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3

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28

COVER: Bison in Theodore Roosevelt National Park, McKenzie County, North Dakota cross Route 10, Scenic Drive, which was rehabilitated in fall 2009 with funds from the American Recovery and Reinvestment Act. (Photo: Kimberly Fisher)

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.

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Javy Awan, Editor and Publications Director
Lea Mae Rice, Assistant Editor
Jennifer J. Weeks, Photo Researcher
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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.

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ALSO IN THIS ISSUE:

COMING NEXT ISSUE

The Federal Highway Administration's Highways for LIFE program, which partners in the development of vanguard technologies and then works to bring them into the mainstream; a tour of the Research and Innovative Technology Administration's purview and domain; initiatives to expand European–U.S. collaboration in transportation research; an update on transportation innovations in the national parks; and photographic highlights from the full scope of activities at the TRB 89th Annual Meeting—and more—will fill the pages of the March–April *TR News*.

PHOTO: CABLE RISDON

U.S. Secretary of Transportation Ray LaHood (*right*) meets with members of the press after addressing a capacity audience at the Chairman's Luncheon, January 13, 2010, during TRB's 89th Annual Meeting in Washington, D.C.

Mutual Benefits and Close Connections

Baseball and America's Streetcars in the 19th Century

ROBERT G. CULLEN

The author is Information Resource Manager, American Association of State Highway and Transportation Officials, Washington, D.C. This article is adapted from a presentation at the 20th Cooperstown Symposium on Baseball and American Culture, 2008.

Mark Twain characterized baseball as "the very symbol, the outward and visible expression of the drive and push and rush and struggle of the raging, tearing, booming 19th century" (*1*). Throughout its formative decades, America's national pastime came to signify more than just a game involving a bat and a ball. The sport reflected and represented the increasingly industrialized, rough-and-tumble, entrepreneurial phase of American history.

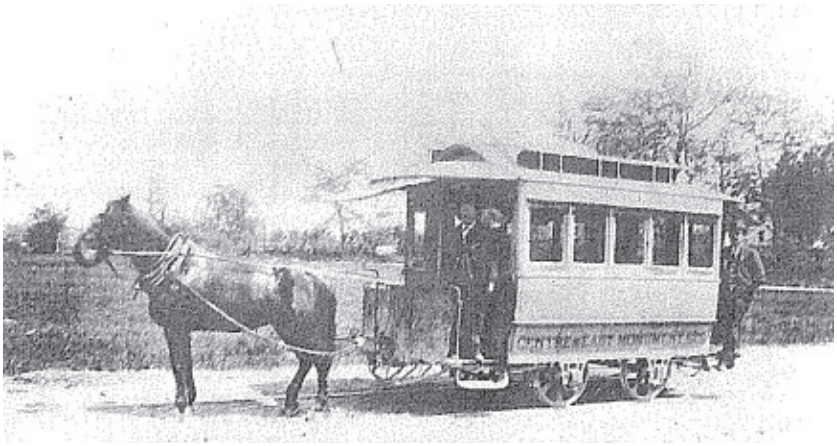
Businesses of the era used baseball to promote products—a marketing trend that took root after the Civil War and expanded dramatically by the 1880s. Some products—such as the bats and uniforms manufactured by the sporting-goods industry—were easily identified with baseball. Other products—such as food and beer—also would become strongly linked with the game. Additional economic interests—for example, those involving tobacco, drugstores, jewelry, and dry goods establishments—had less immediate connections with the sport but sought to capitalize on its popularity.

Streetcars had obvious and unique links with baseball. In the late 19th century, public transit via streetcars regularly intersected with baseball, with mutual benefits. Unlike many other enterprises, streetcars served a practical purpose for baseball—delivering large numbers of people to the games easily, quickly, and cheaply (*2*). Collaboration between baseball and streetcars therefore was consequential for both.

The speed, capacity, and low price of streetcar transportation intersected with the public attraction of baseball games in a way that provided mutual benefits.

Outside South Side Park in Chicago, players in the American League's Chicago White Sox take part in a parade celebrating the team's 1906 World Series championship. Visible on the left side of the image are streetcar tracks, with a streetcar in the background.

PHOTO: CHICAGO DAILY NEWS NEGATIVES COLLECTION, CHICAGO HISTORY MUSEUM



Like other forms of transportation in the mid-nineteenth century, early rail cars were horse-drawn. The rails allowed the cars to travel quickly and offered a smoother ride.

Steady Evolution

Streetcars grew in quality and scope during a time when baseball was steadily evolving. The origins of the streetcar in the United States can be traced to 1827, when a horse-drawn carriage that could carry a dozen passengers was introduced in New York City. This type of carriage became known as the omnibus.

The stagecoach-like means of transportation proved popular but had some conspicuous flaws—for example, shaking noisily over cobblestone streets and getting stuck in mud. The flaws were addressed in 1832, when a horse-drawn rail car began running in New York City between Prince Street in Lower Manhattan and Harlem. Riding on steel rails in the middle of the street, the vehicle provided a quieter and more comfortable ride. The rails also allowed the cars to travel at a faster pace.

Although more promising as a form of mass transit, the rail cars left much to be desired. The rail car needed fewer horses than the omnibus did, but the reliance on animals was still problematic—horses were expensive to sustain, usually lasted no more than 5 years on the job, were susceptible to illness, and posed sanitary challenges. The Civil War underscored the vulnerability of an animal-dependent transportation system when many railway horses were hauled away for military use.

Alternative Power Sources

People started looking for alternative, preferably mechanized, ways to move the nation's streetcars. In 1873, the cable car debuted in San Francisco. The system operated on extensive steel cables placed underground between the rails. A large steam engine in a central powerhouse kept the cables moving.

This conveyor-belt operation was an improvement over the use of horses, and cable cars were a good fit for cities like San Francisco with steep grades and mild climates. Cable cars, however, were not as well-suited for cities with different topographies and less temperate weather. Moreover, the systems were expensive to build, and a single cable break could strand passengers on the entire line.

In the 1880s, several efforts focused on harnessing electricity to mobilize streetcars. Inventor Leo Daft introduced the first-ever commercially operated electric streetcar in 1885. With a power unit, Daft supplied electricity through a third rail between two riding rails on a track in Baltimore. The electric current allowed a locomotive to pull former horsecars forward along the track.

What's a Trolley?

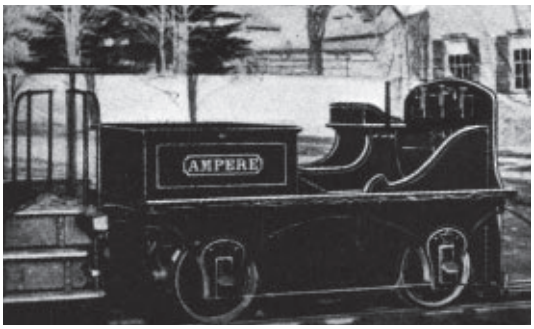
A greater breakthrough, however, occurred in 1888. Frank J. Sprague, an inventor who had worked for Thomas Alva Edison, installed a system of electric streetcars in Richmond, Virginia. The streetcars relied on overhead wires for electricity. The current originated at a central station and traveled from the wire to the car's motor via a long pole. The pole was outfitted with a small wheel called a shoe, which rolled along the wire. The wheel also was known as a trolley, a word soon used to describe that type of streetcar.

Sprague's electric streetcar experiment in Richmond proved a huge success. The overhead wires were more reliable than the third rail for moving the vehicles. The electricity-powered motors were efficient and strong enough to sustain climbs up steep inclines, to operate safely over bumps, and to ensure a smoother ride.

