizens who attended the risk assessment workshop commented that they had no idea that the choices were so severe and real. After the workshop, these citizens formed a group supporting a higher level of road services.

Tillamook County commissioners have targeted late 2010 or spring 2011 for a general obligation bond measure for local roads. In community meetings, information from the performance report is presented to summarize road funding, the cost of services, annual accomplishments, and key network performance indicators, as well as the choices the county faces. A graphical display helps the community participants to visualize road assets and services.

TABLE 8 Information Confidence for Sample Assets, Tillamook County

Asset Information	Confidence
Pavement	Optimal for the first 3 years and moderate in Years 4–10
Bridge	Optimal
Signs	Moderate: inventory and condition managed by trained staff through 2008; condition not entered in IRIS

IRIS = Integrated Road Information System.

TABLE 9 Performance Trends for Selected Assets, Tillamook County

Progress	Indicator	Comment
Good progress	Signs	99% of stop signs in good condition; nighttime visibility for all signs assessed annually
No trend	Guardrails	2007 inventory and condition assessment; 43% in poor condition
Changes are not favorable	Paved roads	Declining condition due to inadequate funds
	Gravel roads	Inadequate staff for regular maintenance
	Bridges	13 bridges in poor condition in 2009, up from 7 in 2008; OTIA funding ends in FY 2010

OTIA = Oregon Transportation Investment Act.

TABLE 10 Road Service Risk Rating for Selected Services, Tillamook County

Selected Service	Asset or Service Subprogram	Risk Rating
Roads	Arterial and collector paved roads	Extreme
Roads	Gravel roads—county maintained	High
Roads	Local access roads	High
Structures	Bridges	High
Traffic safety	Signs—regulatory (stop signs)	High
Traffic safety	Signs—other	Medium

Extreme = immediate action required; high = management attention required; medium = management responsibilities specified and risk controls reviewed; low = manage by routine procedures.

In December 2009, the Tillamook County Public Works director presented the summary of road performance to the Oregon Transportation Commission, which reallocated $900,000 from the state budget to address the county's critical road needs.

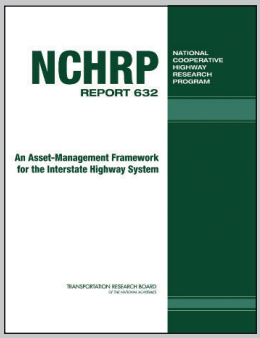
Continuous Improvement

In both North Carolina and Tillamook County, asset management provided agreed-on performance measures and reliable data that captured the current state of the physical assets and that identified needs. Asset management also built confidence in the decision-making capabilities of the organizations.

In North Carolina, DOH Operations has reduced the number of performance measures to about 30, after gaining a better understanding of the value of

Applying Asset Management to the Interstate Highway System

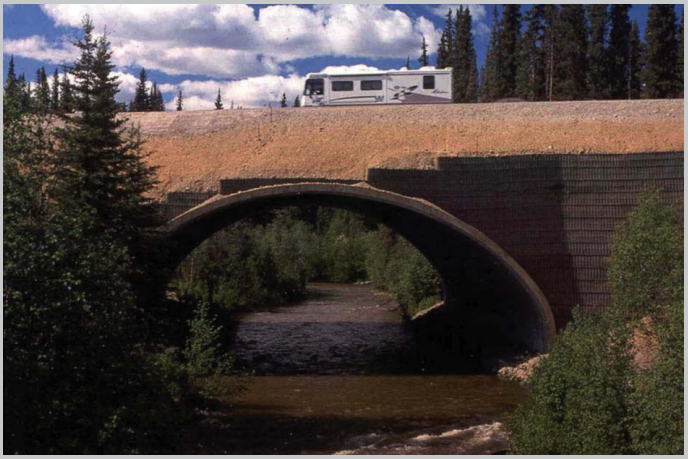
The Interstate Highway System (IHS) has had a profound effect in shaping the nation's trade, economy, travel, and development patterns. To ensure that the IHS's far-reaching road network continues to support global, national, regional, and local movement of people and goods, the National Cooperative Highway Research Program (NCHRP), under Project 20-74, has developed a practical framework for applying asset-management principles and practices to IHS investments. The project findings were published in 2009 as NCHRP Report 632, *An Asset-Management Framework for the Interstate Highway System*.



As the IHS ages and traffic increases, agency staff and stakeholders face a growing challenge: finding cost-effective investment strategies for managing a variety of highway assets by type, segment, corridor, and region—for the entire system. Asset management employs a set of guiding principles and best practices to allocate transportation resources. The framework considers the full range of potential investments, along with safety, operations, environmental management, corridor management, and delivery of projects and programs.

Asset management of the IHS demands a targeted approach, applying a consistent framework and performance expectations and leveraging agency-to-agency institutions and relationships. Although the IHS is a portion of the U.S. transportation network, it is extensive, with many influences on its operation. According to the NCHRP report, each IHS owner

Photo From TR Circular E-C 104



An effective framework for asset management can extend the service life of pavements, culverts, and other assets of the Interstate system.

measuring the right things. The performance measures and targets support what-if analyses with data from the maintenance management system and the pavement management system and are integral to the 5-year work program. Performance measures have been instrumental in the transformation of North Carolina DOT into a results-based organization.

In Tillamook County, information from the 2008 road asset plan created a sense of urgency. Further steps were taken to

- Develop a risk management plan (July 2008);
- Publish annual performance reports with a 3-year work plan including improvements in data quality, tools, and performance reporting (2008, 2009);
- Adopt the asset management policy of the County Board of Commissioners (July 2009); and
- Communicate road performance and challenges to the community, so that the desired level of road services and performance can be identified and funded (2010 and 2011).

Weather events, economic shifts, and expiring funds can focus a community's decision making in the short term. Long-term corporate culture, however, has changed in North Carolina and Tillamook County, as each agency has defined performance. Ongoing communication about service choices, policy, and linking performance reporting to organizational roles, responsibilities, and accountability will sustain these changes.

should periodically develop an Interstate asset management plan that summarizes asset conditions; establishes performance measures, considering available funds; and describes a plan for future investments. Once developed, this plan would support the agency's ongoing allocation of resources for its IHS network and would provide information to be shared among the agencies managing the network.

The NCHRP report suggests that an Interstate asset management plan focus on:

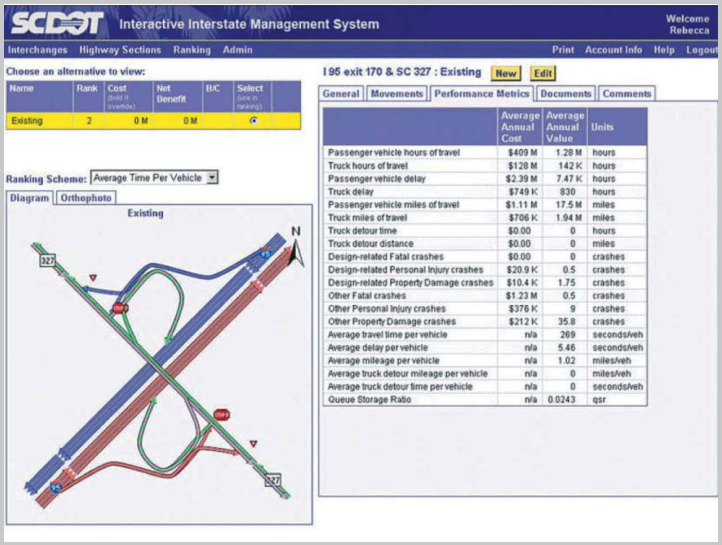


PHOTO: NCHRP REPORT 632

A screen from South Carolina Department of Transportation's interactive Interstate management system, showing a diagram of an interchange on I-95 and predicted performance measures.

- Incorporating system failure risk assessment into the asset management framework. Chapter 3 presents a recommended approach to risk management.
- Guidance for handling IHS assets—particularly assets other than pavements and bridges. Chapter 4 details available data and tools and provides directions for data collecting and analysis.
- A set of measures for discussing IHS performance with an agency, system users, and industry partners—regional and nationwide—as detailed in Chapter 5.

The report also provides guidance on implementing an asset management approach for the IHS, taking into account the basic motives for implementation, the focus area, previous approaches, and the internal and external stakeholders involved in the implementation. By taking advantage of best practices in asset management and risk management, highway system owners and operators can identify and combat the effects of deteriorating infrastructure, minimize costly system disruptions, and keep the national highway system running.

NCHRP Report 632, An Asset-Management Framework for the Interstate Highway System, *is available from the TRB online bookstore at http://books.trbbookstore.org/.*

Driving Asset Management Through Performance

Culture Change and Proven Results at the Missouri Department of Transportation

MARA K. CAMPBELL

The author is Director of Organizational Results, Missouri Department of Transportation, Jefferson City. She serves as TRB State Representative.

Ask a Missouri Department of Transportation (DOT) employee about asset management, and the first response may be a blank stare. Ask about performance management, and the answer invariably will include Missouri DOT's battle cry of "Better, faster, and cheaper!"

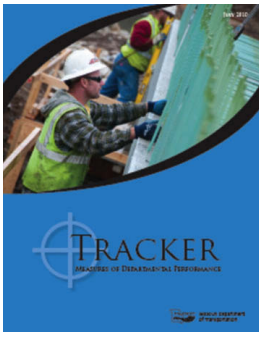
Missouri DOT doesn't use the term asset management as often as most state DOTs do, but under the umbrella of the performance management system, the agency continually addresses the expectation to improve in all areas defined by the principles of asset management. Missouri DOT's commonsense, results-driven approach aligns closely with the asset management standards of maximizing short- and long-term performance, minimizing cost, and improving customer satisfaction.

Asset management is integral to Missouri DOT's performance management system. The key is accountability—another term that Missouri DOT employees have come to understand and embrace in recent years. Accountability has become the norm for managers and front-line workers.

Results Tracker

Missouri DOT has achieved significant improvements in pavement and other assets by implementing a performance management approach throughout the organization. A profound culture change has occurred, with performance management incorporating asset management practices as part of the department's data-driven and results-focused approach.

Tracker, a quarterly publication of departmental performance measures, is a primary indicator of Missouri DOT's progress.[1] The public document is prominently displayed on the agency's website but has extensive internal use to ensure accountability. Tracker spells out the department's mission, values,



Tracker provides a snapshot of Missouri DOT's performance progress—both for department staff and for the public.

[1] www.modot.mo.gov/about/general_info/Tracker.htm.

Photo: Missouri DOT

The performance management system of the Missouri Department of Transportation (DOT) emphasizes accountability and results.

and priorities and is built on 18 tangible results that Missourians expect. More than 100 performance measures directly linked to tangible results are tracked to gauge performance in such areas as traffic flow, pavement and bridge conditions, safety, roadway visibility, customer service and response, innovations, project delivery, environmental impact, access to modal choices, wise use of funding, and economic development.

The performance results documented in Tracker are the focus of mandatory quarterly review meetings. All managers and departments explain their performance to executive leaders and their peers, compare and benchmark their performance with that of other DOTs and organizations, and present the actions taken to continue improvements.

Each division and district also has its own Tracker with metrics specifically related to its functional area; these in turn affect the results and measurements in the department Tracker. The work-level Trackers have played an important role in the culture change that has accepted the performance management model at all levels.

Through Tracker, Missouri DOT has established a set of clearly defined, expected results and performance for the condition of the highway system. Tracker closely links asset management and performance management. Missouri DOT's asset management system is effective because it is part of an organizationwide performance management system. Behind it is the mantra of "better, faster, and cheaper" that guides efforts to improve performance.

Change of Focus

The focus on performance and results is recent. Historically, Missouri DOT has had to do more with less, operating with one of the lowest state gas taxes in the nation; moreover, the federal revenue received per mile of the state highway system annually falls among the lowest 15 percent among the states. The low ranking in revenue per mile is partly the result of the large number of farm-to-market roads incorporated into the state system during the 1950s.

Missouri's state highway system is the seventh largest in the United States, with approximately 33,000 miles. Missouri DOT's 10,249 bridges and culverts also rank seventh in the nation; with 53 major river bridges, Missouri has more major river crossings than any other state.

During the mid-1980s, the department focused on customer satisfaction and new construction. The system underwent significant expansion, but the budgets for asset management and pavement maintenance did not grow comparably. The new construction was not always linked to costs or performance. Attempts to establish a performance management system mostly relied on after-the-fact reporting and were not widely used in planning or decision making.

Photo: Missouri DOT

The Jefferson City Bridge over the Missouri River is one of the state's 53 major river crossings.

The performance management system did not work for maintenance and condition of pavement and other asset conditions. Eventually, Missouri DOT scrapped its 15-year plan because of the difficulty in projecting costs and funding. The replacement 5-year plan focused on high-priority projects. The abandonment of the 15-year plan and its unfulfilled promises, however, eroded Missourians' trust in the department and brought intense scrutiny by elected officials and the media.

Missouri DOT needed a clear, overarching vision and strategies to balance expansion with asset management—a new way of doing business. Executive leadership would have to champion the change, shaping this new way of doing business and the form it should take.

Road Rallies

The changes started slowly in early 2000, with a series of road rallies to determine what was impor-

Photo: Missouri DOT

Customers surveyed in Missouri DOT's road rallies placed highest importance on traffic flow, signs and markings, and roadway condition.

Contrary to expectations, roadside mowing and litter pickup were not ranked as major priorities by road rally participants.

PHOTO: MISSOURI DOT

tant to customers and what their expectations were for road and bridge conditions. Participants included randomly selected citizens; local civic officials; representatives from regional and metropolitan planning organizations, chambers of commerce, and economic development agencies; and Missouri DOT employees.

Rally riders were driven around the state on different roads and bridges and were asked to grade road conditions according to pavement smoothness, lane and shoulder width, striping, signage, and other criteria. Missouri DOT staff previously had rated the roads according to engineering standards. The department could assess the system using the customer scores and could compare what customers found acceptable with the results from the engineering standards. These scores provided a baseline for Missouri DOT to measure success.

The results from the road rallies were used to develop performance measures. What Missouri DOT assumed was important to its customers differed from what the road rally feedback indicated were customer priorities—the physical condition of the roadway, the marking of intersections, traffic flow and congestion, the ease of getting on and off roadways, and bridge width and smoothness. In contrast, Missouri DOT staff had expected that the mowing and trimming of roadsides and the clearing of litter and debris would outrank these.

Distributing Funds

The novel idea of listening to customers led to other significant changes in how Missouri DOT operated and how it allocated resources. For example, the distribution of funds had been the subject of debate for more than a decade. Methods for allocating limited transportation dollars had changed with long-term project plans and with the politics of dividing funds between the urban and rural areas of the state.

In January 2003, the Missouri Highways and Transportation Commission adopted an objective method of distributing transportation funds to reflect the size and use of the system, as well as where people live and work. The new method went beyond the discussions of geography and allowed for allocations based on objective, transportation-related needs.

The fund distribution method also sought a balance between maintaining the already-built system and adding new capacity. The direction set by the capacity expansions of the 1980s had taken a toll on the statewide system—the condition of roads and bridges reflected the past emphasis on expansion. Taking better care of the system—also known as asset management—was overdue.

The 2003 funding distribution formula set aside a fixed amount of funds to take care of the system. Previous methods had similar set-asides, but the amounts were not enough to stop the decline in road conditions. The change allowed the department to stabilize the condition of the system and to begin making improvements.

Missouri DOT's fund distribution plan allocated resources based on an area's size and on its use of the transportation system—whether a rural or urban area.

PHOTO: MISSOURI DOT

Timely Champion

Earlier attempts to implement performance management principles at Missouri DOT did not succeed because commitment and support at the executive level were lacking. In September 2004, Missouri DOT found its champion—Pete Rahn was appointed director. Cabinet Secretary for the New Mexico State Highway and Transportation Department from 1995 to 2002, Rahn brought a charismatic ability to manage a large organization, to articulate a vision for success, to motivate people, and to stay focused. Rahn was an advocate of performance management—Missouri DOT had found the right leader at the right time.

An adage asserts, "What gets measured gets done." Rahn's purposely simple yet effective take on performance management guided Missouri DOT's

successful progress during his 5 years as director.

Early on, Rahn asserted that a good performance management process would allow Missouri DOT to maximize its resources and earn trust and accountability from the public, legislators, and the media. "It will allow us to show a logical, systematic approach to managing taxpayers' money, and most importantly, it will show them the tangible results provided by their investment in us," he noted.

When managers responded that the data to support performance measures—whether from customer feedback or asset management—were not reliable, Rahn reassured them that the data would improve with use. "We have to start somewhere; the fastest way to improve your data and measures is to start using them," he observed. He exhorted the managers to avoid frustration over imperfect measures, because the measures would evolve, with the ineffective and inappropriate ones discarded in favor of better ones.