By providing a major city like Richmond with an entire network of state-of-the-art streetcars, Sprague opened a new world of public transit possibilities. He revolutionized a mode of transportation throughout the United States. Many municipalities, large and small, soon adopted the Richmond-based streetcar model.

Photo: Wikimedia Commons

Electric streetcars, introduced in 1888 in Richmond, Virginia, by Frank J. Sprague, used an electrical current traveling through overhead wires to the car's motor via a long pole and small wheel called a trolley. The new "trolleys," as the streetcars came to be called, were a great success.



Public Domain Photo

An experimental electric locomotive Ampère, built by Leo Daft in 1883. In 1885, Daft introduced the first-ever commercially operated electric streetcar.

A view of Richmond's trolley streetcars. Municipalities across the United States quickly adopted trolleys as a form of public transit.

Streetcar Systems

By 1890, approximately 200 electric streetcar systems were operating in the United States. The growth continued at a dramatic pace—according to an article published in *Harper's New Monthly Magazine* in 1898, "A decade has worked wonders in the evolution of the electric railway, as in many other modern things….It has grown from an experiment to a universal institution" (*3*).

Nationwide, streetcars were found to be dependable, operating in almost any weather condition; were easy to keep clean; and were relatively inexpensive to construct. In addition, the average streetcar fare of five cents was affordable for many. The vehicles significantly trimmed the travel time from one point to another. A person could travel the distance of a half-hour's walk in 10 minutes via streetcar.

The electric streetcar, or trolley, had other major advantages. Steam locomotives could be louder, grimier, more cumbersome, and less comfortable than streetcars, which therefore were considered better suited for urban settings. Streetcars also offered accessibility to areas that were often beyond the immediate reach of railroads. This accessibility led more people to start riding streetcars during the 1890s to work, school, worship, and other vital activities.

Expanding Patronage

Looking to expand this patronage, streetcar companies sought other compelling destinations to encourage ridership and to maximize profits. The companies needed to keep the operating and administrative costs down without increasing fares. To continue extending the transit lines, streetcar executives needed the largest possible customer base to justify new investments in infrastructure and electricity.

Streetcar companies therefore increasingly promoted the recreational opportunities along their routes, especially during evenings, weekends, and holidays, when traditional ridership was low. Summer was seen as a lucrative time for travel to recreational pursuits, and some streetcar lines ran only in the summer months to accommodate the extra traffic. People were encouraged to use streetcars, which normally operated with their sides open at that time of year, to enjoy leisure activities near and far—for example, sightseeing tours in the country, shopping sprees in the city, picnics, day-trips to the seashore, and attendance at concerts and theater matinees.

As part of this outreach, streetcar companies devised other incentives to lure riders onto trolleys. Some companies set up recreation areas at the end of streetcar lines. The areas became known as "trolley parks" and typically included such diversions as roller coasters, carousels, and other amusement attractions. In May 1896, the *Street Railway Journal* reported that at least 100 companies had opened their own trolley parks in the previous 10 years (*1*).

By establishing the parks and facilitating access to other entertainment venues, streetcar executives did much to make the thirst for recreation an integral feature of the trolley experience. "The American people—or at least a very large part of the American people—[have] become a pleasure-loving folk," proclaimed *Harper's New Monthly Magazine*. "Is there a more festive-looking vehicle than the open electric car, with its happy-faced occupants?" (*3*).

In the 1890s, electric streetcar systems gave travelers a quick way to access areas that were too far to walk and too close to take the train.

Baseball Synergy

Baseball became an important way of filling streetcars with "happy-faced occupants." The comparatively

PHOTO: LIBRARY OF CONGRESS, PRINTS AND PHOTOGRAPHS DIVISION, DETROIT PUBLISHING COMPANY COLLECTION

The "Loop the Loop" ride at Coney Island, New York, ca. 1903. The popularity and expansion of streetcar systems led companies to devise marketing plans—such as trolley parks and other recreational activities—that would attract riders.

PHOTO: LIBRARY OF CONGRESS, PRINTS AND PHOTOGRAPHS DIVISION

League Park I in Cleveland was built in 1891 by streetcar magnate Frank D. Robison, who also owned the Cleveland Spiders baseball team. The ballpark was located near two of Robison's streetcar lines.

young sport had mushroomed in popularity, and streetcar companies grasped that providing access to the games could enhance their own business. One streetcar executive commented that it was important "to keep in with the baseball people" (*1*).

Earlier in the century, railroads had established a pivotal relationship with baseball. Trains made it possible for teams to travel hundreds of miles to compete and to bring the games to an expanding pool of spectators. Streetcars, however, could offer a transportation benefit that steam locomotives could not, by carrying spectators directly to the ballparks, further expanding the fan base for games.

The up-and-coming relationship between streetcars and baseball was not coincidental. An estimated 15 percent of the nation's business leaders in the 19th century were transportation executives. Moreover, transit companies serving a total of 78 cities had some financial stake in professional baseball (*2*).

In smaller municipalities, streetcar companies often were one of the few sources of local capital able to maintain a professional team.

Albert L. Johnson, a streetcar executive who was also a baseball magnate, gave an unsentimental but candid explanation of the synergy. He characterized his own considerable efforts to link streetcars with baseball in Cleveland as a "good investment" and freely admitted to "visions of millions of dollars of profits" (*1*).

Johnson's comments exemplify the unvarnished financial approach taking hold of the business of baseball. More specifically, he voiced the view that capitalizing on baseball was a logical extension of other business interests. Streetcar companies found that their engagements with baseball strengthened their ties with government. The companies could watch over more closely—and safeguard—their stakes in local property values, rights-of-way, and long-term leases (*2*).

Riding the Trends

Johnson and his colleagues addressed a burgeoning grassroots need. The middle and upper-lower classes still had their share of hardscrabble times in the late 19th century, but generally they enjoyed more discretionary income and leisure time than before. Consequently, more of them rode streetcars bound for the ballpark (*1, 2*).

The streetcar companies worked to advance and sustain the trend. They built ballparks and leased playing grounds. Several companies subsidized baseball clubs—in the South, Augusta, Birmingham, Charleston, Macon, Mobile, Montgomery, and New Orleans received significant financial backing from companies that sponsored teams. In smaller municipalities as well, streetcar companies often were one of the few sources of local capital that were able to maintain a professional team and became important benefactors.

Streetcar executives in the 1890s, therefore, promoted the construction of ballparks near transit lines. Frank D. Robison, owner of the Cleveland Spiders, built a new park for his team in 1891 at Lexington Avenue and East 66th Street, after the previous park, in another location, was destroyed by fire. The new park—remembered today as League Park I—was situated conveniently near a couple of Robison's streetcar lines (*1, 2*).

Another major league baseball park of that era readily accessible to streetcar lines was Baltimore's Union Park at 25th and Barclay Streets. Home to the Baltimore Orioles for most of the decade, the ballpark may have owed its name to a streetcar company, the Baltimore Union Passenger Railway, which is believed to have paid for some of the ballpark's construction.

Competing for Teams

Many streetcar executives were willing to support a baseball team even at a financial loss, expecting to offset the loss in the long term with an increase in ridership on their vehicles. The best gauge of executives' economic enthusiasm for baseball, however, was the competition to promote ball clubs. During the 1890s, streetcar executives knew that if their company did not sponsor an area ball club, a competing line was ready to do so (2).

One-upmanship was common among competing companies. In 1892, the Atlanta Street Railway financed construction of a ballpark for the Southern League Crackers team in the southern part of the city. The venue was named Brisbine Park in honor of the company's executive. Two years later, the company's main rival, Consolidated Railway, built a larger park—known as the Athletic Grounds—in another part of Atlanta. The Consolidated Railway officials then enticed the baseball team away from Brisbine Park, boasting that their line could deliver a passenger from downtown Atlanta to the new ballpark in five minutes (2).

Another ballpark swap involving streetcars took place in New York City. The Brooklyn Grays—nicknamed the Bridegrooms because several players had married in quick succession—played home games at Washington Park in the Red Hook section of northwest Brooklyn in the early 1890s. A group of community leaders from Brownsville—a residential area in eastern Brooklyn—orchestrated the move of the team to Eastern Park. One of the chief financial backers of the move was streetcar executive Wendell Goodwin, who hoped that a team in Brownsville would encourage more people to use his transit lines.

The move proved to be a bad decision. The rent for the ballpark was steep. In addition, many team fans found the park difficult to reach, and the manner in which Goodwin's transit lines were set up made that trek challenging. To get to the park, fans and players had to cross over the tracks carefully, keeping on the lookout for approaching streetcars.

Photo: Maryland Historical Society

Baltimore's Union Park at 25th and Barclay Streets, one-time home of the Orioles, may have been partially financed by the Baltimore Union Passenger Railway.

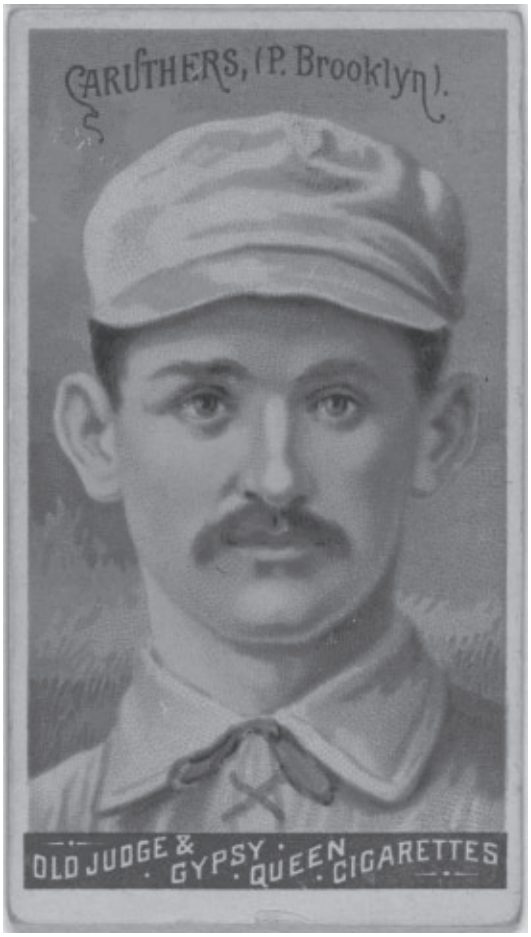


Photo: Library of Congress, Prints and Photographs Division

A baseball card featuring Brooklyn Dodgers player Bob Caruthers. After the Brooklyn Grays' move to Eastern Park, the team's nickname changed from the Bridegrooms to the Trolley Dodgers, because of the hazards of crossing trolley tracks to get to the ballpark.

Making a Name

Goodwin's Eastern Park transit lines may not constitute the most positive example of streetcar service during that era, but they are the source of a lasting baseball legacy. The team's nickname was changed from the Bridegrooms to the Trolley Dodgers, because of the hazards of crossing the tracks and avoiding streetcars to get to the ballpark. The moniker eventually was shortened to Dodgers and remains the team's official name, even after the move from Brooklyn to Los Angeles.

When the Eastern Park lease expired in 1897, the team returned to the safer venue of Red Hook. A new version of Washington Park was built directly across the street from the original. Two streetcar companies with routes passing through the area subsidized construction of the new park. The companies jointly purchased the lot for $15,000 and leased it to the team for $5,000—one-third less than the lease in Brownsville (2).

Over the course of the decade, streetcars took on other roles and cultural references with links to base-

PUBLIC DOMAIN PHOTO

Advertising schemes often brought trolleys and baseball together. In the late 1890s, Cleveland Spiders fans could purchase a game ticket and trolley fare package for 60 cents.

ball. A trolley league of baseball teams that relied exclusively on streetcars to get to and from games sprang up in New England, circa 1899. Many streetcars on ballpark routes carried signs advertising games. In the late 1890s, fans of the Cleveland Spiders could buy 60-cent tickets that included round-trip streetcar fare and admission to the ballpark. The service was popular because fans were spared long waits at the ballpark box office (*1, 4*).

Expressing the Bond

A defining experience of the bond between streetcars and baseball occurred in Baltimore on the night of Thursday, October 10, 1895. The Orioles had beaten the New York Giants the previous month to win the National League pennant for the second year in a row. In the postseason Temple Cup series, however, the Orioles were not faring well against Cy Young and his Cleveland Spiders teammates. The series had opened in Cleveland, and the Orioles were down three games to none (*1, 2*).

Back in Baltimore for the remaining games, the Orioles were treated to a parade by their loyal fans. Ostensibly a belated celebration of the pennant win, the parade also served as a morale-boosting exercise for a team that was now down on its luck. The nighttime parade consisted of a procession of approximately 40 streetcars winding along tracks through the city's streets. The next morning's edition of the *Baltimore Sun* proclaimed, "A man passing over Baltimore in a balloon last night might have imagined that a fiery serpent was creeping through the streets" (*4*).

The streetcars that made up the serpent were festooned with lights and adorned with baseball-themed decorations. The cars leading the parade carried the Orioles, their families, and veteran players from earlier Maryland baseball clubs. Enthusiastic crowds lined up for what the *Sun* called a "trolley party" and "electric parade" (*4*).

Although the Orioles lost the Temple Cup series to the Spiders, the parade in their honor showcased the substance and symbolism of the streetcar–baseball relationship. The streetcar industry, and the role of streetcars in taking fans to baseball games, would continue to grow in the early decades of the 20th century. Eventually many of the vehicles would be supplanted by other mass-transit options, like subways and motorized buses. Still in its infancy in the late 19th century, the automobile likewise would become a formidable competitor.

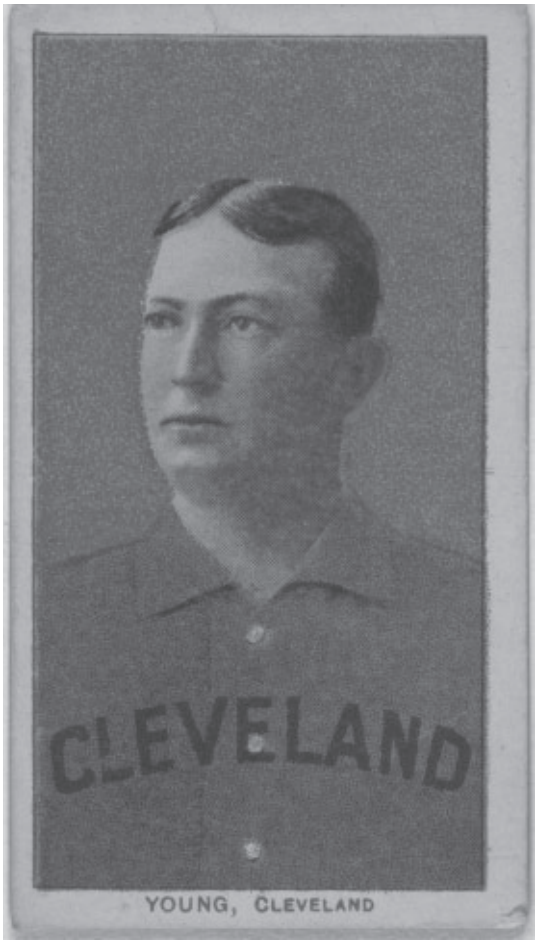


PHOTO: LIBRARY OF CONGRESS, PRINTS AND PHOTOGRAPHS DIVISION

Cy Young led the Cleveland Spiders to a Temple Cup victory against the Baltimore Orioles in October 1895. Back home, Orioles fans staged a streetcar parade in the team's honor as a morale booster.