Implementation Tactics

Rahn demanded results and accountability from employees and contractors. A cheerleader for innovation, he encouraged and endorsed new approaches such as practical design and design–build contracts, but tempered with a responsibility for outcomes. His intuitive methods for challenging his team to perform beyond expectations created an environment of success and a nationally recognized performance management model.

In implementing Missouri DOT's performance management system, Rahn applied four tactics:

- *Empowering*—Instead of top-down, imposed measures, he allowed middle managers who produce the results to develop their own measures.
- *Driving innovation*—Rahn and his team jointly developed a new set of value statements. One of them advises, "Encourage risk and accept failure, because we believe in getting better."
- *Demanding results*—Tangible results are Missouri DOT's bottom line—or in business terms, its profit. There is no alternative—results must be achieved.
- *Holding staff accountable*—Staff who consistently failed to produce results and who performed poorly were seen as tarnishing the trust that others were building with customers.

Sample Results

Missouri DOT is delivering results-driven programs and projects on time and on budget—often ahead of deadline and below budget. A few examples are highlighted below.

Photo: Missouri DOT

Former Missouri Transportation Director Pete Rahn celebrates the completion of the Smooth Roads Initiative in 2007.

Smooth Roads Initiative

In 2006, Missouri DOT completed the Smooth Roads Initiative (SRI) 1 year ahead of the schedule set by Governor Matt Blunt. The SRI delivered smoother pavement, brighter striping, rumble strips, and other safety improvements to 2,200 miles of the state's busiest highways. A survey of Missouri motorists after the completion of the SRI indicated that 79 percent believed the improvements were a good investment of taxpayer dollars, and 80 percent thought that Missouri DOT should continue with similar improvements.

Better Roads, Brighter Future

To continue the progress under the SRI to keep the roadway system in good condition, the Better Roads, Brighter Future (BRBF) initiative began in 2006. The goal of the BRBF was to have 85 percent of Missouri's major roads in good condition by the end of 2011. Each of the department's districts developed a plan to improve major routes by the 2011 deadline. By December 2009, the percentage of major roads in

Missouri DOT's Better Roads, Brighter Future initiative led to an increase in the percentage of major roads in good condition—from 47 percent in 2004 to 86 percent in 2009.

Photo: Missouri DOT

good condition rose to 86 percent, a considerable increase from 2004, when only 47 percent of major roads were in good condition.

The original goal was surpassed 2 years ahead of schedule. The percentage of vehicle miles traveled in Missouri on major highways in good condition has jumped from 58 percent in 2004 to 86 percent in 2009. These two asset management initiatives, bolstered by a robust performance management process, have produced results that have helped to rebuild the public's trust in Missouri DOT.

Practical Design

In 2004, the department began implementing practical design, which challenges project engineers to use nontraditional design methods to develop efficient solutions for project needs. Practical design places a premium on systemwide improvements; its premise is that building a series of good projects will result in a great system. The approach maximizes the value of a project by ensuring that it is the correct solution—or the "right sizing"—for its surroundings.

Practical design works to achieve the purpose and need of a project so that funds are saved instead of being spent on overdesigned items. The savings in turn allow other projects to be built and more of the system to be improved. In layman's terms, "Why drive the Cadillac when the Chevy will get you where you're going?"

Some had criticized practical design for cutting corners, but the approach adheres to two fundamental ground rules:

- Do not compromise safety, and
- Collaborate on the solution.

Practical design produced savings of $400 million for the projects in Missouri DOT's 2005–2009 Statewide Transportation Improvement Program. The savings were invested in additional transportation projects. Since then, Missouri DOT has incorporated practical design into all projects from the conceptual stages; it has become part of the agency's way of doing business.

Alternate Bid Paving Projects

Working with the asphalt and concrete industries, Missouri DOT introduced alternate bidding—contractors can propose asphalt or concrete in bidding on construction projects. Traditionally, Missouri DOT had specified the materials. By allowing bidders to determine which type of pavement they could deliver for the best price while meeting the performance requirements, Missouri DOT has gained a 25 percent increase in bidders and a cost savings of between 9 and 10 percent. Since late 2003, alternate bidding of pavements has saved the state approximately $20 million.

2009 Report Card

In 2009, ETC Institute completed an annual, comprehensive, statewide customer satisfaction survey to evaluate Missouri DOT's performance and to identify the transportation services and improvements most important to Missourians. Results were as follows:

- Customer satisfaction with Missouri DOT reached an all-time high of 85 percent, a 7 percent increase from 2008 and a dramatic increase of 17 percent from 2003.
- The percentage of customers who are "very satisfied" is 24 percent, compared with 5 percent in 2003.
- The percentage of customers who view Missouri DOT as the state's transportation expert is 91 percent, up 6 percent from 2008.
- Eighty-nine percent trust Missouri DOT to keep its commitments.

A Way of Doing Business

Organizational change elicits many responses—skepticism, rebellion, predictions of failure—in addition to the perceived impact on employees. In the 5 years since Missouri DOT began its performance management journey, the doubters have become believers. At all levels, performance management is no longer considered extra work, but the way of doing business. Performance management ties

Photo: Missouri DOT

The use of practical design in Missouri DOT's I-64–I-70 interchange project produced a cost savings of more than $37 million. The method has saved Missouri DOT $400 million from 2005 to 2009.

together programs and projects across the agency and has created a momentum for producing results better, faster, and cheaper.

Performance management and asset management work together at Missouri DOT; asset managers receive the support they need to make improvements. At Missouri DOT, asset management is the performance management system for highways.

As the steward of the state's transportation assets, Missouri DOT is responsible for providing the best value to Missourians for every dollar spent. A mindset of continuous improvement to achieve expected results permeates the department as managers identify new ways to gain cost and time savings. Frontline employees have contributed to the development of process improvements in administration and business services, reduced levels of fleet and equipment, and in some instances, have reduced human resources.

Savings and Investments

The goal is to save money to invest in roads, for example:

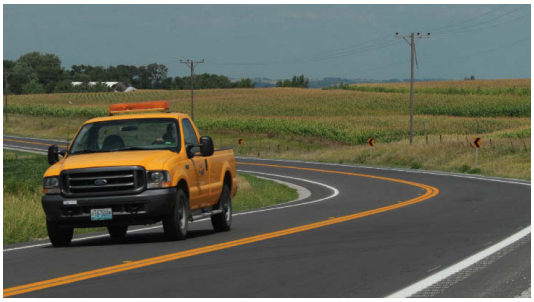
- For projects completed in the 5-year period from 2005 to 2009, final costs of $6.321 billion were within 1.02 percent of programmed costs, or $64.8 million less than the programmed cost of $6.385 billion.
- Vehicle fleet size decreased by almost 100 units in 2009 and has decreased by more than 250 units in the past 2 years.
- From 2008 to 2009, fuel consumption decreased by 6.8 percent, conserving approximately 600,000 gallons of fuel.
- The percentage of vendor invoices paid on time in 2009 was 96 percent compared with 82 percent in 2006, gaining on-time discounts and better bids from vendors.
- Process improvements, a streamlined bidding process, and innovative contracts have lowered project costs with more bids per job and with contractors offering innovative ideas and construction techniques.
- Best practices have been identified and implemented for mowing, to save time and reduce the need for expensive equipment.

Effective Tool

Asset management incorporated into an organizational performance management system is an effective management tool at Missouri DOT. The success of the business model is well documented through significantly improved performance.

The continued success of the agency depends on a sound performance management system that encompasses all aspects of operating, maintaining, and expanding the transportation assets, with the flexibility to adapt to customer needs and an uncertain funding environment. Those at Missouri DOT who vehemently opposed performance management 5 years ago would now be the first to defend it—and to fight to save it.

Photo: Missouri DOT



A Missouri DOT vehicle travels along a rural road. The department has decreased its fleet size significantly in the past 2 years.

Developing Asset Management Programs for Airports

MARCI A. GREENBERGER

Like other transportation organizations, airports have limited resources. Airport managers therefore are looking for efficient and effective ways to manage airport assets and infrastructure. Some airports already gather and analyze data on available assets, using technologies developed for specific purposes, such as pavement management or computer maintenance management systems. These systems usually are not available organizationwide and are not managed and maintained for such uses. Centralizing the data for all assets, however, can enhance the ability of airport management to make effective financial and strategic decisions. Further research is needed to provide airports with an approach to asset and infrastructure management that includes physical, financial, and human resources information.

TRB's Airport Cooperative Research Program (ACRP) is addressing this research need through Project 01-16, Asset and Infrastructure Management for Airports. The objective is to develop

- A primer for executive-level decision makers at airports of all sizes, to provide an overview of an asset and infrastructure management program, presenting the components as well as the benefits and costs, based on experience; and
- A guidebook on developing and implementing an asset and infrastructure management program that (*a*) captures best management practices and (*b*) assists in incorporating the programs into airports of all sizes.

The research project is under way through GHD Consulting, Inc., with completion scheduled for winter 2012. For more information, visit the ACRP website, www.trb.org/acrp.

The author is Senior Program Officer, Airport Cooperative Research Program, TRB.

Local Communities Adopting Asset Management

Initiatives, Models, and Results in Michigan and Wisconsin

STEVE WARREN

The author is Deputy Director, Kent County Road Commission, Grand Rapids, Michigan.

Local communities are starting to get it, to understand the benefit of taking an asset management approach to maintain their infrastructure systems. Large and small local agencies are embracing a better way of managing their transportation networks—their paved roads in particular. These agencies are turning away from the past practice of addressing the "worst first," and adopting instead a strategy of "preserve first."

The benefits of asset management are well documented and include efficient use of financial resources, increased reliance on a broader mix of fixes, and a system condition that improves over time. These are significant outcomes, but the communities that benefit the most go beyond the technical aspects of pavement management and apply asset management as an inclusive process, inviting their constituents to participate.

These agencies are involving a variety of community stakeholders in a decision-making process founded on the principles of asset management. In Michigan and Wisconsin, for example, statewide initiatives have encouraged local agencies to adopt an asset management approach to paved road conditions.

A chip seal operation undertaken by the Kent County Road Commission in Michigan. Encouraged by statewide initiatives, local communities have realized the benefits of an asset management approach.

Photo courtesy of Steve Warren

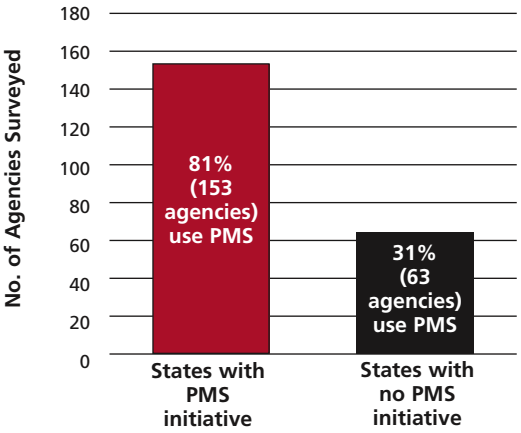


FIGURE 1 Local agencies using pavement management systems.

Guiding Change

The times demand a better approach. People need to understand a concept and be convinced of its benefits before they are willing to change. Local transportation agencies in Michigan and Wisconsin are gaining greater understanding of asset management principles and of the long-term benefits of pavement preservation strategies.

Convincing technical staff about the benefits of pavement preservation is different from persuading elected and appointed officials, major stakeholders, and the public to embrace the practice. For many, improving roads in apparently good condition is counterintuitive if the worst roads are going untreated. Education and training of local officials, therefore, is a major focus of the statewide asset management programs in Michigan and Wisconsin.

In a survey about the use of pavement management systems (PMS) at the local agency level in the Midwest—the states of Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin—de Melo e Silva et al. found that states with statewide pavement management initiatives had a significantly higher percentage of local agencies using PMS (Figure 1). Of the 189 agencies responding from Michigan and Wis-

consin—both of which have statewide pavement management initiatives—81 percent claimed to use a PMS for their systems. Of the 204 agencies in states with no such initiatives, only 31 percent claimed to use a PMS (*1*). Statewide initiatives therefore have a positive effect on pavement preservation efforts at the local level.

Statewide Coordination

In 2004, the Michigan Legislature created the Transportation Asset Management Council (TAMC) to implement asset management statewide and to advise the State Transportation Commission on a strategy. The legislature recognized that road ownership in the state was large and diverse, involving three levels of government: state, county, and city or village. The Michigan Department of Transportation (DOT) is the largest road agency within TAMC, with 9,700 miles to maintain; 617 counties, cities, and villages collectively have jurisdiction over the remaining 110,000 miles, or 92 percent of the public road system.

To implement asset management statewide, the legislature wanted all three levels represented on the council and requested other major governmental stakeholders to participate. TAMC consists of representatives from the County Road Association, the Municipal League, Michigan DOT, the Association of Regions, the Transportation Planners Association, the Township Association, and the Association of Counties.

Strategic Initiatives

Since 2004, TAMC has expanded the practice of asset management by focusing on four strategic initiatives (*2*):

- Surveying and reporting the condition of roads and bridges,
- Assessing completed and planned investments,
- Supporting the development of asset management tools and procedures, and
- Providing education and training on the benefits of developing road improvement programs through the use of asset management principles and procedures.

Photo courtesy of Terry McNinch, Michigan LTAP

A driver and passenger log data in a Pavement Surface Evaluation and Rating (PASER) survey. Road surveying is one of TAMC's four strategic initiatives.

Photo courtesy of Steve Warren

Michigan's Transportation Asset Management Council (TAMC) brings together representatives from all levels of government—state, county, and local jurisdictions.

According to the council, successful implementation of a statewide asset management strategy depends on the extent of its adoption at the local level. Education and training therefore are essential for agency staff and for the nontechnical decision makers serving on boards and councils. One of the fundamental elements of the council's education and training program is the *Asset Management Guide for Local Agencies in Michigan,* which contains detailed descriptions of condition assessment, pavement preservation techniques, and trade-off analysis to develop a multiyear improvement program, along with background information on TAMC.

Elements of Training

The council sponsors education and training sessions annually, coordinated through the Michigan Local Technical Assistance Program (LTAP). The major elements include the following:

- *Asset Management Workshop.* A daylong session covers the principles of asset management and their rationale and presents tools for agency implementation. The training provides step-by-step instructions for starting up within a local agency. Although targeted to technical staff, the training is also appropriate for elected officials.
- *Annual Asset Management Conference.* The Transportation Asset Management Conference was launched in 2006, and two annual conferences were conducted in 2008 and 2009, one each in Michigan's Upper and Lower Peninsulas. The full-day programs inform attendees about the council's activities, focusing on the results of the annual statewide condition assessment of roads and bridges. Featured each year are presentations from local agencies about their suc-

Photo: Michigan LTAP

The Michigan Local Technical Assistance Program, sponsored by TAMC, hosts transportation asset management training sessions for local officials, such as this one in Kalamazoo.

cess in implementing asset management. In 2009, TAMC introduced an awards program to recognize outstanding achievement by organizations and individuals in implementing the core principles of asset management.

◆ *Introduction of Asset Management for Local Officials.* Involving local elected and appointed officials in asset management is a priority for TAMC. The council sponsors a half-day training course, Introduction of Asset Management for Local Officials, for community decision makers responsible for transportation programs and investments. Attendees learn about the principles of asset management, the basics of road construction, the causes of deterioration, condition rating, and the process of developing a multiyear improvement program. The session emphasizes the long-term benefits that can be achieved through investments in pavement preservation.

◆ *PASER Training.* Pavement condition rating is essential in implementing asset management statewide in Michigan. The Pavement Surface Evaluation and Rating (PASER), developed in Wisconsin, employs a 1 to 10 (poor to good) scale to assess pavement surface deterioration. TAMC uses PASER to evaluate pavement conditions statewide, and many other road agencies use it in their asset management programs. The PASER training covers the process of recording and submitting condition ratings to TAMC and provides consistent direction to all agencies in the use of the methodology for their federal-aid routes. This facilitates the assembly and analysis of information on the condition of the entire system for the State Transportation Commission and the legislature. Local agency participants gain the skills to assess pavement conditions on their non-federal-aid roads.

Photo courtesy of Terry McNinch, Michigan LTAP

Laptop data collector and other PASER tools allow road agencies to record and submit pavement ratings and data to TAMC.

In addition to the education and training sessions sponsored by TAMC, Michigan LTAP conducts training in the use of ROADSOFT™, a computer-based program that helps agencies predict system conditions under various improvement and investment scenarios. This capability is critical to the asset management process. ROADSOFT applies the PASER data to develop pavement deterioration curves. The program is available to Michigan transportation agencies at no cost, and more than 250 agencies are using it. TAMC conducts its statewide strategic analysis with ROADSOFT (*2*).