Sociocultural Force

Nonetheless, the streetcar deserves recognition as the forerunner of those more modern modes and for its crucial contribution to bringing previously far-flung locales closer together. For baseball, streetcars played an important role in diversifying the attendance at games. In addition, hefty investments of money and infrastructure by streetcar executives contributed in the long term to establishing ballparks as permanent fixtures on the American landscape.

These contributions underscore the lasting impact of streetcars on baseball's growth as a sociocultural force, even though the clang and clatter of a trolley is no longer instantly and widely associated with the crack of a bat and the cheers of a crowd rooting for the home team. The study of streetcars in the 19th century illustrates transportation's time-honored influence not just on destinations, such as ballparks, but on everyday life.

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Creating Organizational Change in Departments of Transportation

Applying Self-Assessment Processes to Align Goals

KATHLEEN M. IMMORDINO AND ERNEST KOVACS

Immordino is Director, Organizational Research and Assessment, Center for Organizational Development and Leadership, Rutgers University, New Brunswick, New Jersey, and former Assistant Commissioner of the New Jersey Department of Transportation (DOT). Former Manager of Organizational Development and Training, New Jersey DOT, Kovacs is Assistant Professor, Administrative Science, Fairleigh Dickinson University, Madison, New Jersey.

Leaders and managers in state departments of transportation (DOTs) across the country face many critical challenges, such as deteriorating infrastructure and competing priorities. These needs are complicated by a difficult economic climate of reduced budgets and fewer staff.

Business as usual—continuing to operate in the same manner and with the same organizational structure that has been in place—may no longer be effective in addressing the current levels of need. Instead, transportation agency leaders must determine how best to deploy the limited human and fiscal resources and how to effect the organizational changes necessary to direct the available resources to the highest priority and to the most critical issues.

The Case for Change

Successfully creating the case for change requires a strategy to focus staff attention on the most critical areas by assessing the agency's highest priorities and by identifying the issues that are impeding increased effectiveness. A recent study documented how a state DOT used an organizational self-assessment process to create a focus and initiate organizational change.

The New Jersey DOT conducted an organizational self-assessment of its Division of Local Aid and studied the resulting effect on staff. The assessment process followed the guidelines of the Baldrige National Quality Program. Organizations such as the American Association of State Highway and Transportation Officials, the Federal Highway Administration, and the National Partnership for Highway Quality have noted that the Baldrige National Quality Program can be an appropriate model for assessing the effectiveness of transportation agencies.

To meet the challenges of maintaining the transportation system, state DOTs nationwide—and transportation agencies at all levels—are pressed to increase their effectiveness and their efficiency. The Baldrige criteria are appropriate for examining the workings of the organization as a whole or of a part of the organization.

PHOTO: JACLYN IMMORDINO, JAI DESIGN STUDIOS

Employees of the New Jersey DOT Division of Local Aid discuss ways to implement ideas gained from the organizational self-assessment process: (*left to right*) Deven Patel, Shukri Abuhuzeima, Judith Bole, and Cheryl Kokotajlo.

A Transportation Executive's Guide to Organizational Improvement, produced under National Cooperative Highway Research Program Project 20-24(42), Guidelines for State DOT Quality Management Systems, notes that as of 2006, 29 states were using some modified version of the Baldrige criteria to encourage innovation and improve performance.

What Is Baldrige?

The U.S. Congress created the Baldrige National Quality Program through the Malcolm Baldrige National Quality Improvement Act of 1987. The National Institute for Standards and Technology, part of the U.S. Department of Commerce, manages the program, which is based on the premise that certain values and characteristics can be identified in companies that have demonstrated organizational excellence.

The prestigious Malcolm Baldrige National Quality Award promotes the results of the program—although only a small group of the organizations that apply the Baldrige assessment structure aspire to compete for the national award. The Baldrige model establishes criteria for performance excellence in seven categories:

- Leadership;
- Strategic planning;
- Customer focus;
- Measurement, analysis, and knowledge management;
- Workforce focus;
- Process management; and
- Results.

Each of these categories contains a series of questions about the organization's processes, programs, and results. Researching the information to answer the questions in the criteria for performance excellence focuses attention on the organization's strengths and on the areas that require improvement. The criteria reflect the areas associated with organizational excellence in the public and private sectors alike.

Adapting the Process

The Baldrige process calls for the preparation of an organizational description or profile, followed by extensive internal information gathering to obtain detailed responses to the questions in each of the seven categories. The Baldrige process is thorough but time-intensive.

In 1999, New Jersey DOT conducted an assessment of the entire agency with teams of employees trained in the Baldrige criteria. The process took more than one year to complete. When considering another assessment in 2005, New Jersey DOT leaders took account of limited time and resources and looked for a means to conduct an assessment in a shorter period. To accomplish this, they charged one departmental division to pilot a workshop model that condensed the Baldrige process.

The pilot consisted of a facilitated assessment workshop, completed in two sessions that occupied a total of one-and-a-half days. The focused, concentrated effort required a much smaller investment of time but engaged the participants in a way that produced results. The workshop facilitators were able to guide the employee participants to a consensus on the most significant issues for their organization and to reinforce their capacity to launch initiatives that could improve organizational performance.

To make the workshop more useful for transportation agencies, the facilitators adapted the Baldrige criteria to include language and examples that would resonate with transportation agencies. The modifications incorporated terminology that was more applicable and recognizable to transportation professionals.

For example, questions that referred to customers

PHOTO: NATIONAL INSTITUTES OF STANDARDS AND TECHNOLOGY

Vice President Joseph Biden addresses the Baldrige Award presentation ceremony, December 2009, commenting that "good enough wasn't good enough" for the three award recipients and praising their commitment to "improving, inventing, and innovating."

were changed to relate to constituents and stakeholders. Questions about financial performance adjusted references to profit and loss into measures more suited to state and federal transportation funding mechanisms. Adapting the assessment program to a workshop format recognized the pressing nature of work in the agency and allowed representative participants to produce solid results with a minimal investment of time.

To ascertain whether change took place, web-based surveys were administered before and after the workshop, asking participants to identify the critical issues facing the organization. A comparison of the issues identified before the workshop with those identified after the workshop showed that participants changed their views after the assessment. The after-workshop responses showed that participants approached a greater degree of agreement on the critical organizational issues and on the relative priorities of the issues.

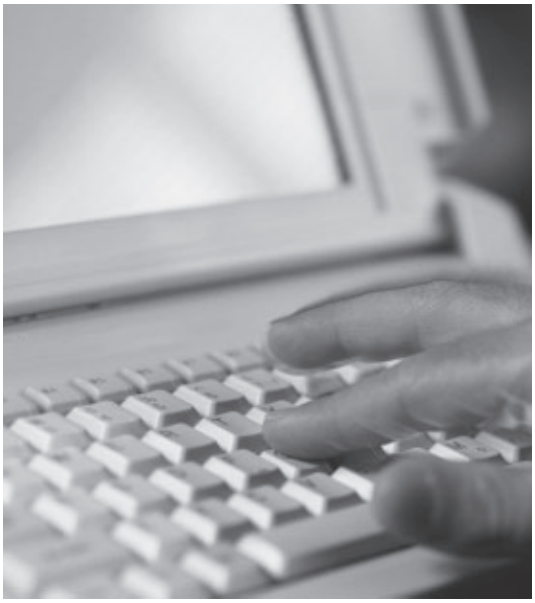
Applying the Model

The New Jersey DOT Division of Local Aid proved an ideal candidate for the adapted Baldrige process. The division is responsible for the distribution of federal and state funds for transportation projects to county and municipal governments. Working with county and municipal engineers, the division provides funding for smaller infrastructure projects. The division has a central office staff plus four field offices geographically dispersed throughout the state to meet the needs of customers or constituents. When the assessment workshop was offered, the Division of Local Aid was the first to volunteer and identified a significant cross-section of staff as participants.

A week before the workshop, each participant from the division received an e-mail with a link to an online preassessment survey to be completed before the first day of the workshop. The survey asked the participants to identify the critical issues facing the division and to rank the issues according to priorities. Respondents were assured of anonymity.

Conducting the Workshop

The workshop was conducted by facilitators from outside of the department who had experience in working with the Baldrige criteria. The facilitators began the workshop by providing an overview of the Baldrige program and of the categories in the criteria for performance excellence. The facilitators explained each of the seven categories and reviewed the questions to be answered. Examples of best practices in each category were presented to illustrate some of the ways in which highly effective organizations operate.



Online surveys, before and after the workshop, allowed participants to identify and rank critical issues anonymously.

Group Discussions

Assigned to small groups, the participants discussed the questions and shared the information needed for the responses. By combining people from different parts and levels of the organization in the small groups, facilitators were able to increase the efficacy of the workshop. The assignments ensured that each person brought different kinds of information and different perspectives to the group discussions.

After collecting the information, each group engaged in brainstorming to identify the strengths and the opportunities for improvement in their division. Each group presented its observations to the workshop participants as a whole.

Scoring Performance

Participants then were instructed in the Baldrige scoring process and applied it. They assigned a point value from 0 to 100, reflecting personal perceptions of the division's current state of operation in each category. The point values were to reflect three considerations:

- Does the division have a systematic approach to the functions within the category?
- Is the approach widely deployed throughout the division?
- What is the extent of documented positive results for the division on the measures related to the category?

An organization in the initial stages of a strategic planning effort might be rated at 10 percent, for example, but an organization with fully implemented strategic planning, recognized as a national leader

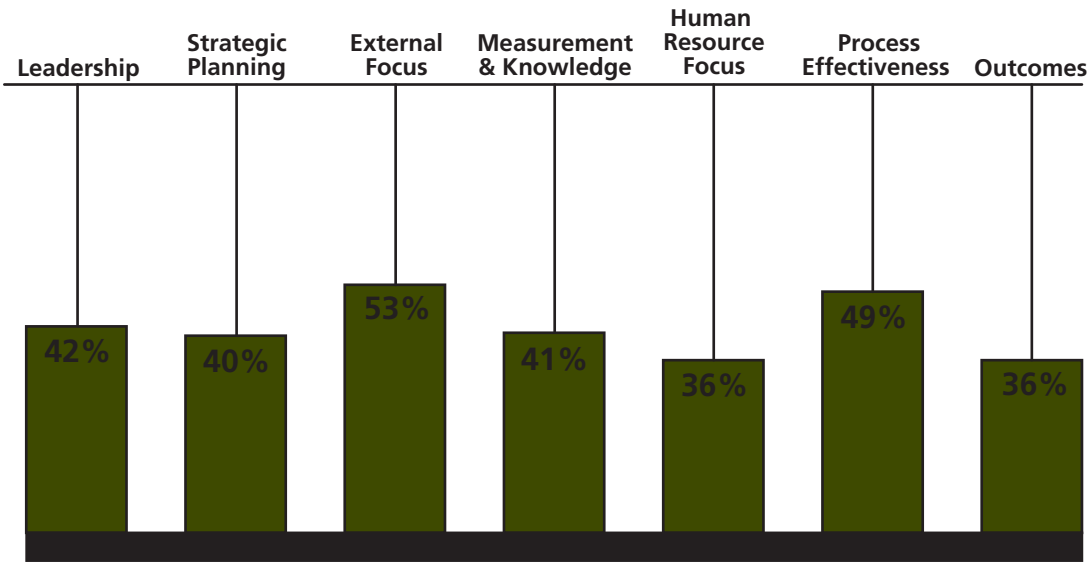


FIGURE 1 Diagram of the division profile created when participants assigned scores to each category.

among similar agencies, and with documented effectiveness, might be rated at 100 percent. The point values provided a way to compare the division's relative strengths in each of the seven areas (Figure 1).

Prioritizing Opportunities

The second half of the workshop was conducted one week later and built on the information developed by the discussion groups. The identified strengths provided a good sense of the current state of the division, but the second session focused on working with and prioritizing the identified opportunities for improvement.

The participants discussed the list of opportunities and refined it into a set of problem statements. A vote was taken on which problems were the most critical, establishing priorities. The group assigned team leaders, tasks, and target dates for the items with the highest priorities. The result was a set of initial project plans for further work and implementation after the completion of the self-assessment workshop.

Assessment Outcomes

Within one week of completing the self-assessment, the participants received an e-mail with a web link to a survey that repeated the original questions about issues and priorities. The survey results revealed several important outcomes.

Changing Views of Critical Issues

Before taking part in the assessment, Local Aid staff members identified 22 different issues they considered critical. After the assessment, participants rated only eight of those issues as critical (Table 1, this page). Of the four issues most often identified as critical in the preassessment survey, only two were still seen as critical afterwards, with only one of those still ranked in the top four.

The issue ranked as the most critical—"Not having enough funding"—remained constant across both surveys. The substantial changes to the balance of the list, however, could be attributed to the information that participants gained during the assessment and to changes in perspective that resulted from the discussions.

Emphasizing Process Improvement

Several new items were added to the list of critical issues after the assessment. One of these—"Need to streamline processes"—tied for third most critical issue. The division's processes were the subject of a substantial amount of discussion during the workshop. Initially, participants differed on what should be considered the core processes of the division. Agreement also was lacking on the extent to which the processes are formally documented.

After comparing information and discussing the various points of view, the group reached consensus. The participants agreed that the processes were not always implemented in the same way among the regional offices and that the division would benefit

TABLE 1 Comparison of Participant-Identified Critical Issues, Before and After the Assessment

Issues rated most critical before the assessment	Issues rated most critical after the assessment
1. Not having enough funding	1. Not having enough funding
2. (tie) Lack of staffing	2. Maintaining division data bases
2. (tie) Politicization of processes	3. (tie) Closing out projects
3. Trust Fund renewal	3. (tie) Need to streamline processes

from standardizing and streamlining the processes for major work activities and programs.

Applying Diverse Perspectives

The assessment process brought together the perspectives of different employee groups on issues they might not otherwise have opportunity to discuss. Discussion about the category of measurement, analysis, and knowledge management revealed concerns about the division's project database, from data entry to system maintenance and report generation.