Local Agencies Forum

Wisconsin also has a statewide initiative to encourage the implementation of asset management and pavement preservation at the local government level. As in Michigan, most of the road miles in Wisconsin are under the jurisdiction of local agencies. Nearly 2,000 counties, cities, villages, and towns maintain approximately 90 percent of the state's 114,000-mile public road network (*3*).

In 1994, the Secretary of Wisconsin DOT established the Local Roads and Streets Council (LRSC) to provide advice on local transportation issues and to serve as a forum for local agencies to discuss issues. LRSC includes representatives from the four local agency transportation groups: the Counties Association, the League of Municipalities, the Towns Association, and the Alliance of Cities.

Wisconsin DOT and LRSC cooperatively developed the Wisconsin Information Systems for Local Roads (WISLR) to receive, store, and disseminate local road inventory and condition data. WISLR assists local agencies in evaluating system needs and in developing cost-effective pavement maintenance and improvement programs.

Wisconsin Workshops

Transportation officials in Wisconsin also rely on education and training to advance the practice of asset management at the local level. Based at the University of Wisconsin–Madison, the Wisconsin Transportation Information Center—the state's LTAP—provides workshops on road condition rating using the PASER

methodology and on implementing pavement management using the WISLR program (*4*).

Wisconsin DOT maintains a telephone hotline and e-mail support for local officials who need assistance with the program. The WISLR program has been demonstrated at local government association meetings to increase understanding of the concepts and the tools of asset management.

Community Involvement

Asset management programs and improved pavement preservation strategies are producing significant benefits for local communities. Several agencies in Michigan and Wisconsin are using asset management to educate stakeholders about the basics of pavement deterioration and to explain the logic and sense of a mix-of-fixes preservation strategy.

The community involvement has broadened awareness of system conditions and trends, making it easier for agencies to explain the challenges. This in turn builds community consensus on a plan of action and, in some instances, has gained increases in funds to implement planned improvements. In general, local transportation agencies are finding that an open and inclusive asset management process leads to greater transparency and accountability for their actions, increasing community trust and acceptance.

Opportunity to Educate

In Michigan, the Emmet County Road Commission works with its 16 township governments to maintain a local, non-federal-aid network of 589 miles of predominantly rural roads. The condition of this system has declined gradually, as confirmed in pavement condition data collected since 1994. During that time, the Road Commission had allocated dollars from the townships for improvements according to the traditional worst-first strategy.

After participating in training sessions on asset management sponsored by TAMC, Brian Gutowski, the Road Commission's engineer–manager, realized that the folks back home needed to hear more about pavement preservation and the mix-of-fixes approach to maintaining roads. Gutowski asked Michigan LTAP to customize a training session for elected officials on the basics of roadway deterioration and the wisdom of making timely improvements to keep good roads in good condition.

The township officials took the information and set forth a plan of action. Chairman of the Emmet County Road Commission Frank Zulski, Jr., has observed, "Training local officials about asset management was instrumental in getting them on board with the program." During the election of 2004, each township passed a property tax levy to implement pavement preservation in its area. Today, Gutowski works with township officials to review their pavement ratings and reach consensus on where best to invest dedicated preservation dollars.

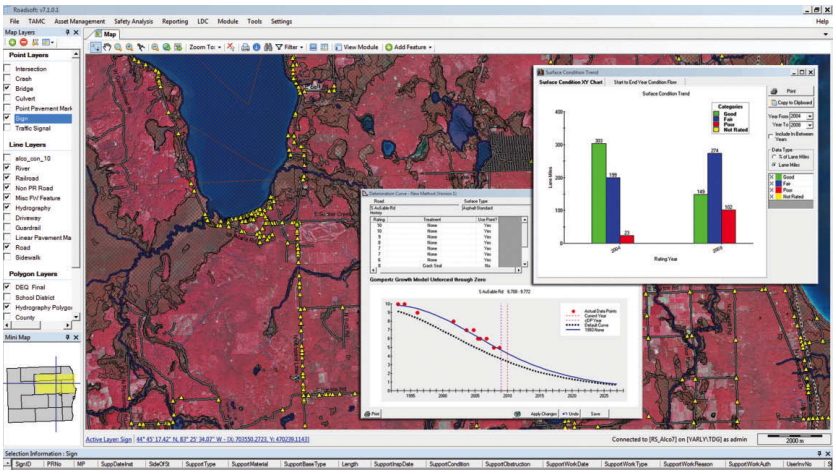


PHOTO COURTESY OF TERRY MCNINCH, MICHIGAN LTAP

ROADSOFT analyzes road data, collected with PASER, to predict system conditions under various scenarios.

Raising Awareness

Agreement among agency staff and board members, however, may not be enough to change from worst-first to an approach focused on pavement preservation. Often the understanding and consensus of the broader community is necessary for success. The staff and board of the Roscommon County Road Commission (RCRC) in North Central Michigan, for example, recognized the need to emphasize systemwide pavement preservation—but they also realized that to be successful, they needed to reach out to stakeholder groups around the county. These people have a vested interest in the condition of the road system and could influence the level of funding.

RCRC organized a local Asset Management Advisory Board with representatives from area schools, transit, the economic development authority, the chamber of commerce, the county commission, the merchant association, the township, the city, and Michigan DOT. RCRC staff and the advisory board members received training in the fundamentals of asset management from Michigan LTAP. With that understanding and the results of pavement condition ratings, RCRC and the advisory board developed consensus on several pavement condition goals and developed a plan to achieve those goals for the county, as well as for individual townships.

"Asset management helped the community understand the challenges facing the Road Commission and why preserving existing pavements with a mix-of-fixes approach makes sense," notes RCRC Chairperson Kimberly Akin. "It really got people involved."

Photo: Wisconsin DOT

Joe Nestler, Wisconsin DOT, delivers a presentation on Wisconsin Information Systems for Local Roads (WISLR) analysis tools to the Local Roads and Streets Council in Wisconsin Rapids. Demonstrations have enhanced local governments' understanding of asset management.

Building Consensus

The City of Ferndale in Michigan has demonstrated that building community consensus generates positive results. In 1992, the suburban Detroit community of 20,000 failed to pass a $20 million bond proposal to improve its 75-mile network of streets and aging water and sewer infrastructure. Byron Photiades, Director of Ferndale's Department of Public Works (DPW), recommended that the city council form a citizen advisory committee with representatives from each of the city's voting precincts to investigate the issues and to make recommendations for proceeding.

After a year-and-a-half study, the citizen group—known as MAIN, for Maintain our Aging Infrastructure Now—recommended a package of three bond proposals totaling $45 million to rebuild the city's water, sewers, and roads. According to Ferndale Mayor Robert Porter, "People became convinced, and then they convinced the political leaders."

With a stronger base of support, city staff made several presentations around the community about the need, benefit, and effect of the new proposal. In 1995, the citizens of Ferndale voted in favor of the more robust proposal.

Photiades points to the value of building citizen support: "Nothing that's administratively driven is very successful—you need grassroots support." Since 1995, the city has invested $58 million to upgrade water and sewer facilities and has repaved every street in the city. The citizen advisory group remains active, to ensure that the upgraded facilities are properly maintained.

Photo courtesy of Steve Warren

A newly preserved section of pavement in Emmet County, Michigan. The Emmet County Road Commission lobbied Michigan LTAP for customized asset management training and adopted a "preserve first" approach to its roads.

Transparency and Accountability

Perhaps the greatest benefit of an open and inclusive asset management process is the increased transparency and accountability. In the City of Oconomowoc, a small Wisconsin community on the I-94 corridor between Milwaukee and Madison, local officials, stakeholders, and the community at large have come to understand and trust the decisions the road agency is making to manage roads and bridges appropriately and to invest tax dollars wisely.

In 2005, an analysis of pavement rating data revealed that Oconomowoc's allocation of $100,000 annually for road improvements was inadequate to improve and preserve the condition of its 73-mile street network. Aided by the WISLR program, the city's staff and consultant demonstrated alternative future investment scenarios to improve conditions, making presentations at open public forums, in interviews with the media, and on field trips with the city council to educate people about the situation and the choices of solutions. The mayor and city council members soon approved a tenfold increase in the annual budget appropriation for street preservation.

Analysis also demonstrated that additional investments were needed to address the backlog of roads awaiting more costly structural improvements and reconstruction. The city council understood and trusted the analysis and approved two $5 million bond issues to complete the improvements. According to DPW Director Mark Frye, "The mayor and city council wanted to give us the dollars we needed to improve the roads—we just needed to give them the reasons why."

Local and Statewide Benefits

Local transportation agencies are realizing the benefits of asset management, especially as a means of educating and involving constituents in the decision-making process. Asset management is helping agencies provide answers to some fundamental questions about road and bridge networks—for example, Are conditions getting better or worse? What is the

Photo courtesy of Steve Warren

The Roscommon County Road Commission's Asset Management Advisory Board, made up of stakeholders from across the county, developed pavement condition goals and a plan to achieve them.

vision for the future? What is the plan to achieve that vision? Is progress being made?

People within these communities are paying attention to—and gaining greater awareness of—system conditions and trends. Agencies in turn are finding it easier to demonstrate alternatives to working on the worst parts of the system first, by building consensus on the cost-effectiveness of pavement preservation. In this way, local agencies are achieving a greater level of transparency and accountability in their community. In several instances, agencies have gained additional, needed financial resources to implement their plans.

Statewide asset management initiatives in Michigan and Wisconsin are demonstrating success. Local agencies are establishing their own asset management programs through a variety of education and training opportunities; receiving technical assistance, including the collection and storage of condition data; and making use of available analysis tools to develop improvement plans that fit local needs and desires.

Programs like ROADSOFT and WISLR provide local agencies with the ability to make projections and to analyze the consequences of various improvement and investment options. These are powerful tools for explaining to local officials, stakeholders, and the general public what is happening to the transportation system and for convincing them that they can influence the future.

Moving to a National Scale

Experience with statewide initiatives in Michigan and Wisconsin could prove useful in considering asset management on a national scale. Most of the transportation assets around the country are under local jurisdiction. Approximately 75 percent—or 3.0 million miles—of the national street and highway network are under the jurisdiction of 38,000 local agencies and tribes (5). To realize the benefits of asset management on a national scale, implementation at the local agency level is essential.

References

1. de Melo e Silva, F., T. McNinch, and J. Dong. *Meaningful Use of Collected Local Roads Data and Information*. Midwest Regional University Transportation Center, University of Wisconsin, Madison, 2008, pp. 2–5. http://www.mrutc.org/research/0605/06-05_FR.pdf.
2. *Asset Management Guide for Local Agencies in Michigan*. December 2007. http://www.michigan.gov/documents/mdot/AMC_MichiganDOT_Guide_Local_Agencies_180204_7.pdf.
3. Wittwer, E. *Wisconsin Information Systems for Local Roads: A Partnership to Improve the Management of Roads Under the Jurisdiction of Local Governments*. University of Wisconsin, Madison.
4. WISLR in Action. *Crossroads*, Summer 2009, p. 3. http://trust.dot.state.wi.us/wislr/.
5. Sanders, D., and D. Shea. LTAP/TTAP: 25 Years of Service. *Public Roads*, November–December, 2008, p. 8. http://www.ltapt2.org/downloads/publicRoads.pdf.

Visualization of Transportation Assets with Geobrowsers

Cost-Effective Tools for Exploration, Interaction, and Decision Making

M. T. DARTER, T. A. LASKY, AND B. RAVANI

Darter is Research Software Engineer, Lasky is Research Engineer, and Ravani is Professor, Advanced Highway Maintenance and Construction Technology Research Center, Department of Mechanical and Aeronautical Engineering, University of California–Davis.

According to one definition, visualization is a process that transforms data into images for interpretation. For transportation asset management, the focus is on geovisualization—that is, geographic visualization or cartographic visualization—"a field of research and practice that develops visual methods and tools to support a wide array of geospatial data applications" (*1*). Geovisualization emphasizes exploration, interaction, and decision making, which are appropriate for asset management (Figure 1).

Visualization is part of the asset management process and a desired endpoint. It can increase the effectiveness of the process by bringing more people together to solve problems and by connecting abstract field data and analysis with direct, practical knowledge. Effective visualization leverages knowledge in a way that would be difficult by any other means; it increases the effectiveness of decision making, communication, and planning.

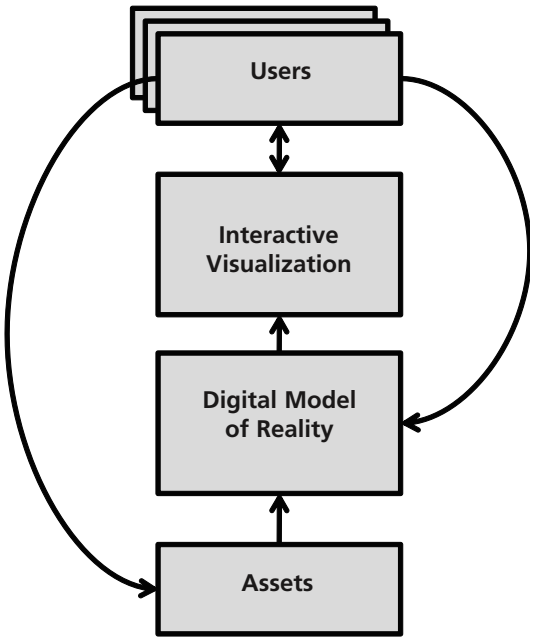
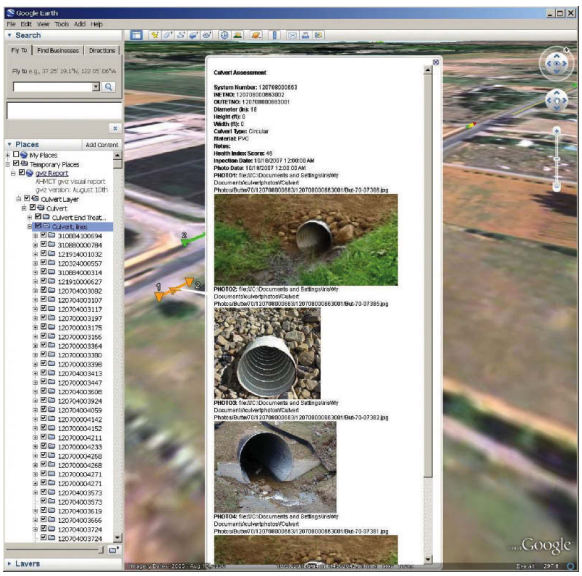


FIGURE 1 Interactive visualization process.



Geovisualization can help forecast changes in transportation assets by highlighting the relationship between the assets and the physical world. The screen displays the asset attributes and inspection photographs from a culvert assessment.

In its simplest form, visualization uses images to represent data and geometric forms. Taking the process further, it embeds visual representations of assets and their properties within a virtual world. Asset management applying visualization appeals to users' innate abilities to reason and think visually. In transportation applications, visualization is effective at showing the relationships between assets and the physical world and at depicting past and future changes. The screen capture on page 29 shows surveyed culverts and pavement sections projected onto terrain; in generated visualizations, line and area colors indicate condition.[1]

[1] Photographs and figures in this article are available in color at http://onlinepubs.trb.org/onlinepubs/trnews/trnews270.pdf.

Surveying the Benefits

Benefits for such applications may include the following:

- Facilitating the detection of errors in tabular data that otherwise would be difficult to find—such as incorrect geographic positions, attributes, and analysis results;
- Unifying the representation of diverse assets across functional areas into a single model that includes terrain and possibly buildings;
- Tracking assets with real-time data from field sensors—for example, vehicle locations with the Global Positioning System (GPS); congestion maps from vehicle detector stations; travel time estimates; lane closure information; transit vehicle locations; road weather management from road weather information system stations; or bridge surface conditions;
- Discovering relationships between spatial features;
- Improving maintenance planning and coordination through visual reports;
- Improving planning by facilitating an evaluation of the consequences of failure—for example, the proximity of assets to steep terrain, congestion hotspots, or bridges; and
- Communicating current and proposed plans to management and providing for discussion among team members with diverse backgrounds and interests.