In particular, the discussion demonstrated the benefit of including employees from all occupational groups in the assessment—the perspectives of the administrative and clerical employees on the problems with the database differed from those of the program staff. Through the discussion, both sides came to see that the problem was not in the construction of the database, as originally thought, but in the inconsistent processes for recording and tracking data.

With staff members in different occupational groups identifying different problems with the system, participants were able to recognize that the problem was more extensive and therefore was an important issue to resolve. Although improving the database was not on the original list of critical issues, the group selected it at the end of the assessment as one of the four highest priorities for action.

The group discussion on feedback from stakeholders also yielded practical insights. An exchange about how feedback is received—in writing, by phone, via e-mail, or in face-to-face communication—and then reviewed and shared with staff revealed that different staff groups received different amounts of feedback. The group recommended the establishment of a more formal process to convey positive and negative feedback from stakeholders to the staff.

Rethinking Human Resources Issues

"Lack of staff" tied for second most critical issue before the assessment but was not listed at all in the postassessment survey results. In the workshop, the group focused more on what could be accomplished with current staff by improving processes than on the lack of staff.

The discussions demonstrated the benefit of including employees from all occupational groups in the assessment. Each group engaged in brainstorming and presented its observations to the workshop as a whole.

After discussing the questions in the workforce focus category, participants may have concluded that human resources issues were not the highest priority for improvement in relation to the six other categories. Although participants still may have believed that the human resources issues should be addressed, they no longer saw this as an area in which the most progress could be made, considering the other opportunities for improvement.

Changing the Measures of Success

Participants also were asked how the effectiveness of the division should be judged—in other words, how organizational success should be measured. The measures of success suggested by participants also changed after the assessment (Table 2). The responses after the assessment reflected quality management concepts, including the measurement of outcomes and the focus on stakeholders.

The most frequently mentioned item in the preassessment survey, "ability to administer and close out projects," was replaced by the more measurable "project completion" and "projects/volume of work under construction." Instead of measuring success by the ability to administer programs, participants recommended measurement according to "efficiency in administering programs." The percent of participants who suggested "excellent customer service" as a program benchmark more than doubled.

Positive Changes in Staff Knowledge and Outlook

A key assumption is that a self-assessment process will increase staff members' knowledge of the orga-

TABLE 2 Participant Responses to the Question: On What Should Division Effectiveness Be Judged?

Preassessment	%	Postassessment	%
1. The ability to administer and close out projects	15.1	1. Project completion	18.6
2. Efficiency in administering programs	13.2	2. (tie) Efficiency in administering programs	14.0
3. Project completion	7.5	2. (tie) Excellent customer service	14.0
4. Excellent customer service	5.7	3. Projects and volume of work under construction	11.6

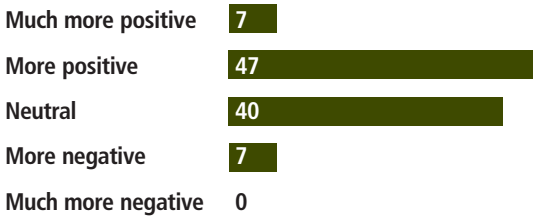


FIGURE 2 Postassessment changes in attitude about the workplace. (Participant responses to the question: How would you describe the way you see the division now compared to what you thought before the assessment?)

nization by learning from the contributions of colleagues during the workshop. In the Division of Local Aid, 26 percent of the participants indicated that they had gained new information about the division and its work from the exchanges during the assessment process. In addition, a total of 54 percent said that they had a more positive perception of the organization after participating (Figure 2, this page).

In a follow-up interview six months after the workshop, the director of the Division of Local Aid said that immediate action was taken after the assessment to implement the decisions and to institute changes in the organization, as well as to reinforce the ideas developed in the workshop. The director stated that the participation of staff in the self-assessment had "a lot of impact" on the work unit—the staffers who participated in the assessment were more focused on measures of stakeholder satisfaction. As a result, the director believed that the assessment had a sustained, positive impact on the organization and that future assessments would be valuable in monitoring the organization's continued progress.

Implications for Assessment Processes

The use of the Baldrige criteria in transportation organizations is consistent with trends in the industry, such as calls for stakeholder engagement in projects and recognition of the need to assess satisfaction with processes and projects alike. At the same time, transportation agencies are being asked to streamline processes, increase the use of technology, and make more effective use of human resources. The Baldrige process provides a method for leaders, managers, and process owners to self-assess their agency's performance capabilities in a systematic way. The process helps transportation professionals to prioritize areas for improvement and to build the commitment and sense of project ownership that will improve organizational performance.

Two factors contributed greatly to the success of New Jersey DOT's organizational self-assessment. First was the recognition that time can serve as a barrier to the assessment process. Condensing to a one-and-a-half day workshop format focused attention on the process and on the specific categories of information. The reduced amount of time was reasonable and allowed staff members to participate without significant disruption of the division's work.

The second contributor to the program's success was the decision to make small—but important—transportation-oriented changes to the language of the Baldrige criteria and to include examples that were more recognizable to people who work in transportation agencies.

Foundations for Change

The workshop itself does not create change—the project plans must be carried out and the changes implemented afterwards. The participation by staff members encourages a commitment to make the initiatives for change more likely to succeed.

Using a self-assessment process in a state DOT—whether for the department as a whole or for a division, program, or office—creates a shared understanding among the participants about the current state of the organization, what it needs to do to accomplish its mission, and its strengths and priorities for improvement. The structured format provided by the Baldrige criteria, combined with the workshop approach, brings people together to focus on value-added processes and programs. The rigor of the self-assessment process gives the leaders of any state DOT a way to examine the department's priorities and to determine if current activities are in alignment.

An applied Baldrige assessment provides a tested method for transportation agencies to establish the foundations for organizational change. New Jersey DOT and its Division of Local Aid found that the participants gained new information about the division and were able to compare various perspectives on business processes. As a result, the participants became more open to the idea that change was both positive and possible.

Improving Transportation Organizations

More information about the Baldrige National Quality Program and quality processes in transportation is available on the Internet:

- Baldrige National Quality Award, http://baldrige.nist.gov/;
- *A Transportation Executive's Guide to Organizational Improvement,* American Association of State Highway and Transportation Officials, www.transportation.org/sites/quality/ docs/NCHRP%20Guide%20master%206%2030%2006.pdf; and
- National Partnership for Highway Quality, www.nphq.org/.

Making the Most of Available Funds

FINDINGS FROM THE TRANSPORTATION RESEARCH BOARD'S 2009 FIELD VISIT PROGRAM

Specialists in the Transportation Research Board's Technical Activities Division identify current issues, collect and generate information on the issues, and disseminate the information throughout the transportation community. The TRB Annual Meeting, TRB-sponsored conferences and workshops, standing committee meetings and communications, publications, and contact with thousands of organizations and individuals provide TRB staff with information from the public and private sectors on all modes of transportation.

A major source of this information is the TRB annual field visit program. Transportation professionals on the TRB staff meet on site with representatives of state departments of transportation (DOTs) and with representatives of universities, transit and other modal agencies, and industry. In addition, TRB staff is involved with planning and delivering conferences, workshops, and meetings. This report summarizes what the TRB staff learned from visits and activities during the past year.