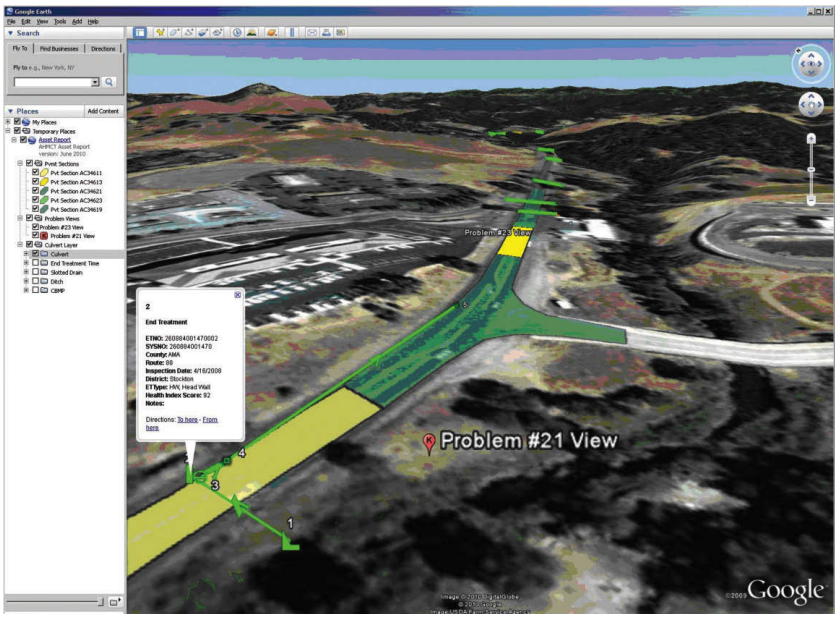
Geobrowsers

Traditionally, asset visualization has required the purchase of expensive software licenses and an investment in substantial user training. New options have increased the ease of use, the ability to connect several systems, and the cost-effectiveness. Some examples include geobrowsers such as Google Earth, Bing Maps, ArcGIS Explorer, and World Wind.[2] Geobrowsers use free or low-cost software to enable asset visualization and improve the ease of use. The capabilities for commodity visualization—visualization that relies on easily available and affordable hardware—are evolving rapidly.

The use of geobrowsers for transportation visualization in general, and for asset management in particular, is a recent development. Geobrowsers use advances in web infrastructure and standards, networked mapping, the public availability of GPS, and developments in geographic information systems (GIS).

Geobrowsers apply the same architecture as the World Wide Web, which has adopted open standards such as HTTP (hypertext transfer protocol) and HTML (hypertext markup language), web servers, and web browsers (Figure 2, page 30). Geobrowsers similarly use open standards such as HTTP and KML (keyhole markup language), servers, and geobrowsers.

The open standards, a web-like architecture, and a low-cost or free browser client have enabled powerful commodity visualization. Geobrowsers can link multiple sources of information in the same way that a web browser links multiple web servers on a single web page.



Culverts and pavement sections are projected in a Google Earth geobrowser.

Asset Visualization

A geobrowser can be considered a commodity version of a GIS viewer. Unlike a typical GIS, however, a geobrowser does not store or analyze spatial information but focuses on

1. Rendering spatial information provided by KML servers,
2. Providing a fast and intuitive interface, and
3. Providing limited accuracy.

The attributes of assets can be displayed within balloons, with custom icons, and with specific colors. Independent imagery can be overlaid to display other assets. This is useful when a higher- resolution image is needed for a specific area.

Building 3-D models for embedding within the geobrowser is another capability still being explored for asset visualization (see screen capture, page 30).

Advances and Advantages

Geobrowsers have opened new opportunities, bene-

An undermined shoulder on an Oregon state highway. Visualization applications can assist in evaluating the location of assets near steep terrain.

Photo: Oregon Department of Transportation

[2] All products noted in this article are registered, copyrighted, or trademarked by their respective owners. These marks are omitted throughout for conciseness.

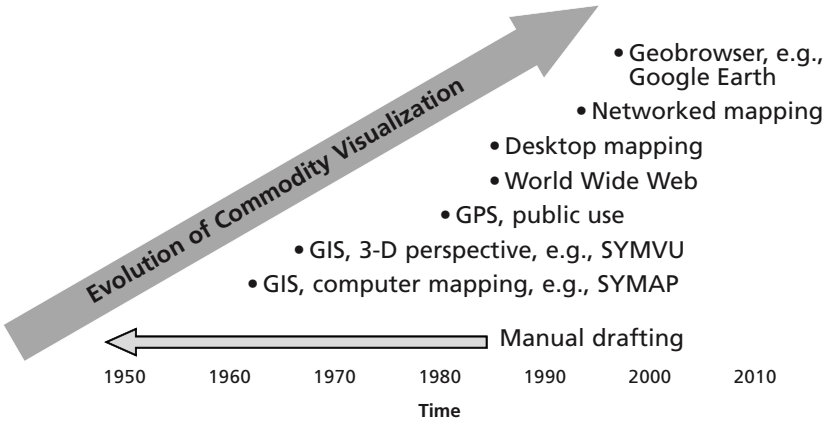


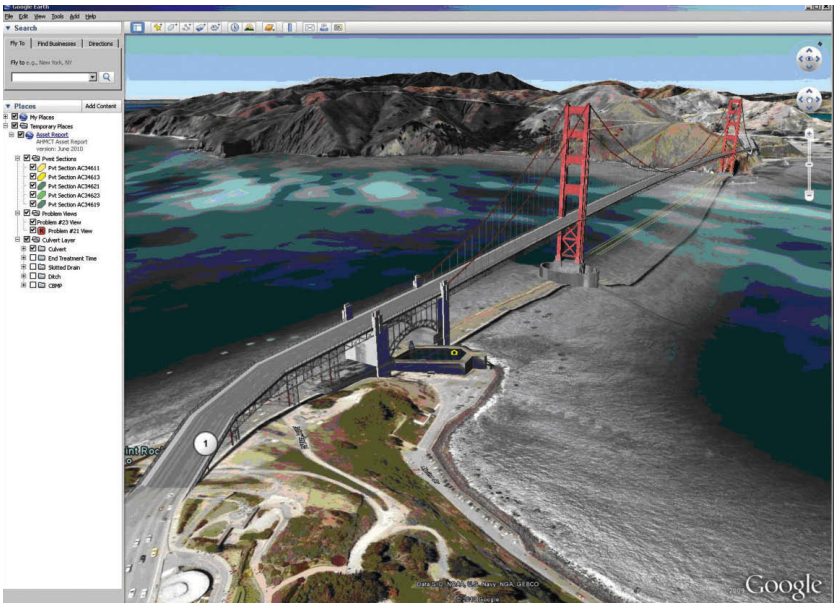
FIGURE 2 Evolution of visualization.

fits, and challenges for asset visualization. The tools are relatively new, and the capabilities are evolving rapidly. Because geobrowsers use the same architecture as the web, many visualization benefits parallel those of the web.

Geobrowsers provide visualization capabilities that are easy to use and that require little training, if any—this differs from the traditional GIS approach. The geobrowser focuses on presenting visual information without adding the complexity of the user interface associated with feature editing and analysis. A rough analogy would be that geobrowsers are more like web browsers, and traditional GIS tools are more like word processors.

The ability to zoom, pan, tilt, fly to other positions, click spatial features, and use hierarchical folders is intuitive, draws on computer skills, and encourages exploration. The simple focus on presenting visual information democratizes the access to—and the understanding of—visual information.

Technology to build embedded 3-D models in geobrowsers is being explored as a visualization technique.



The intuitive interface enables the use of visualization by transportation staff with diverse professional backgrounds, as well as by the public. Moreover, geobrowsers can function on different computer platforms. The Open Geospatial Consortium has standardized KML, which is supported by many applications. Google Earth, for example, executes on Windows, Linux, and Macintosh, as well as on smart phones such as the iPhone and Android.

The approach is low in cost—the browsers and standardized protocols are inexpensive or free. Integration with web browsers and standardization will continue to drive client costs down.

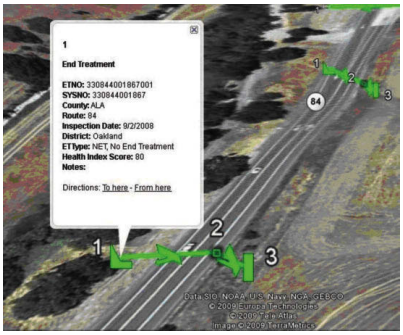
Visualization files can be distributed independently of the original visualization data such as the databases and spreadsheets. Visualization files can be e-mailed, archived, or placed on public servers, creating opportunities to communicate future plans and improvements to the traveling public.

Just as web browsers can unify text and pictures originating from several web servers, geobrowsers can unify spatial information from several unrelated sources. This may be a particularly important benefit for cost-constrained public transportation agencies, which may have difficulty developing new centralized systems.

Software development with geobrowsers is likely to be less expert-dependent than traditional GIS development, which can require an expert software engineer and a GIS specialist. This should lower software development costs and increase accessibility. KML standardization eliminates proprietary lock-in by vendors, and many open-source or free software packages are available, also facilitating low-cost development.

This approach may be helpful in providing new visualization capabilities without changing information technology requirements. That is, new systems or applications may not be required if one person or functional area is able to generate visualization files and to forward them to others, independently of the original data. This may eliminate expensive and time-consuming approvals for new centralized systems. In addition, the ability to create videos and tours may prove useful for management presentations.

Visualization is not an end result, but a key part in the process of collecting and analyzing spatial data. For example, validating spatial inventory data collected via GPS is difficult—or impossible—without a visual context for the roads, buildings, terrain, and other assets. The easy ability to import spreadsheet or database files with comma-separated values facilitates the integration of visualization with data collection. Integrating visualization into the process can improve the understanding and identification



This performance-based asset management visual report calculates water drainage in culverts.

of incomplete or inaccurate data. This is promising for maintenance planning, budget optimization, and functional area analysis, for example; the screen capture above shows some of these applications for water drainage calculations of culverts.

Challenges and Concerns

Some challenges and concerns arise in visualizing assets with a geobrowser. Geobrowsers are not fully functional replacements for traditional GIS but are tools for easily viewing georeferenced assets from many sources, integrated into a virtual world. The emphasis is on accessibility and ease of use. The spatial analysis of relationships between geometric features—such as their adjacency, containment, or proximity—is performed with external tools, and the results are rendered in KML.

Accuracy and resolution also may be issues, depending on the desired application and the quality of the imagery. The resolution of stock terrain overlay images, for example, varies from less than 1 meter per pixel in urban areas to approximately 15 meters per pixel in some rural areas. Higher-resolution, custom image overlays may not always be available. In general, if high accuracy is essential to the application, a geobrowser is probably not the best approach.

Another concern is the practical maximum size of static KML files. This limit is proportionate to the number of spatial features that KML files may contain before performance degrades to an unacceptable level. Workaround solutions may include

- Turning off all spatial features by default;
- Subdividing large KML files into multiple, smaller files that each cover a geographic subset; or
- Using a dynamic KML server.

Visualizing data stored in a database and performing a spatial analysis requires custom development. Constructing KML files manually is possible—but tedious—through a combination of SQL (structured query language), spreadsheets, text editors, and other procedures. If applications can export XML (extensible markup language) data, XSLT (extensible stylesheet language transformation) is likely to work for the conversion to KML.

Geobrowsers and 3-D visualization within web browsers are relatively new capabilities, and feature sets and functionality are changing rapidly—for example, the Google Earth API, Plugin, and My Maps have been introduced in the past 2 years.

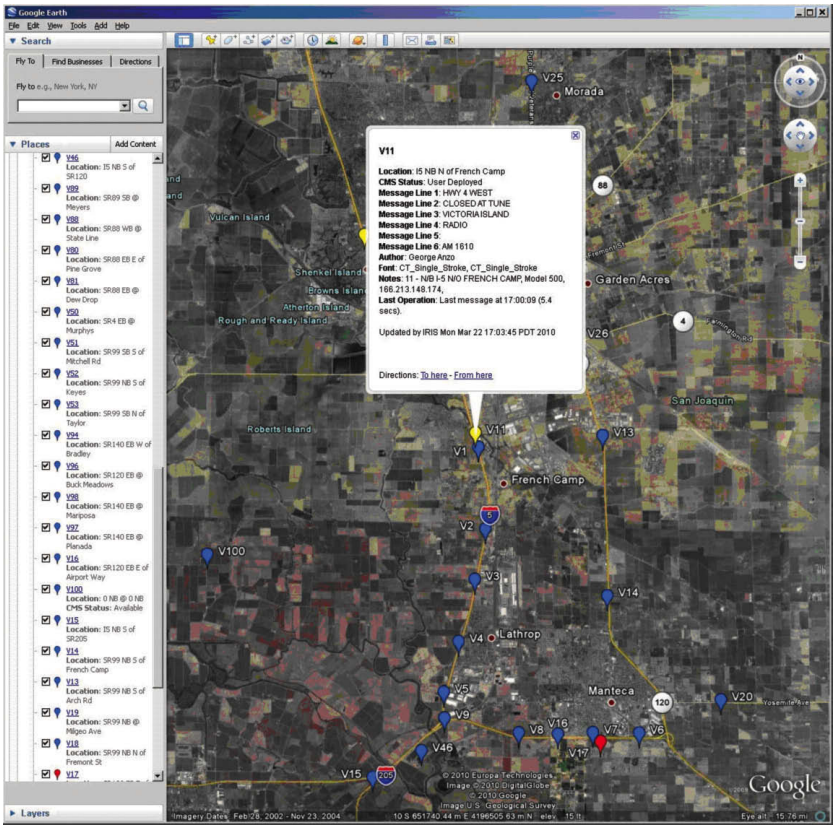
The democratization, access, and understanding of visual information that geobrowsers make possible may raise issues of liability and privacy. Liability concerns must be balanced against the need to provide information and transparency.

Work in Progress

Done well, visualization brings together people, their knowledge, and abstract asset data. This combination can generate new ideas, approaches, checks on the validity of data, or the realization that further analysis is necessary.

Geobrowsers offer a universal tool for visualization that is lower in cost—and sometimes free of

This map shows the locations and displays the text on dynamic message signs in real time. Geobrowsers offer a low-cost, accessible method of visualization for a variety of assets.



charge—easier to use, and built on open standards. This approach has few barriers—asset data in spreadsheets or rectangular files can be visualized with relatively small effort, and extensions can be added for systems to generate visualization files. The ability to extend and visually link asset data from transportation systems may be attractive to agencies that need visualization capabilities but are limited by fixed or shrinking budgets.

Acknowledgments

The authors thank the Division of Research and Innovation, California Department of Transportation (Caltrans), which has supported this work through the Advanced Highway Maintenance and Construction Technology Research Center at the University of California, Davis. The authors also thank Manuel Morales, Caltrans Culvert Program Coordinator; Jack Stickel, Chair, TRB Statewide Transportation Data and Information Systems Committee; and Michael Manore, Chair, TRB Visualization Committee, for their valuable input.

Reference

1. MacEachren, A. M. Geovisualization for Knowledge Construction and Decision Support. In *IEEE Computer Graphics and Applications*, 24(1), 2004, pp. 13–17.

Asset Management Resources

Electronic Resources

Transportation Asset Management Today
http://assetmanagement.transportation.org/

Midwest Regional University Transportation Center
www.mrutc.org/assetmgmt/index.htm

U. S. Domestic Scan Program: Best Practices in Transportation Asset Management
http://onlinepubs.trb.org/onlinepubs/trbnet/acl/NCHRP2068_Domestic_Scan_TAM_Final_Report.pdf

FHWA Asset Management
www.fhwa.dot.gov/infrastructure/asstmgmt/index.cfm

International Technology Exchange Program: Transportation Asset Management in Australia, Canada, England, and New Zealand
http://assetmanagement.transportation.org/tam/aashto.nsf/All+Documents/30F144B18E33667A852570A000468331/$FILE/TAM-International_Scan_Final_Report.pdf

Completed NCHRP Projects

Project 19-04, A Review of DOT Compliance with GASB 34 Requirements
http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_522.pdf

Project 20-24(11), Asset Management Guidance for Transportation Agencies
http://downloads.transportation.org/amguide.pdf

Project 20-57, Analytic Tools to Support Transportation Asset Management
http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_545.pdf

Project 20-60, Performance Measures and Targets for Transportation Asset Management
http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_551.pdf

Project 20-74, Developing an Asset Management Plan for the Interstate Highway System
http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_632.pdf

Synthesis of Highway Practice 37-03, Managing Selected Transportation Infrastructure Assets
http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_syn_371.pdf

Ongoing NCHRP Projects

Project 8-36 (Task 84) and Project 25-25 (Task 51), Asset Management of Environmental Mitigation Features

Project 08-69, Supplement to the AASHTO Transportation Asset Management Guide, Volume 2—A Focus on Implementation

Project 08-70, Target-Setting Methods and Data Management to Support Performance-Based Resource Allocation by Transportation Agencies

Project 14-20, Consequences of Delayed Maintenance

Project 20-74A, Development of National Level of Service Criteria for the Interstate Highway System

Project 20-83(03), Long-Range Strategic Issues Affecting Preservation, Maintenance, and Renewal of Highway Infrastructure

Electronic Circulars

Asset Management in Planning and Operations: A Peer Exchange (2005)
http://trb.org/publications/circulars/ec076.pdf

Geospatial Information Technologies for Asset Management: A Peer Exchange (2006)
http://onlinepubs.trb.org/onlinepubs/circulars/ec108.pdf

Integrating Asset Management into the Metropolitan Planning Process: A Peer Exchange (2006)
http://www.fhwa.dot.gov/Planning/statewide/intassetmgmt.pdf

Integrating Roadway, Traffic, and Crash Data Safety: A Peer Exchange (2007)
http://onlinepubs.trb.org/onlinepubs/circulars/ec111.pdf

Transportation Asset Management: Strategic Workshop for Department of Transportation Executives (2008)
http://onlinepubs.trb.org/onlinepubs/circulars/ec131.pdf

POINT OF VIEW

The Right Fix at the Right Time

KIRK T. STEUDLE

The author is Director, Michigan Department of Transportation, Lansing, and Chair of the Oversight Committee for the Second Strategic Highway Research Program (SHRP 2).