FINDINGS FROM TRB's 2009 FIELD VISIT PROGRAM

The economic downturn, which began to affect state revenues during 2008, cut substantial amounts from state budgets in 2009. During fiscal year 2009, states reduced their general fund expenditures by 4.8 percent, according to the National Governors Association and the National Association of State Budget Officers. Reductions of at least 4 percent are expected in fiscal year 2010, as state revenue collections historically lag behind national economic recovery.

With the expiration of the Safe, Affordable, Flexible, Efficient Transportation Equity Act: A Legacy for Users in September 2009, the focus is on how the next bill will be funded and constructed. The expected series of short-term extensions is likely to intensify the funding uncertainties. Despite an $8 billion cash infusion to the Highway Trust Fund, agencies are grappling with financial shortfalls that have led to staff and service cutbacks, ranging from employee furloughs to the closing of traveler rest stops.

But even while these budget cuts were making headlines, TRB staff on field visits witnessed an untold story behind the scenes—leaders and staff in transportation agencies across the country are working harder than ever to serve their customers despite unprecedented financial challenges. They are applying dedication and innovation to make the most of the available funding and resources.

Institutional Issues

Policy, Management, and Leadership

The American Recovery and Reinvestment Act (ARRA), signed into law on February 17, 2009, provided $787 billion in funding, with $48.1 billion to U.S. DOT. Included was the Transportation Investment-Generating Economic Recovery Program, which made $1.5 billion in "TIGER grants" competitively available for capital investments in surface transportation projects that can have a significant impact on the nation, a region, or a metropolitan area.

PHOTO: KIMBERLY FISHER

U.S. DOT received 1,400 grant applications, requesting a total of more than $58 billion.

Some state DOTs are taking measures for future improvements. Arizona DOT has invested $11 million in a comprehensive statewide planning effort called Building a Quality Arizona. The program is a 40-year vision for the future aimed at engaging the public in conceptual thinking about their transportation needs and mobility desires. The effort emphasizes the links between mobility, land use, and economic vitality.

This collaborative effort has used an extensive public outreach process that includes open houses, focus groups, community workshops, website and online workshops, meetings with local elected officials and with representatives of neighboring states, and consultations with regional technical advisory teams.

At the open houses, stakeholders are asked to determine what resources to invest, how to shape the vision into reality, and what investments to make. The three-stage session starts with a video, *Arizona: Then, Now, and Ahead*, which presents a historic journey from the construction of the Interstates to the future of transportation. The next stage features Arizona DOT's recommendations based on the needs and community priorities, illustrated on a state map along with the vision and guiding principles, which include multimodal mobility; economic vitality; sustainability and environment; and safety and security. The last stage invites attendees to provide feedback and comments. Arizona DOT will use the input in long-range planning and in developing transportation infrastructure and services.

The Interstate 10–Hassayampa Valley Framework Study, conducted in 2006–2007, launched the Building a Quality Arizona process.

PHOTO: BOB HAZLETT, MARICOPA ASSOCIATION OF GOVERNMENTS

Planning

In recent years, the planning process has incorporated the consideration of such issues as greenhouse gas emissions, sustainable transportation, the failing

Highway Trust Fund, safety, and operations. Other issues have gone through cycles of priority and focus—such as transportation for the elderly who are aging in place, alternatives to the single-occupant vehicle, and high-speed rail.

Successful transportation planning agencies that can respond to critical issues in a timely way have demonstrated similar characteristics—strong connections to their community, a fundamental understanding of their community, and robust tools for the analysis of planning and policy questions. Although difficult to quantify, these three characteristics have served as a good gauge of a planning agency's effectiveness and ability to remain relevant in turbulent times.

Strong working relationships and established communication links with individuals and agencies outside transportation also have proved critical when new issues arise. For example, in many states, strong ties with safety officials have facilitated the inclusion of safety into the planning process.

A fundamental understanding of the community, region, or state also has reaped benefits, spanning economic drivers, demographics, community concerns, travel characteristics, and their evolution. Decision makers and the public usually cannot give a planning agency several years to develop the specific analysis tool or technique to answer an urgent policy issue. Forward-looking programs are developing, maintaining, and improving analysis tools so that agencies can respond in a timely way.

Legal Issues

The ARRA has emphasized the expeditious spending of stimulus funds. Many continue to explore and test innovative funding, public–private partnerships, and innovative contract delivery systems. Legal issues involving public–private partnerships seem to have no limit. With all its complexities, the topic again has captured the attention of transportation officials because of completed and pending megadeals.

With the renewed emphasis on infrastructure issues, the transportation legal community has recognized the need for state DOTs to update their manuals on design and construction. The pending release of the Highway Safety Manual will assist in these efforts, along with training related to the manual. Also highly anticipated is the next edition of the *Manual on Uniform Traffic Control Devices*, which promises increased precision in its requirements, as well as limits on the use of discretion in design.

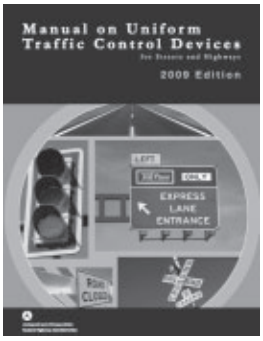
State DOT attorneys are keeping abreast of changes in environmental law and other developments. Of particular interest is the recent decision by the U.S. District Court for the Eastern District of Wisconsin in *Highway J Citizens Group v. U.S. DOT.* The ruling found that open house hearings do not satisfy the federal public hearing requirements administered by the Federal Highway Administration (FHWA) [23 USC §128(a)]. If other districts reach similar decisions, transportation projects that use open house hearings may need to modify their practices.

Energy and Climate Change

Legislatures at all levels of government are passing bills that require significant reductions in greenhouse gas emissions, cuts in vehicle miles traveled, and a reduction in the reliance on the automobile in the near future. Transportation and energy professionals are working to identify programs and projects to achieve these goals while maintaining and improving the transportation system and providing reasonable alternatives. Transportation agencies recognize that investment at all levels of the nation's transportation infrastructure must involve environmental stewardship and the mitigation of the impacts on global climate change.

Many national and international policy decisions are pivotal, including global policies in response to the 2009 Copenhagen conference on climate change and the cap-and-trade legislation under consideration in Congress. These developments, along with new research findings, may answer the following questions:

◆ Should the U.S. transportation sector be prepared to reduce greenhouse gas emissions in pro-



Upcoming edition of the *Manual on Uniform Traffic Control Devices*.

PHOTO: OREGON DOT

Oregon DOT's equipment (*above and below*) to measure vehicle miles traveled (VMT) is part of an effort to reduce VMT and greenhouse gas emissions.

PHOTO: OREGON DOT

portion to its contributions to the problem?

◆ Should solutions specifically address transportation, or should transportation be included in more general policies, such as the carbon tax or the cap-and-trade proposals?

◆ What options offer the most potential—efficiency and technological innovation, alternative fuels, or travel behavior and demand management?

Environment

In 2009, state DOTs continued to focus on water quality issues, including total maximum daily load levels in stormwater runoff and treatment options to reduce pollution levels. Agencies are looking at innovative ways to engage and inform the public about the environmental effects of projects, notably concerns about noise and air quality.

With an increased public and federal focus on green issues, state DOTs have explored ways to make projects more sustainable. Some have implemented strategies associated with the Leadership in Energy and Environmental Design certification for construction projects.

Other environmental issues addressed at the state level include the use of alternative fuels in state-owned vehicles, the effects of transportation-related vibration on historic properties, hazardous materials management, and managing and developing effective roadway crossings for wildlife.