States and cities across the country are facing a financial crisis more severe than any they have experienced in decades. Some are dealing with double-digit unemployment or foreclosure rates and face budget deficits of millions of dollars—if not billions. All over the United States, public officials are scrambling to find efficiencies, enact reforms, and raise revenues to address the shortfalls.

For many, this is a first since the Great Depression. States that have known only growth and prosperity for decades suddenly must resolve budget gaps. In cities that were buoyed by a rising tide of real estate values, the property values—and the tax revenues derived from them—are falling dramatically.

Investing for the future is not easy for public agencies that have to make many difficult financial decisions immediately. Some are trying to fix the worst problems and hoping things will get better. In the long term, however, the "worst first" approach costs more.

IMAGE: MICHIGAN DOT

A need to use resources wisely in a volatile state economy led the Michigan Department of Transportation (DOT) to employ an asset management approach in the early 1990s.

The Michigan Approach

Michigan has a different perspective. The state's economy is closely tied to the automobile manufacturing industry and has experienced dramatic economic ups and downs. State unemployment rates are in the double digits today, but this is not the first time that this has happened in the past two decades. According to a saying, when the economy in the rest of the country catches a cold, Michigan's economy comes down with the flu. In the past, when the national economy started to perk up, Michigan's economy perked first and fastest.

Anticipating the economic cycle is something public officials in Michigan have taken for granted, like getting ready for a winter snowstorm. When a blizzard is on the way, people stock up on supplies; similarly, public agencies in Michigan always have looked for efficiencies, reforms, and savings to weather the tough times.

For nearly two decades, the Michigan Department of Transportation (DOT) has applied an asset management approach to investing in its infrastructure. Michigan DOT's local transportation partners have worked to do the same for almost 10 years.

In 1999, Michigan's state legislature created the Act 51 Transportation Funding Study Committee, a task force to analyze transportation needs and funding. The task force learned about Michigan

POINT OF VIEW presents opinions of contributing authors on transportation issues. The views expressed are not necessarily those of TRB or TR News. *Readers are encouraged to comment in a letter to the editor on the issues and opinions presented.*

PHOTO: MICHIGAN DOT

The Michigan DOT experience favors asset management—a fix to preserve a road's useful life is less expensive than waiting until the road needs to be replaced.

DOT's asset management approach, then already in place. Their charge, however, involved transportation needs and funding statewide, not only for Michigan DOT. A primary recommendation therefore was that a "long-term, planned asset management process be extended to statewide use for transportation facilities."

Implementing statewide asset management across jurisdictions, across agencies, and under a unified approach was an ambitious idea at the time. But Michigan DOT and its local partners took on that goal and succeeded.

Lessons Learned and Confirmed

Since then, as a member of the American Association of State Highway and Transportation Officials' Subcommittee on Asset Management, I have visited with colleagues from other states—and from other countries—to learn more about how they use asset management and to see their results firsthand. The lessons learned from national and international asset management scans have confirmed key lessons from Michigan's experience:

A sustained asset management effort requires a long-term organizational commitment.

After the enactment of the Intermodal Surface Transportation Efficiency Act (ISTEA) in 1991, Michigan DOT leaders developed an organization-wide database to provide comprehensive and consistent data on Michigan DOT assets. The intent was to create one database for easy and routine use by decision makers throughout the department; the database was strongly championed within the organization, even after the management system requirements of ISTEA were softened. The database helped to further the asset management process at Michigan DOT well before the advent of the federal Governmental Accounting Standards Board Statement 34, which required state and local governments to report all financial transactions, including the value of their infrastructure assets, in their annual financial reports.

Michigan DOT also had the benefit of legislative action to further its asset management approach. In 2002, acting on the recommendation of the task force, the state legislature created the Transportation Asset Management Council to oversee the multi-jurisdictional data collection. Today the council oversees comprehensive, unified data collection at the state, county, and city levels to assess the condition of roads and bridges in Michigan and reports the results annually to the legislature. These efforts allow all of the transportation agencies to make highly informed decisions about investment in road networks. [For more information about the council, see the article in this issue by Steve Warren, a council member and deputy director of the Kent County Road Commission (page 22).]

Asset management works best as an integral part of the agency culture.

Asset management is not just another item on the to-do list—it has become part of Michigan DOT's organizational culture. Asset management is part of a push to identify and support good business practices and to improve operations. Although initially seen as a way to stretch taxpayer dollars, the approach has helped Michigan DOT streamline operations and reduce administrative costs.

Converting the culture required that data-driven decision making and performance measurement become part of everything the agency does. Agency planning and policy documents consistently addressed asset management, and the decision-making process was aligned to achieve asset management goals.

Developing an asset management culture does not require waiting for the money or spending years to design database information systems. An agency can start with a modest, targeted approach that evolves into something more comprehensive. The key is to start—dramatic change does not occur overnight.

Michigan DOT established an Asset Management Division in the Bureau of Transportation Planning to give asset management an appropriate initial focus within the agency and to coordinate activities statewide. Putting the division under planning reinforced application of the asset management approach in developing and approving projects throughout the department. The division provides staff support to the Transportation Asset Management Council

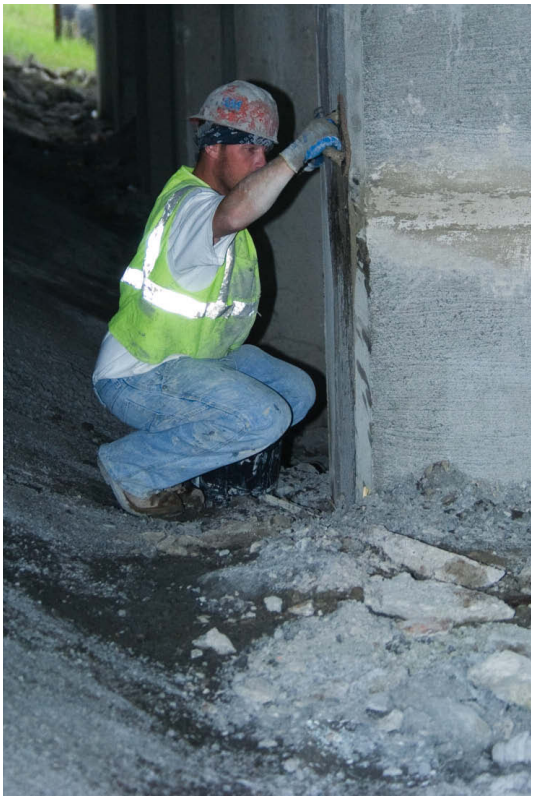


PHOTO: MICHIGAN DOT

Michigan achieved a set of highway and bridge condition goals set in 1997—a majority of pavements and bridges in good condition by 2008—thanks to its asset management approach.

and handles data-related functions, such as traffic data collection and monitoring, pavement condition monitoring, and maintenance of the state's geographic information systems base map and referencing system.

Asset management stretches resources and can help agencies compete for funding.

In 1997, even though the efforts were in their early stages, Michigan DOT's asset management approach helped convince the Michigan legislature to provide additional resources for transportation investment. Michigan DOT chose to forgo the worst-first approach to managing assets and instead embraced an approach emphasizing preservation and improved operations. The intent, in part, was to stretch taxpayer dollars; but from a business standpoint, the approach simply made sense. If reconstructing a road costs five to seven times as much as an investment that will prolong the roadway's useful life, making the right fix at the right time makes sense.

Similarly, if an agency is going to outsource its delivery of programs and services—an option that many are contemplating in the fiscal crisis—having an effective asset management program in place is key. Asset management can be part of the contract agreement, ensuring that the asset is returned to the owner in good condition and that good service is provided to users during the contract period.

Effective asset management relies on well-defined performance measures.

Asset management efforts achieve success when linked to strategic goals and desired outcomes. When the Michigan legislature approved the 1997 gas tax increase, the State Transportation Commission, which sets policy for Michigan DOT's program, approved a set of goals for the condition of the agency's highways and bridges:

- 95 percent of freeway pavements in good condition by 2007;
- 95 percent of freeway bridges in good condition by 2008;
- 85 percent of nonfreeway pavements in good condition by 2007; and
- 85 percent of nonfreeway bridges in good condition by 2008.

The goals were clear, well-defined, and easily measurable. Progress was measured and reported to the commission annually. In the political process under which the agency operates, the deadline for achievement was far enough away that most elected officials and political appointees felt comfortable about their own level of accountability.

The hard-working staff at Michigan DOT undertook the directives and made investment decisions accordingly. Michigan DOT achieved the condition goals on schedule. Since then, the agency has developed additional goals that help expand performance measurement to other programs and other modes.

Data-driven decision making and asset management can help agencies meet the ever-growing demand for transportation service in a fiscally constrained environment. Clearly defining the level of service or condition for different types of assets makes it possible to reassess the levels of service or condition when resources diminish, as they have for so many agencies lately.

Education and communication are tools to further an asset management approach.

Sharing Michigan DOT's asset management approach with local transportation partners proved relatively easy. Local agencies were eager to stretch their transportation funds. The key was helping the agency decision makers understand how a relatively small investment to preserve an asset in fair condi-

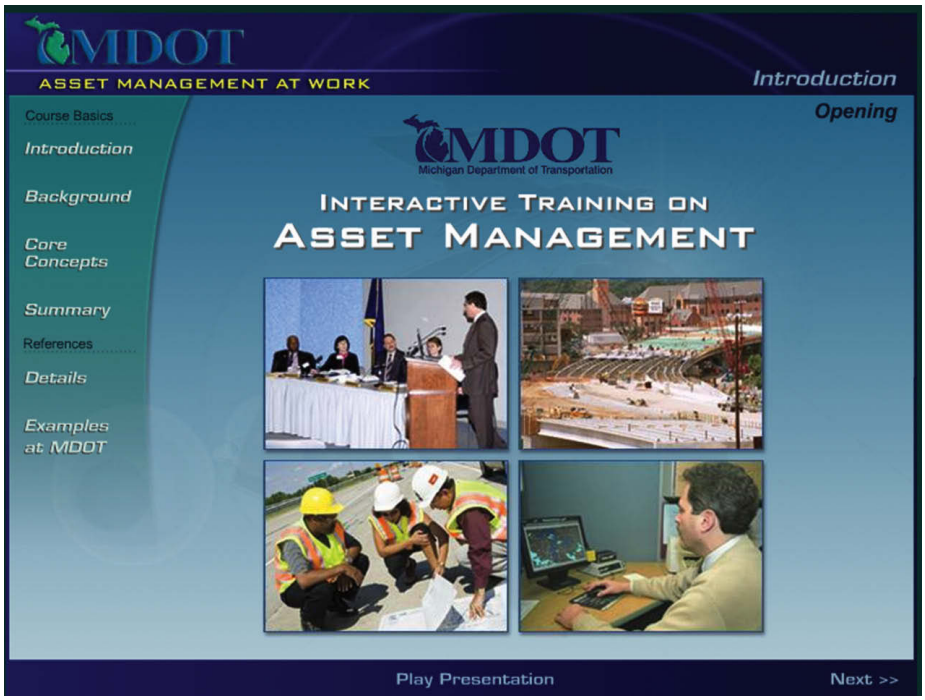


IMAGE: MICHIGAN DOT

Communication and education measures—such as this interactive training—are vital to an effective asset management program.

tion can save more money in the long term.

Michigan DOT developed a series of educational materials on asset management early in the process; the materials have been widely shared during the past 10 years via print and electronic means. National Highway Institute courses and courses offered through Michigan's Local Technical Assistance Program (LTAP) were selected to educate Michigan DOT and local agency staff about implementing asset management.

Educating every employee about asset management was included as a goal in the department's 2006 strategic plan. The Asset Management Division developed an interactive electronic training program to provide employees with the basics and details of the asset management process at Michigan DOT. The Asset Management Division recently produced a video about asset management for roads and bridges; another video, on facilities, is planned for production this year. The interactive training program and the roads and bridges video were presented to the Transportation Asset Management Council and to several of Michigan DOT's external stakeholders and were made available to legislators and their staffs.

New Tests

Two years ago, the legislature established the Transportation Funding Task Force, or TF2. Members were charged—again—with examining Michigan's transportation needs and funding. Through the multijurisdictional approach to asset management, Michigan DOT and its local partners were able to demonstrate the efficiencies and reforms undertaken, as well as the logical, data-driven approach to investment. The agencies convinced TF2, which agreed unanimously and without any doubts that Michigan needs to double its investment in transportation. The TF2 members, representing a spectrum of business and labor organizations, called on the Michigan legislature to increase transportation funding in November 2008—just as the national economy was beginning its downturn.

With the decline of the American automobile manufacturing industry, Michigan's economy no longer may benefit from robust economic rebounds. Projections show that the state's economy is in transition and may not experience significant growth for as many as 30 years. Michigan has struggled with double-digit unemployment and huge budget deficits in the past few years. Nevertheless, TF2 continues to push the legislature to increase transportation revenue.

In these economic circumstances, the legislature could have dismissed the TF2 recommendations summarily—except for the credibility earned through the results of the strictly disciplined asset management approach employed by Michigan transportation agencies for the past 10 years. Legislators have introduced bills to enact nearly all of the TF2 recommendations, and hearings on several pieces of legislation are under way.

How well does asset management work? The Michigan transportation community awaits the funding decisions hopefully and expectantly.

TRB Meetings

November

8–10 International Conference on Commercial Driver Health and Wellness
Baltimore, Maryland

16 Commodity Flow Survey Workshop
Washington, D.C.

17–19 1st International Symposium on Advances in Transport Sustainability*
Tempe, Arizona

December

1–3 7th International Bridge Engineering Conference: Improving Reliability and Safety—Restoration, Renewal, and Replacement
San Antonio, Texas

2011

January

23–27 TRB 90th Annual Meeting
Washington, D.C.
www.TRB.org/AnnualMeeting

February

7–11 2nd International Conference on Construction Management*
Orlando, Florida

March

13–16 Geo-Frontiers 2011*
Dallas, Texas

16–18 Joint Rail Conference: Shared Corridors, Shared Interests*
Pueblo, Colorado

May

1–4 International Transportation Economic Development Conference: Economic Impact of Connecting People, Goods, Markets, Employment, Services, and Production*
Charleston, West Virginia

8–12 13th TRB National Transportation Planning Applications Conference
Reno, Nevada

18–20 3rd International Conference on Roundabouts
Carmel, Indiana

18–20 4th International Transportation Systems Performance Measurement Conference
Irvine, California

June

2–3 5th International Conference on Bituminous Mixtures and Pavements*
Thessaloniki, Greece

6–7 Using National Household Travel Survey Data for Transportation Decision Making Workshop
Washington, D.C.

9–11 2nd GeoHunan International Conference: Emerging Technologies for Design, Construction, Rehabilitation, and Inspections of Transportation Infrastructure*
Hunan, China

14–17 1st International Conference on Access Management*
Athens, Greece

27–30 6th International Driving Symposium on Human Factors in Driver Assignment, Training, and Vehicle Design*
Lake Tahoe, California

28–July 1 6th International Symposium on Highway Capacity and Quality of Service
Stockholm, Sweden

July

10–13 TRB Joint Summer Meeting
Boston, Massachusetts

24–27 10th International Conference on Low-Volume Roads
Orlando, Florida

August

30–Sept. 1 Emerging Issues in Safe and Sustainable Mobility for Older People
Washington, D.C., area

September

13–16 Smart Rivers 2011: Systems Thinking*
New Orleans, Louisiana

14–16 3rd International Conference on Road Safety and Simulation
Indianapolis, Indiana

October

2–6 7th World Congress on Joints, Bearings, and Seismic Systems for Concrete Structures*
Las Vegas, Nevada

November

15–19 8th International Conference on Managing Pavement Assets*
Santiago, Chile

Additional information on TRB meetings, including calls for abstracts, meeting registration, and hotel reservations, is available at www.TRB.org/calendar). To reach the TRB staff contacts, telephone 202-334-2934, fax 202-334-2003, or e-mail lkarson@nas.edu. Meetings listed without a TRB staff contact have direct links from the TRB calendar web page.

*TRB is cosponsor of the meeting.

Get on the Bus

Connecting Small Communities on Montana's Hi-Line

DAVID KACK

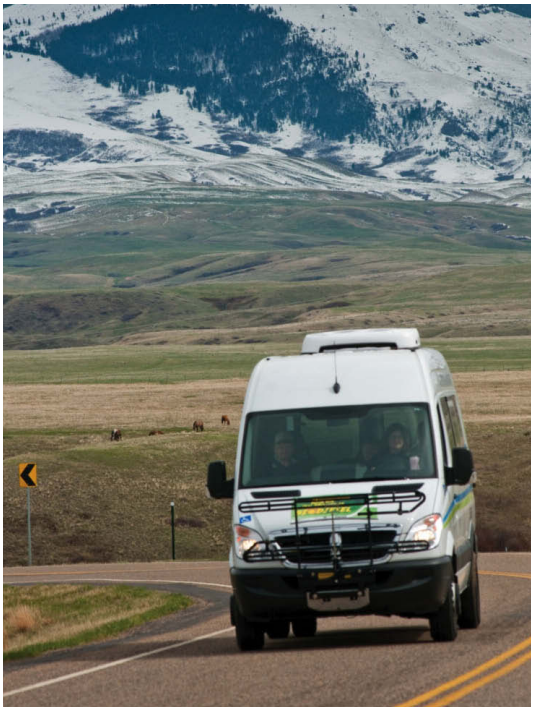
The author is the Mobility and Public Transportation Program Manager, Western Transportation Institute, Montana State University, Bozeman.

In frontier and rural areas, reliable transportation within small towns and from small towns to larger communities is one of many challenges, as residents pursue employment, educational opportunities, medical needs, and recreational activities, and make other necessary trips. Access to transportation services is a key to sustaining the livelihood and enhancing the vitality of smaller communities in a rural region.

Problem

Transportation has been a major need for people living in the Hi-Line region of north central Montana; residents often must travel to obtain or retain employment, receive an education, and gain access to medical care and other basic services. Blaine and Hill Counties along Montana's border with Canada were without public transportation services for nearly 20 years. A previous transit system had offered limited service connecting two towns, Havre and Great Falls, but eventually ceased operation.

Havre is the Hill County seat, with a population of 9,700, and offers medical, employment, and retail services. But the population density in the outlying areas is low—1.5 residents per square mile—so that establishing a transit system that would allow residents access to services in Havre was difficult. In addition, two Native American reservations, Rocky Boy's in Hill County and Fort Belknap in Blaine County, had struggled to provide transit services within and outside their boundaries.



NCMT bus provides much-needed service in a remote rural area. In addition, buses have piloted the year-round use of a locally grown and produced 5 to 20 percent biodiesel blend, processed by the Bio-Energy Center at Montana State University–Northern.

Solution

Initiating a regional transit service in this area had been a key goal of Opportunity Link, Inc., a nonprofit organization based in Havre. The organization strives to create and implement strategies to reduce poverty in the Hi-Line region and to encourage community-driven partnerships. In August 2008, efforts began on the development of a transit service.

Dubbed North Central Montana Transit (NCMT), the proposed service aimed to connect Havre, the largest city in the region, to Harlem, Chinook, and the Fort Belknap Indian Reservation in Blaine County, and to Box Elder and Laredo in Rocky Boy's Indian Reservation. Additional service would connect all of these communities to Great Falls, Montana, 114 miles from Havre. Great Falls is the only urban community in the area, with larger medical, educational, and retail facilities.

Opportunity Link enlisted the public transit research expertise of the Western Transportation Institute (WTI) at Montana State University–Bozeman. The WTI team was asked to provide project management and to develop a plan for implementing public transportation on the Hi-Line.

WTI's coordination plan considered the resources available for a transit system and how the various stakeholders would work together to implement and

support the proposed service. The plan was developed through community meetings and through meetings with key partners, such as the tribal and county governments. The planning process also included the system's partner agencies and organizations, as well as representatives of the communities and areas to be covered by the bus system, in considering the proposed routes and services.

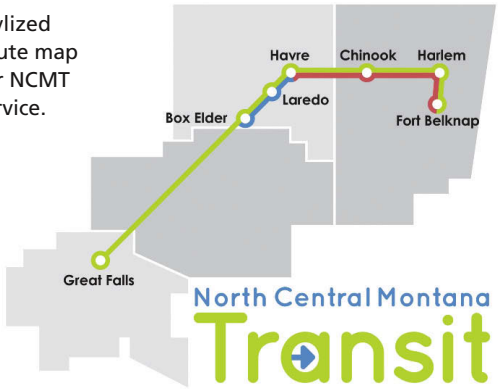
Route planning tasks addressed specific operational details, such as identifying origins and destinations and the best routes for connecting those points. The cost of operating these routes was compared against a draft budget, and adjustments were made to keep service levels and the overall cost of the services within the budget. The routes and service levels were modified several times as updated budget information became available.

As part of the process, stakeholders formed a Transportation Advisory Committee (TAC) consisting of elected officials; representatives from senior centers, transportation agencies, and medical, education, social service, community-based, and minority advocacy organizations in Hill and Blaine Counties; and representatives of tribal agencies from the Fort Belknap and Rocky Boy's Indian Reservations. The North Central Montana Regional TAC approved the coordination plan in February 2009.

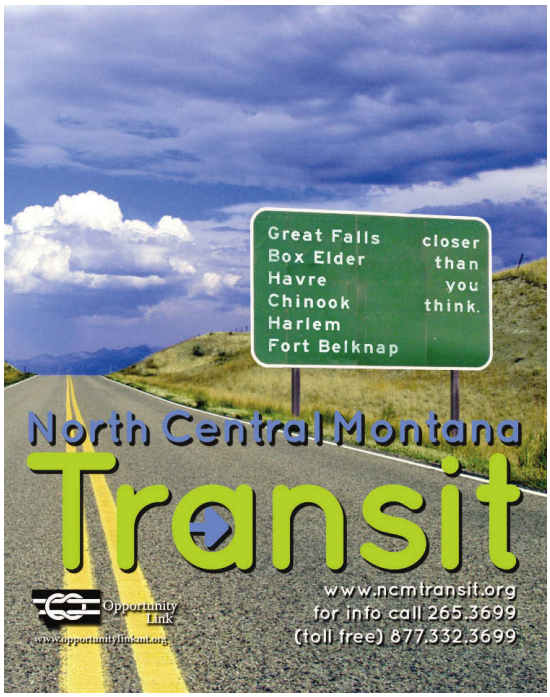
Application

With the help of WTI, Opportunity Link submitted the application and coordination plan to the Montana Department of Transportation's Operating Grant Program. In the application, the TAC requested $75,000 for operating funds from the Federal Transit Administration and three 21-passenger buses. Partners including Montana State University–Northern, Blaine and Hill Counties, Northern Montana Hospital in Havre, and other local agencies and organizations provided local funding.

On August 24, 2009, one of the new NCMT buses, with 18 passengers on board, made its maiden voyage; more than 200 supporters cheered it on. In the first week of operation, NCMT provided 139 rides, followed by more than 200 rides in the second week, when the line received its first request for posting marketing materials in the buses. As of March 2010, NCMT ridership had increased to an average of 300 to 400 rides per week, with a monthly average of nearly 1,600 rides. The weekly totals matched what some had projected for the monthly ridership totals.



Stylized route map for NCMT service.



NCMT poster campaign emphasizes the more convenient connections between major rural origins and destinations.

Benefits

In urban areas, public transportation, or transit, is often viewed as a means to address congestion. In rural and frontier areas, however, transit is often needed to provide mobility for those who lack access to basic services—such as the grocery store, medical care, or education. Despite this critical need, public agencies traditionally have considered transit systems infeasible and unaffordable in areas with low population densities.

The successful creation of a transit system within a region can expand viable transportation options, providing economic and environmental benefits for the communities and an improved quality of life for residents. For this reason, the Federal Highway Administration and the Federal Transit Administration recognized Opportunity Link and its partners in NCMT with the 2010 Transportation Planning Excellence Award. The biennial award recognizes outstanding initiatives to develop and implement innovative transportation planning practices. NCMT was honored in two categories: Planning and Leadership and Tribal Transportation Planning. NCMT has shown that public transportation can succeed in rural and frontier areas through partnerships and coordination.

For additional information, contact David Kack, Western Transportation Institute, 2327 University Way, Bozeman, MT 59715; telephone: 406-994-7526; email: dkack@coe.montana.edu.

EDITOR'S NOTE: Appreciation is expressed to Peter Shaw and G. P. Jayaprakash, Transportation Research Board, for their efforts in developing this article. Shaw retired in July 2010 after 18 years as TRB Public Transportation Specialist.

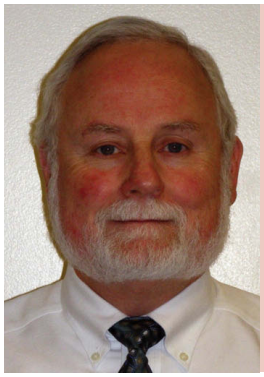
Suggestions for "Research Pays Off" topics are welcome. Contact G. P. Jayaprakash, Transportation Research Board, Keck 488, 500 Fifth Street, NW, Washington, DC 20001 (202-334-2952; gjayaprakash@nas.edu).

Barney T. Martin, Jr.

Modjeski and Masters, Inc.

Barney T. Martin, Jr., discovered his passion for bridges early in his career, as a recent college graduate and civil engineering officer in the U. S. Air Force—his first design assignment was a small timber bridge on the golf course of an Air Force base. In 1976, Martin joined Modjeski and Masters, Inc., as a design engineer, starting a long career with the firm, overseeing the design and rehabilitation of many bridges.

His expertise in bridge design was forged as design engineer for portions of the Scotlandville Bypass in Baton Rouge, Louisiana; the US-167 interchanges near Lafayette, Louisiana; and the C&G Railroad Bridge at Waverly, Mississippi. Promoted to associate in 1980, Martin managed the redecking and strengthening of a major cantilever truss bridge in New Orleans, along with the design and construction of a rolling leaf bascule bridge over Louisiana's Lake Pontchartrain for Norfolk Southern Railway. In 1992, Martin moved to New York as manager of Modjeski and Masters' Poughkeepsie office. His knowledge broadened in scope to include the repair and rehabilitation of suspension bridges and the assessment of main cables and suspender ropes. In 2000, he became vice president of Modjeski and Masters and was named president of the firm in 2007.



"Effective and meaningful transportation research answers our questions as to 'why,' and provides us with the 'how,' which we can use to achieve our desired objectives."

Martin pursued graduate study, both part- and full-time, throughout his career. He received a master's degree in civil engineering in 1981 and a doctorate in structural engineering from Tulane University in 1992, when he was 40 years old. "Returning to school at that age, after a significant number of years of practical experience, greatly aided my perspective on the research I was performing," Martin recalls.

Martin credits his commitment to education, collaboration, and research as key to his professional development. "As individuals with a scientific background, we all have a desire to understand why certain phenomena occur," Martin comments. "As engineers, we seek to use that understanding to overcome or use those phenomena." In 2000, he taught a graduate seminar in suspended bridge cable corrosion at Budapest University of Technology in Hungary; he also led professional engineer review courses at Rensselaer Polytechnic Institute in Troy, New York, for several years.

Martin has supervised the cable inspection, suspender replacement, steel repair, and anchorage dehumidification of the Mid-Hudson Bridge between Poughkeepsie and Highland, New York; a project to replace the subfloorbeams, joints, and bearings of the Ambassador Bridge between Detroit, Michigan, and Windsor, Ontario; a cable replacement study for the Bear Mountain Bridge in New York; and the design and preparation for a second international crossing at Port Huron, Michigan. A registered engineer in 14 states, Martin also led cable assessment projects for the Bronx–Whitestone Bridge in New York City, the Wurts Street Bridge between Kingston and Port Ewen, New York, and other structures.

Martin has participated in, and contributed to, the International Cable-Supported Bridge Operators' Conference since 1991 and has presented papers at the 2008 and 2009 U.S.–Japan Bridge Engineering Workshops. He has coauthored many papers and technical reports, including "Evolution of Parallel Wire Cable Condition Assessment—A Case Study" (2008), "Structural Details to Accommodate Seismic Movements of Highway Bridges and Retaining Walls" (1997), and "Long-Term Performance of Prestressed, Pretensioned, High-Strength Concrete Bridge Girders" (1995). He has provided peer reviews recently for such journals as the Precast–Prestressed Concrete Institute's *PCI Journal*, the American Concrete Institute's *ACI Structural Journal*, the *Transportation Research Record: Journal of the Transportation Research Board*, and the American Society of Civil Engineers' *Journal of Bridge Engineering*.

Martin has been a member of TRB's Concrete Bridges Committee since 1993, and served as its chair from 2003 to 2009. Other TRB activities include the Committee for the Sixth International Bridge Engineering Conference, the Structures Section, the Steel Bridges Committee, and the Design and Construction Group. "Effective and meaningful transportation research answers our questions as to 'why,' and provides us with the 'how,' which we can use to achieve our desired objectives," notes Martin. "This is what TRB-initiated research accomplishes."

Martin has participated in several National Cooperative Highway Research Program (NCHRP) project panels, most recently for NCHRP Synthesis 393, *Adjacent Precast Concrete Box Beam Bridges: Connection Details*. He is the coauthor of the report for NCHRP Project 20-07 (Task 217), Verification and Implementation of Strut-and-Tie Model in Load and Resistance Factor Design Bridge Design Specifications, and was a member of the international scanning team on Assuring Bridge Safety and Serviceability in 2009.

Reginald R. Souleyrette

Iowa State University

Gerald and Audrey Olson Professor of Civil Engineering at Iowa State University (ISU), Reginald R. Souleyrette has focused his research on information technology—especially on highway safety geospatial information systems (GIS). As associate director of ISU's Institute for Transportation (InTrans)—formerly the Center for Transportation Research and Education (CTRE)—Souleyrette has led research on the development of traffic forecasting models, radioactive waste transportation, school district planning, telecommuting, and airport issues. His skill at bringing in researchers and graduate students to work on transportation problems as a team helped establish InTrans' successful research model.

"Transportation research provides many opportunities to address significant societal problems and opportunities."

Souleyrette received bachelor's and master's degrees in civil engineering from the University of Texas at Austin, and a doctorate in civil engineering from the University of California (UC), Berkeley. In 1989, he began working as assistant professor at the University of Nevada–Las Vegas. There he helped to develop a transportation engineering program and a transportation research center; he served as the center's first assistant director. Working in partnership with William L. Garrison of UC Berkeley, Souleyrette studied the relationship between transportation and production.

In 1993, Souleyrette joined the growing transportation engineering program at ISU as assistant professor in the Department of Civil, Construction, and Environmental Engineering and as associate director of research at CTRE. He served as assistant director at the U.S. Department of Transportation's (DOT) Midwest Transportation Center, established the Midwest Travel Model Users Group, and helped create the Iowa Geographic Information Council (IGIC). He was appointed full professor in 2003; as a major professor, he has mentored more than 50 graduate students.

"Take advantage of being young and new to the field," Souleyrette advises new transportation professionals. "Cultivate a sense of being part of something larger than yourself. Transportation research provides many opportunities to address significant societal problems and opportunities."

He currently focuses on development of the U.S. Road Assessment Program (usRAP) and other safety data–related projects. Sponsors for Souleyrette's research include such organizations as U.S. DOT; the Iowa Department of Health; the U.S. Department of Energy; the National Park Service; several state DOTs; the Federal Highway Administration; the AAA Foundation for Traffic Safety; the Midwest Research Institute; and the Iowa Highway Research Board.

High expectations from the public with regard to information systems present fruitful research opportunities, Souleyrette comments: "Smarter systems are needed to tailor the right information to the right people at the right time, in a straightforward and intuitive way. Public–private partnerships in data and information systems are the key; we must continue to demand transparency and access to information, to make the best decisions in our private and public lives."

Souleyrette points to a successful collaboration of Iowa state agencies that used data and technology to address highway safety problems, such as the Iowa Traffic Safety Data Service he manages with research engineer Zach Hans—one of his first graduate students. Vital to the process was an active leadership and the willingness of public health, engineering, enforcement, and research and education officials to work together. "This has resulted in capacity for Second Strategic Highway Research Program safety work, data-driven decisions, and cross-group TRB collaborations," he observes.

In 1996 he collaborated with Garrison on "Transportation, Innovation, and Development: The Companion Innovation Hypothesis" in *The Logistics and Transportation Review*. Other notable projects Souleyrette has been a part of include early traffic GIS planning tools; TraCS Incident Location and analysis tools, in collaboration with Dan Gieseman; and remote sensing research.

"I am lucky to be part of a team of bright and hardworking transportation professionals who really care that the work they do makes a difference," Souleyrette notes. Honors that he has received as part of research teams include the National Roadway Safety Award, the Iowa Department of Public Safety Commissioner's Special Award for Traffic Safety, the National Safety Council's 26th International Traffic Records Forum Best Practices Award, and three separate Engineering Student Council Leadership Awards. For his work with IGIC, Souleyrette received the Governor's Volunteer Award for Service to the State of Iowa. He credits the team of faculty, professional staff, and students for these awards and the success of his programs.

Souleyrette has participated in TRB technical committees since 1991, when he joined the Metropolitan Policy, Planning, and Processes Committee. He has served on the Task Force on Geographic Information Systems for Transportation, the Geographic Information Science and Applications Committee, and is chair of the Data and Information Systems Section.

PHOTO: MARYLAND SHA

U.S. Navy Principal Investigator Robert Neyland and other archaeologists are working to determine the location of a War of 1812 shipwreck.

State Grant Finances Search for War of 1812 Ship

The Maryland State Highway Administration (SHA), along with the Maryland Historical Trust and the U.S. Navy, is funding the search for the remains of a War of 1812 shipwreck in the shallows of the Patuxent River, near Upper Marlboro, Maryland. Past underwater archaeology surveys have indicated the presence of an early 19th century wreck in the river, but not enough evidence has been gathered to identify the ship.

In early August, archaeologists mapped an underwater area thought to be the resting place of the flagship USS *Scorpion* or another vessel that Commodore Joshua Barney "scuttled"—deliberately sank to prevent British capture and use against American forces—in 1814. After engaging the HMS *St. Lawrence*, Barney's 18-ship flotilla had retreated to the shallow waters of the Patuxent River, where the British Navy had a blockade set up to trap them. Shortly after he scuttled the ship, Barney led his troops into the Battle of Bladensburg, Maryland.

Research teams first used a magnetometer to detect the presence of metal and locate the general area of the wreck; they then employed the more precise hydroprobe, which uses a linear series of water jets 1 in. in diameter to pinpoint the wreck location. Underwater archaeologists are now excavating two 6-ft by 10-ft test units to identify their original location on the ship. For the next 2 years, archaeologists will test the site in preparation for placement of a cofferdam that will allow the wreck to be excavated as a dry site.

For more information on the progress of the excavation, visit the project blog at www.scorpionarchaeology.blogspot.com.

Ohio Tests Green Initiatives

A Gateway Rest Area Green Technology Demonstration Project conducted by the Ohio Department of Transportation (DOT) will evaluate alternative energy technologies to reduce harmful vehicle emissions, with the goals of decreasing Ohio DOT's carbon footprint and of creating local jobs.

With funding sources that include a $1.6 million U.S. Department of Energy grant under the American Recovery and Reinvestment Act's Energy Efficiency and Conservation Block Grant Program, administered through the Ohio Department of Development, Ohio DOT aims to develop a best-practice model that can be deployed across all of its facilities. Before a large-scale investment can be made, however, each alternative energy technology must be evaluated for statewide implementation.

Project phases, which include systems in Ashtabula, Wood, and Belmont Counties, are scheduled for completion in 2011. CH2M Hill is developing a design–build scope for the Ashtabula location. Equipment to be tested includes turbines, solar arrays, pedestals for truck-stop electrification, and level-II electric vehicle chargers.

The average Ohio DOT Travel Center rest area currently consumes approximately 300,000 kW annually, at a cost of $30,000 per year; the 100-kW wind turbines that are being tested produce an estimated 150,000 kW annually—half of the total rest area energy consumption.

Other Ohio DOT energy initiatives include a wind turbine on SR-2 in Ottawa County, assessment of a turbine at a District 12 rest area or maintenance facility, and a power purchase agreement pilot project. In partnership with the University of Toledo, First Solar, and Xulight, Ohio DOT is installing a 113-kW solar array to offset the power consumption of the Veterans Glass City Skyway Bridge over the Maumee River in Toledo.

For more information, contact Jennifer Gallagher, Ohio DOT, at 614-644-5928 or jennifer.gallagher@dot.state.oh.us.

Online Shopping's Effects on Transportation Demand

Researchers at the University of Minnesota's (UM) Humphrey Institute of Public Affairs recently studied patterns of online shopping and in-store shopping. Sponsored by UM's Intelligent Transportation Systems Institute, the study employs a conventional shopping survey, an activity diary, probit models, and structural equation models (SEM) to examine this relationship and how it affects travel.

According to the study, migration from in-store shopping to online shopping could affect freight and personal transportation over time. The potential growth of delivery trips to consumers—bypassing wholesalers and retailers—could lead to changes in freight transportation; household shopping travel, however, could drop if online shopping replaced in-store shopping, or it could increase if online shopping encourages more trips to the store. The study examines whether shopping patterns differ by geographical area, how online shopping affects an individual's physical shopping and activity participation, and the implications for transportation planning.

A case study of Minnesota's Twin Cities concluded that because of the vast amounts of product information online, the Internet tends to generate shopping demand. Using SEM and controlling for confounding factors, researchers found that online buying often leads to further in-store purchases; however, the online information search seems to have more of a complementary effect on traditional shopping than does online buying. According to the report, online searching frequency has a positive impact on online and in-store buying frequency. Researchers note that the study will not be complete until results of the activity diary are processed.

For the full report, visit www.its.umn.edu/Publications/ResearchReports/reportdetail.html?id=1942.

Economic Downturn Slows International Traffic

The global economic downturn has taken a toll on the transportation sector, according to reports from the International Transport Forum (ITF) at the Organisation for Economic Co-operation and Development (OECD). ITF statistics show a drop in global freight and passenger transportation, along with reduced greenhouse gas (GHG) emissions, in many countries.

According to ITF, world container traffic fell by 26 percent in 2009 (in 20-ft. equivalent units), air freight ton-kilometers dropped by 10 percent, and rail ton-kilometers decreased by 23 percent. In the European Union (EU), road ton-km dropped by slightly more than 21 percent, and rail freight data in the United States and Russia underwent reductions of approximately 14 percent and 12 percent, respectively. Some data indicate a slight recovery: the rail freight decline was leveling off in many countries at the end of the third quarter of 2009, but overall rail freight numbers are still lower than they were before the downturn. Inland transportation infrastructure continues to grow in Eastern and Central Europe—by more than 17 percent from 2007 to 2008—but in Western Europe, the United States, and Japan, infrastructure investment grew more slowly—by 2.5 percent in the same period.

Although less affected by the downturn than freight traffic, global passenger transportation experienced some decline. According to ITF, air passenger traffic in International Air Transport Association member countries and rail passenger transportation in ITF member countries both fell by approximately 3.5 percent in 2009.

The economic crisis has contributed to the sharpest drop in GHG emissions in 40 years—an estimated 3 to 10 percent decline in 2008, according to ITF reports. Global CO_2 emissions continue to grow, although at a slower rate; the rate of emissions growth from 1990 to 2007 was an estimated 45 percent, and emissions are projected to increase approximately 40 percent by 2030.

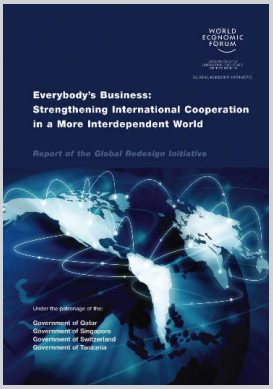
For more information, visit www.international transportforum.org.

Photo: Werner Hennies, Flughafen München GmbH

Air passenger traffic in many European countries fell in 2009, according to data from the International Transport Forum.

Economic Forum Advances Goals for Transportation Sector

Raise the profile of the transportation sector in global discussions and enhance global, national, and cross-industry collaboration; encourage the adoption of best practices; and increase technological and financial innovation are among the recommendations released by members of the World Economic Forum's Global Agenda Council on the Future of Transportation. At its Global Redesign Summit in Doha, Qatar, May 30–31, the forum also recommended empowering the ITF through a mandate to G-20 nations to promote sustainable transportation beyond the OECD countries; a specific set of data points for all nations; an online, open mechanism for the exchange of best practices; the elimination of unjustified transportation-related subsidies, and consideration of external costs of various modes; best practices for road maintenance, road accidents, freight transportation, fuel-efficient driving, and nonmotorized transportation; encouraging innovation and technology in cities; and the launch of operating expense–focused public–private partnerships and business models.



For more information, contact John Moavenzadeh, john.moavenzadeh@weforum.org, or Mariana Torres-Montoya, mariana.torres-montoya@weforum.org.

SHRP 2 composite pavement research is conducted at MnROAD in cooperation with Minnesota DOT.

SHRP 2 Shifting into Implementation

With more than 80 research contracts under way in the Second Strategic Highway Research Program (SHRP 2), the focus is turning to the development of research results into products for transportation agencies. The development process includes symposia, workshops, field tests, and demonstration projects to prepare research results for implementation. Transportation agencies nationwide are participating in preimplementation activities.

In cooperation with the Minnesota Department of Transportation (DOT), SHRP 2 researchers constructed experimental composite pavement sections at the MnROAD Cold Weather Road Research Facility. The project will enhance understanding of the performance characteristics of durable pavements and will advance the SHRP 2 goal of highway renewal with rapid techniques for long-lasting facilities.

A project to pilot-test the website for Transportation for Communities—Advancing Projects Through Partnerships (TCAPP) involves four state DOTs and their partners, including metropolitan planning orga-

Cooperative Research Programs News

Alternative Fuels to Reduce Emissions at Airports

More than 60 airports nationwide are located in areas that have failed to attain targeted reductions for emissions of fine particulate matter ($PM_{2.5}$). As air travel demand grows, these airports face increased pressure to reduce their contributions to local greenhouse gas emissions; regions of the country with particulate matter exceeding the National Ambient Air Quality Standards limits are required to develop a plan to bring affected areas back into attainment. A combination of actions—aircraft technology advancement, efficient operational procedures, and use of alternative fuels—is necessary to address air quality–related environmental concerns effectively.

PA Government Services, Inc., has received a $499,798, 16-month contract [Airport Cooperative Research Program (ACRP) Project 02-23, FY 2010] to estimate the $PM_{2.5}$ contribution from airports; evaluate the impact that alternative fuels may have in reducing $PM_{2.5}$ emissions from aircraft engines, auxiliary power units, ground transportation, and other combustion sources; and identify the opportunities and challenges presented by adopting alternative fuels to reduce airport-related $PM_{2.5}$ emissions.

For further information, contact Joseph D. Navarrete, TRB, 202-334-1649, jnavarrete@nas.edu.

Effective Removal of Pavement Markings

Lane shifts often are necessary during road construction projects and require that pavement markings be obscured or removed for new markings to be applied. Pavement marking systems, however, are designed to be durable and strongly bonded; must be capable of withstanding years of traffic wear; and should resist environmental damages. For these reasons, many new systems are epoxy-based and adhere adamantly to pavement. Obscuring methods such as black tape tend not to last long enough, often have different reflective properties than the pavement, and may confuse drivers. Chemical solvents raise safety and environmental concerns. As a result, pavement markings typically are ground down, leaving scars in the surface that can be mistaken for functional pavement markings under low light or wet conditions. The *Manual on Uniform Traffic Control Devices* (MUTCD) requires that all visible traces of existing markings be obliterated and does not allow for removal methods that cause damage; however, no specification has been developed for an acceptable level of pavement scarring.

Texas A&M University has received a $200,000, 14-month contract [National Cooperative Highway Research Program (NCHRP) Project 14-22, FY 2010] to determine best practices for the safe, cost-effective, and environmentally acceptable removal of work zone and permanent pavement markings with minimal damage to the surface or to the underlying pavement. Researchers will examine solutions such as mechanical processes; environmentally acceptable chemical removal systems; durable coating that can blend into the

Photo: Lea M. Rice

nizations, city and county agencies, resource agencies, Federal Highway Administration division offices, universities, and research organizations. The website—a collaborative resource for highway capacity project planning—comprises results from several SHRP 2 Capacity research projects; other project results are expected. Each team will test a different aspect of TCAPP—application to a current corridor study, use of the performance measures framework, and evaluation of collaborative relationships. The findings will help to refine TCAPP's functionality and content.

IMPROVING TRAVEL DATA—Consultant Alan Pisarski offers comments at a meeting of the Committee on Strategies for Improved Passenger and Freight Travel Data, Tuesday, August 17, at The National Academies' Keck Center in Washington, D.C. The study committee is assessing federal, state, and local travel data and will make recommendations for an affordable and sustainable system for estimating personal and freight travel data to inform transportation planning and decision making.

pavement; or methods of covering the pavement width completely.

For further information, contact David A. Reynaud, TRB, 202-334-1695, dreynaud@nas.edu.

Guidelines for Cost-Effective Safety Treatments of Roadside Ditches

Roadside ditches are critical for the control of storm water runoff on highways, but they can be hazardous when errant motorists leave the roadway—reports show that more than 1,000 fatalities per year can be attributed to ditches. The preferred ditch configurations featured in the American Association of State Highway and Transportation Officials' (AASHTO) *Roadside Design Guide* are based on the results of limited testing and simulations conducted in the 1970s and often are not practical for roads with limited rights-of-way. Solutions such as enclosed drainage systems, culvert ends, inlets, headwalls, and holding basins can be expensive or can become roadside obstacles themselves; although a ditch barrier reduces the clear zone, it often is not cost-effective, and it presents maintenance and operational issues. By identifying the factors and dynamics involved in crash events, countermeasures can be developed and implemented to mitigate roadside ditch crashes.

The Texas A&M Research Foundation has received a $400,000, 24-month contract (NCHRP 16-05, FY 2010) to develop guidelines for the cost-effective treatment of roadside ditches to reduce the severity of ditch crashes.

For further information, contact Charles W. Niessner, TRB, 202-334-1431, cniessner@nas.edu.

Highway Infrastructure and Operations Safety Research Needs

The rate of highway traffic injuries and deaths has decreased steadily over time but is still unacceptably high. Although the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users has increased safety funding, and states have developed and implemented strategic highway safety plans, research is needed into innovations that would reduce injuries and fatalities significantly; a coordinated research investment is required.

The University of North Carolina Highway Safety Research Center has received a $500,000, 30-month contract (NCHRP 17-48, FY 2010) to design a detailed methodology to identify and evaluate highway infrastructure and operations safety research needs and to develop a formal national research agenda.

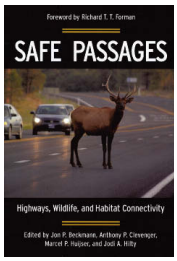
For further information, contact Christopher Hedges, TRB, 202-334-1472, chedges@nas.edu.

Improved Right-of-Way Procedures and Business Practices

To improve project development and delivery and long-term right-of-way asset management, state departments of transportation are seeking to simplify and streamline their right-of-way procedures and business practices. Current procedures—products of decades' worth of statutes, case law, regulations, management styles, and best practices—vary widely, and the long-term property assets acquired in the right-of-way process must be accurately inventoried, evaluated, maintained, and managed, sometimes for several years. This management typically does not include the roadway right-of-way after construction is complete, however. Streamlined, simplified procedures and business practices are needed.

Texas A&M University is the recipient of a $500,000, 24-month grant (NCHRP Project 20-84, FY 2010) to develop improved right-of-way procedures and business practices for project development and delivery; investigate best practices for the long-term management of right-of-way assets; and compare a typical right-of-way business model with an improved model.

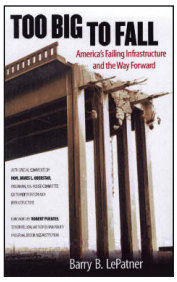
For further information, contact David A. Reynaud, TRB, 202-334-1695, dreynaud@nas.edu.



Safe Passages: Highways, Wildlife, and Habitat Connectivity
Edited by Jon P. Beckmann, Anthony P. Clevenger, Marcel P. Huijser, and Jodi A. Hilty. Island Press, 2010; 396 pp.; $40; 978-1-597-26654-3.

Through a broad overview of developments in reducing the toll that roads take on animals, this volume features the latest information on the emerging science of road ecology and how it can help mitigate harmful interactions between roads and wildlife. Presenting practical tools and examples, *Safe Passages* examines habitat connectivity in relation to roads; planning approaches and technologies to mitigate the impact of highways on terrestrial and aquatic species; public participation in projects to promote highway–wildlife connectivity; successful case studies from partnerships across North America; and other recent innovations and developments. Detailed case studies span a range of projects and activities—from site-specific wildlife crossing structures to statewide planning to national legislation—illuminating the cooperative efforts of transportation agencies, land and wildlife management agencies, and nongovernmental organizations.

The books in this section are not TRB publications. To order, contact the publisher listed.

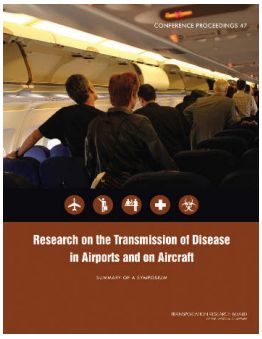


Too Big to Fall: America's Failing Infrastructure and the Way Forward
Barry B. LePatner. Foster Publishing, 2010; 224 pp.; $27.95; 978-0-984-49780-5.

In August 2007, the I-35W bridge in Minneapolis collapsed, killing 13 people and injuring 145 others. Subsequent investigations revealed that the accident could have been prevented and yet may be repeated at many of the nation's bridges—more than 50 percent of which are past their intended life span.

The author chronicles the problems that in his view led to the I-35W bridge collapse—poor bridge design, shoddy maintenance, ignored repair recommendations, and misallocated funding—and reviews the responses to the tragedy. The meaning of the I-35W bridge collapse for the country as a whole is explored, and the possibility of a nationwide infrastructural breakdown is outlined. The author uncovers government failures at the national and state levels and points out the ways in which the national transportation funding system prioritizes new projects instead of maintaining aging infrastructure. The role of infrastructure in economic strength and national security is examined.

TRB PUBLICATIONS



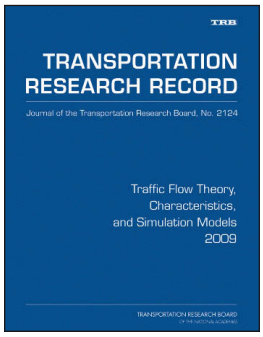
Research on the Transmission of Disease in Airports and on Aircraft: Summary of a Symposium
TRB Conference Proceedings 47
Presentations from a September 2009 symposium that examined the status of research on the transmission of disease on aircraft and in airports are summarized, and the potential applications of research results to the development of protocols and standards for managing communicable disease incidents in aviation settings are explored. Areas for additional research are also outlined.

2010; 60 pp.; TRB affiliates, $34.50; nonaffiliates, $46. Subscriber category: aviation.

Environment 2009
Transportation Research Record 2123
Papers tackle environmental subjects, including transportation planning and National Environmental Policy Act processes, in-cab air quality of trucks with different air conditioning methods, emissions inventories for construction vehicles, the energy and environmental impacts of high-speed roundabouts, a macroscopic emission model for China, and particulate emissions from transit buses. Also examined are the effect of high-occupancy toll lanes on mass vehicle emissions, the environmental impacts of high-emitting vehicles, emissions models of freeways with high-occupancy vehicle facilities, the environmental impacts of a major freight corridor, planning combined wildlife and pedestrian highway crossings, vehicle pass-by noise emission from onboard sound intensity levels of tire–pavement noise, vertical distribution of truck noise sources by acoustic beam forming, test variables for onboard sound intensity measurements, the preservation of a historic national park roadway, and the environmental impacts of cured-in-place pipe.

2009; 179 pp.; TRB affiliates, $52.50; nonaffiliates, $70. Subscriber category: energy and environment.

TRB PUBLICATIONS *(continued)*



Traffic Flow Theory, Characteristics, and Simulation Models 2009
Transportation Research Record 2124
Traffic flow theory and modeling techniques, car-following and lane-changing models, traffic flow characteristics, and traffic simulation models are explored in this volume, with papers on modeling acceleration decisions for freeway merges, stop-and-go traffic patterns, an analysis of the breakdown process on congested freeways, the macroscopic effects of multianticipative driving, a procedure for calibrating the Gipps car-following model, the influence of various restrictions on speed–flow models, an analysis of traffic flow on ring road expressways in Beijing, the features of freeway traffic oscillations, a new calibration methodology for microscopic traffic simulation, and more.

2009; 256 pp.; TRB affiliates, $59.25; nonaffiliates, $79. Subscriber category: highway operations, capacity, and traffic control.

Social Equity, Gender Issues, and Mobility
Transportation Research Record 2125
Authors investigate issues of social equity, gender, and mobility in transportation, with papers that explore the mitigation of diesel truck impacts in environmental justice communities; public versus private mobility for low-income households; gender difference in bicycling behavior; an activity-based model of women's activity-travel patterns; and children's travel patterns and exercise in a rail-based, developed area of Japan.

2009; 43 pp.; TRB affiliates, $35.25; nonaffiliates, $47. Subscriber category: planning and administration.

Bituminous Materials and Mixtures 2009, Volume 1
Transportation Research Record 2126
Bond strength of tack coat materials, the fatigue endurance limit of hot-mix asphalt, forensic analysis of reflective cracking on an Interstate highway, a surrogate performance indicator for the control of thermal cracking, intrinsic healing properties of asphalt binders, and asphalt binder creep and recovery tests are examined in this volume, along with crumb rubber and fiber-modified bituminous mixes, field performance testing of reclaimed asphalt pavement mixes, moisture damage in warm-mix asphalt containing moist aggregate, foamed warm-mix asphalt projects, a higher specification for reclaimed asphalt pavement, and other subjects.

2009; 160 pp.; TRB affiliates, $49.50; nonaffiliates, $66. Subscriber category: materials and construction.

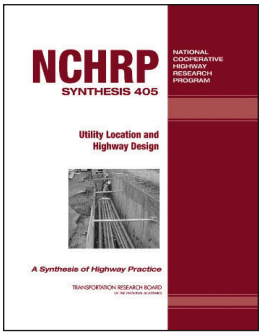
Bituminous Materials and Mixtures 2009, Volume 2
Transportation Research Record 2127
The 20 papers in this volume explore variability in the American Association of State Highway and Transportation Officials' (AASHTO) T-283, the modified Lottman test; noise and friction of dense-graded asphalt, stone matrix asphalt, and porous friction course; bonding of hot-mix asphalt and concrete surfaces; the energy ratio concept as a predictor of top-down cracking; low design temperatures of asphalt pavements in dry-freeze regions; finite element analysis of hot-mix asphalt cracking; micromechanical hot-mix asphalt modeling; low-temperature field performance and laboratory testing; the refinement of flow numbers as determined by an asphalt mixture performance tester; long-lasting asphalt mixtures; fracture resistance of Illinois hot-mix asphalt overlay mixtures; an effective temperature for analysis of permanent deformation and fatigue of asphalt mixtures; artificial neural networks for estimating the dynamic modulus of asphalt concrete; and more.

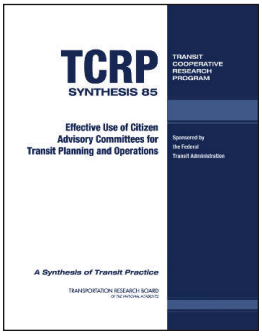
2009; 186 pp.; TRB affiliates, $52.50; nonaffiliates, $70. Subscriber category: materials and construction.

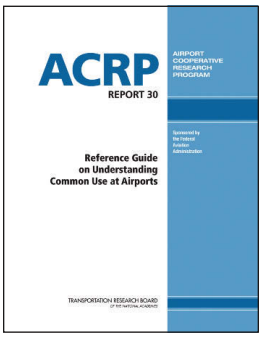
Traffic Signal Systems 2009
Transportation Research Record 2128
Papers on subjects including green time at congested traffic signals, traffic signal maintenance and operations needs, railroad-preempted intersections, three-dimensional mapping of inductive loop detector sensitivity, cycle length performance measures, and optimization of a coordinated–actuated traffic signal system are presented, along with bicyclist intersection crossing times, optimization of traffic control to reduce fuel consumption and exhaust emissions, optimization of field signal timings, a platoon-priority and advance warning flasher system at high-speed intersections, red light running prediction, microscopic modeling of traffic signal operations, a local synchronization control scheme for congested interchange areas, a distributed Ethernet network of

The TRR Journal Online website provides electronic access to the full text of more than 10,000 peer-reviewed papers that have been published as part of the Transportation Research Record: Journal of the Transportation Research Board *(TRR Journal) series since 1996. The site includes the latest in search technologies and is updated as new TRR Journal papers become available. To explore the TRR Online service, visit www.TRB.org/TRROnline.*

TRB PUBLICATIONS *(continued)*







To order TRB titles described in Bookshelf, visit the TRB online Bookstore, at www.TRB.org/bookstore/, or contact the Business Office at 202-334-3213.

advanced pedestrian signals, traffic scenarios for large arterial networks, green-extension policies, and a safety evaluation for intergreen intervals at signalized intersections.

2009; 235 pp.; TRB affiliates, $56.25; nonaffiliates, $75. Subscriber category: highway operations, capacity, and traffic control.

Median Intersection Design for Rural High-Speed Divided Highways

NCHRP Report 650

Crashes on rural divided highways typically cluster at intersections. Transportation agencies have implemented treatments to reduce the crash frequency and severity; many of the treatments are relatively new and have only been installed at a few sites. This report examines innovative geometric and operational treatments and their application in the field. Ten case studies illustrate common safety issues at median intersections on rural divided highways, analyze causal factors, and identify effective ways to improve safety.

2010; 158 pp.; TRB affiliates, $46.50; nonaffiliates, $62. Subscriber categories: highways; design; safety and human factors.

LRFD Design and Construction of Shallow Foundations for Highway Bridge Structures

NCHRP Report 651

This report studies recommended changes to Section 10 of the AASHTO Load and Resistance Factor Design (LRFD) Bridge Design Specifications for the strength limit state design of shallow foundations. The current specifications were calibrated using a combination of reliability theory, allowable stress design, and engineering judgment. Large databases of tested foundations were needed to facilitate LRFD parameter evaluation; this research is the first to introduce large-scale, reliability-based design calibration of shallow foundations using databases.

2010; 139 pp.; TRB affiliates, $42.75; nonaffiliates, $57. Subscriber categories: highways; bridges and other structures; geotechnology.

Utility Location and Highway Design

NCHRP Synthesis 405

In highway design planning, a compromise must be reached between relocation of all above- and below-ground utilities in the area and leaving all the utilities in place. Such a compromise can result in substantial savings in cost, impacts, and time. This synthesis surveys practices used by transportation agencies for the consideration of utilities during the project development process—at what point in the process utility impacts are assessed and relocation decisions made; what policies, regulations, manuals, and guidelines are used; and how design decisions are influenced by utilities.

2010; 44 pp.; TRB affiliates, $28.50 ; nonaffiliates, $38. Subscriber categories: design; highways.

Current Practices in Greenhouse Gas Emissions Savings from Transit

TCRP Synthesis 84

Data were gathered from a sample of transit agencies—via a literature review, survey, and interviews—to determine the role of transit agencies in reducing greenhouse gas (GHG) emissions. Public transportation can displace emissions from other modes by reducing private vehicle miles traveled, cutting on-road congestion, and facilitating compact development patterns. Transit agencies also can reduce their own GHG emissions; according to the synthesis, every agency that responded to the survey is planning to do so.

2010; 78 pp.; TRB affiliates, $36.75; nonaffiliates, $49. Subscriber categories: energy; environment; public transportation.

Reference Guide on Understanding Common Use at Airports

ACRP Report 30

Designed to help airports and airlines explore the integration of common use in their operations, this reference guide outlines financial, operational, liability, safety, customer service, and competitive elements of a common-use approach for airport facilities and services. An accompanying CD-ROM includes spreadsheet models and provides an alternative approach to the information in the reference guide.

2010; 232 pp.; TRB affiliates, $58.50; nonaffiliates, $78. Subscriber category: aviation.

Airport Revenue Diversification

ACRP Synthesis 19

Different sources of revenue for airports are explored, separating core aeronautical revenue from ancillary revenues. Drawing from a literature review and expert interviews, this volume also examines ways in which airports have diversified their activities, and highlights the challenges that arise when nonaeronautical activity is proposed on land subject to Federal Aviation Administration grants, obligations, and assurances.

2010; 55 pp.; TRB affiliates, $30.75; nonaffiliates, $41. Subscriber categories: aviation; finance.

INFORMATION FOR CONTRIBUTORS TO

TR NEWS

TR News welcomes the submission of manuscripts for possible publication in the categories listed below. All manuscripts submitted are subject to review by the Editorial Board and other reviewers to determine suitability for *TR News*; authors will be advised of acceptance of articles with or without revision. All manuscripts accepted for publication are subject to editing for conciseness and appropriate language and style. Authors receive a copy of the edited manuscript for review. Original artwork is returned only on request.

FEATURES are timely articles of interest to transportation professionals, including administrators, planners, researchers, and practitioners in government, academia, and industry. Articles are encouraged on innovations and state-of-the-art practices pertaining to transportation research and development in all modes (highways and bridges, public transit, aviation, rail, and others, such as pipelines, bicycles, pedestrians, etc.) and in all subject areas (planning and administration, design, materials and construction, facility maintenance, traffic control, safety, geology, law, environmental concerns, energy, etc.). Manuscripts should be no longer than 3,000 to 4,000 words (12 to 16 double-spaced, typed pages). Authors also should provide appropriate and professionally drawn line drawings, charts, or tables, and glossy, black-and-white, high-quality photographs with corresponding captions. Prospective authors are encouraged to submit a summary or outline of a proposed article for preliminary review.

RESEARCH PAYS OFF highlights research projects, studies, demonstrations, and improved methods or processes that provide innovative, cost-effective solutions to important transportation-related problems in all modes, whether they pertain to improved transport of people and goods or provision of better facilities and equipment that permits such transport. Articles should describe cases in which the application of project findings has resulted in benefits to transportation agencies or to the public, or in which substantial benefits are expected. Articles (approximately 750 to 1,000 words) should delineate the problem, research, and benefits, and be accompanied by one or two illustrations that may improve a reader's understanding of the article.

NEWS BRIEFS are short (100- to 750-word) items of interest and usually are not attributed to an author. They may be either text or photographs or a combination of both. Line drawings, charts, or tables may be used where appropriate. Articles may be related to construction, administration, planning, design, operations, maintenance, research, legal matters, or applications of special interest. Articles involving brand names or names of manufacturers may be determined to be inappropriate; however, no endorsement by TRB is implied when such information appears. Foreign news articles should describe projects or methods that have universal instead of local application.

POINT OF VIEW is an occasional series of authored opinions on current transportation issues. Articles (1,000 to 2,000 words) may be submitted with appropriate, high-quality illustrations, and are subject to review and editing. Readers are also invited to submit comments on published points of view.

CALENDAR covers (*a*) TRB-sponsored conferences, workshops, and symposia, and (*b*) functions sponsored by other agencies of interest to readers. Notices of meetings should be submitted at least 4 to 6 months before the event.

BOOKSHELF announces publications in the transportation field. Abstracts (100 to 200 words) should include title, author, publisher, address at which publication may be obtained, number of pages, price, and ISBN. Publishers are invited to submit copies of new publications for announcement.

LETTERS provide readers with the opportunity to comment on the information and views expressed in published articles, TRB activities, or transportation matters in general. All letters must be signed and contain constructive comments. Letters may be edited for style and space considerations.

SUBMISSION REQUIREMENTS: Manuscripts submitted for possible publication in *TR News* and any correspondence on editorial matters should be sent to the Director, Publications Office, Transportation Research Board, 500 Fifth Street, NW, Washington, DC 20001, telephone 202-334-2972, or e-mail jawan@nas.edu.

◆ All manuscripts should be supplied in 12-point type, double-spaced, in Microsoft Word 6.0 or higher versions, on a CD or as an e-mail attachment.

◆ Submit original artwork if possible. Glossy, high-quality black-and-white photographs, color photographs, and slides are acceptable. Digital continuous-tone images must be submitted as TIFF or JPEG files and must be at least 3 in. by 5 in. with a resolution of 300 dpi or greater. A caption should be supplied for each graphic element.

◆ Use the units of measurement from the research described and provide conversions in parentheses, as appropriate. The International System of Units (SI), the updated version of the metric system, is preferred. In the text, the SI units should be followed, when appropriate, by the U.S. customary equivalent units in parentheses. In figures and tables, the base unit conversions should be provided in a footnote.

NOTE: Authors are responsible for the authenticity of their articles and for obtaining written permissions from publishers or persons who own the copyright to any previously published or copyrighted material used in the articles.