PHOTO: ALLISON CONLEY

PHOTO: ALLISON CONLEY

North Carolina's first sustainable rest area opened in late 2009 on Highway 421 near North Wilkesboro. The building's sustainable features include a small building footprint, 4.5 acres of reforestation, a photovoltaic system, and preferred parking for fuel-efficient vehicles and vanpools.

PHOTO: ENTERPRISE GIS

Enterprise Geographic Information Systems applications are used by transportation agencies such as Georgia DOT.

Data and Information Technologies

To support increasingly complex decision making, state DOT data departments are moving away from an emphasis on data sets to focus on information. Performance measures are setting data program priorities. To sort out the links from data programs to decisions, many state DOTs are initiating data business plans to determine the data needed for key decisions and the investment required to maintain appropriate data quality.

The emphasis on decision making also drives timeliness requirements. Performance measures demand data more frequently, for the quarterly reports that are replacing annual summaries. Federal data partners also are seeking more frequent data updates to monitor national trends. States are developing data-sharing relationships with local and regional partners and are learning to meet such requirements as web-based tools, well-defined procedures, frequent training, and shared benefits.

To make best use of constrained resources, more real-time data are needed, leading to closer relationships between the state data operations communities, with continued improvement of the Archived Data User Service to capture operational data for decision making. Many DOTs are purchasing private data instead of generating the data themselves. Many have purchased probe data, for example, to identify congestion problems and to support performance measures.

Enterprise geographic information systems (GIS) have become a key tool in integrating data to support departmental decisions, as well as in displaying information. Many third-party software providers are integrating GIS into their products. Decisions on safety improvements, for example, require the integration of location-specific data on crashes, traffic, and road-

ways available in the new generation of safety tools.

Balancing the requirements for spatial accuracy, timeliness, and completeness with necessary investment is a major challenge. Choosing the right tools and integrating them across the entire DOT is important.

Security and Critical Infrastructure Protection

States and communities, as well as the private sector, are benefiting from the Department of Homeland Security's (DHS) Centers of Excellence, which bring together experts and researchers to conduct multidisciplinary studies and educational programs. The centers addressing transportation security issues—prevention, protection, preparedness, response, recovery, resiliency, and training—organized and hosted events in several states and cities in 2009, often with participation by TRB.

State and local governments have established 58 fusion centers to gather intelligence on terrorist and criminal activities and to share this information among government agencies. The Department of Justice and DHS have established guidelines for the centers, which focus on research and analysis to identify trends and prevent incidents.

Major security projects in 2009 include the opening of a multimillion dollar security center at the Port of Long Beach, with offices for federal, state, and local enforcement agencies. The center will gather and share information on terrorist and criminal activity in Southern California. A consortium of five deepwater ports on the Mississippi River received a $75 million DHS grant to establish a security layer along a key 300-mile stretch of the waterway; Louisiana has appropriated the first phase of matching funds.

PHOTO: JOEDY CAMBRIDGE

California's Operational Area Satellite Information System, or OASIS—subject of a conference poster display (*above*)—can be transported anywhere in the state to provide emergency communications.

Caltrans is partnering with the Office of Emergency Services on the Operational Area Satellite Information System (OASIS). Housed in a portable trailer that can be towed to any area of California, OASIS provides around-the-clock coverage in any emergency for which communication services are vital.

PHOTO: JEFF DOW/RENO-TAHOE INTERNATIONAL AIRPORT

Construction crews remodel the Reno–Tahoe International Airport's airport baggage check-in project, which was unveiled in December 2009. All airline ticket counters now operate from inside the newly remodeled ticket lobby.

Aviation

The volatile economies worldwide continue to affect the aviation industry, causing airlines and other aviation businesses to continue reductions in schedules and service levels. Revenues are down at airports throughout the country.

The federal government has yet to decide how to fund aviation system infrastructure needs—including technological infrastructure updates—and the pending reauthorization. Concerns remain about how to generate the funds—through changes to fuel taxes, user fees, or other charges, including passenger facility charges. Monies made available through the federal stimulus packages, however, have been put to good use throughout the airport system; many much-needed, shovel-ready projects are under way.

The national focus on green technology has produced an unanticipated consequence—the proliferation of wind turbine farms near airports, often close to critical flight paths. Although the turbines are not tall enough to require notification of the Federal Aviation Administration, the structures may cause safety concerns for pilots navigating around obstacles not shown on aeronautical charts.

Other issues that airports and state DOTs are addressing include wildlife strikes; mitigation of aviation-related effects contributing to climate change; noise levels; the fate of the Essential Air Service program; security at general aviation airports; and the new security program for large aircraft.

FINDINGS FROM TRB's 2009 FIELD VISIT PROGRAM

PHOTO: HANK SUDERMAN

A car carrier travels southbound I-75 just south of Perry, Georgia. The recession has led to a decline in automobile sales.

Freight Systems

The economic recession has translated into precipitous declines in freight transportation volumes for all modes. In the U.S. economy, personal consumption accounts for roughly 70 percent of gross domestic product. When consumers cut back spending, serious economic consequences follow. Because freight transportation is a derived demand, understanding both consumer behavior and the responses of producers and suppliers is necessary.

Major shifts in consumption patterns have occurred during the recession, with declines in expenditures for automobiles, homebuilding, and discretionary household goods. A reduction in the demand for imported goods caused large declines in import trade, most notably through the West Coast ports. Many factors will determine how and when Pacific trade traffic will rebound. East Coast ports are gearing up for more imports from all water routes, as well as from the shifts anticipated when the Panama Canal expansion is completed.

Public–private partnerships are developing new corridors for more efficient freight movement, including the Heartland Corridor's double-stack route from Hampton Roads, Virginia, to Chicago, a combined effort of Norfolk Southern and the states of Virginia, West Virginia, and Ohio; the competing National Gateway project by CSX, connecting mid-Atlantic ports with the Midwest and Ohio Valley; and the north–south Crescent Corridor, involving Norfolk Southern and five states, with the lead state of Pennsylvania seeking ARRA funds.

States taking a systems view of freight issues include California, building on its 2007 Goods Movement Action Plan to foster freight mobility, economic development, reduced environmental impacts, and public safety; and Maryland, which published a Statewide Freight Plan in 2009 to guide investments and program changes to accommodate freight transportation demand.

Highways

Design

Despite an unprecedented decline in revenue, state DOTs are trying to accommodate an increased demand for the restoration, renewal, and replacement of critical infrastructure. A reduction in design staff through retirements and other attrition is adding to the difficulties, but many innovative practices, tools, and methods have been developed.

Pavement and bridge management systems have enhanced project selection at the executive and policy levels. The systems are gaining acceptance and use, along with asset management principles. Many state DOTs are looking forward to integrating their pavement and bridge management systems with roadside inventory and maintenance databases to create statewide infrastructure management systems.

Determined to spend limited funds for the most favorable impacts on the environment and the needs of the public, many states are incorporating the newest materials and methods to obtain the safest, most durable, and sustainable designs. These approaches include precast bridge and pavement elements; concrete and asphalt incorporating recycled materials; and preparations to apply the principles of the *Mechanistic–Empirical Pavement Design Guide*.

States are designing accelerated bridge construction projects using high-performance materials, including steel, concrete, and polymers. The Vermont Agency of Transportation is designing bridges with integral abutments to mitigate environmental impacts and to reduce materials, costs, construction schedules, and future maintenance.

PHOTO: HIGHWAYS FOR LIFE

Placement of the abutment forms in the Lamson Bridge reconstruction project, part of a Highways for LIFE Maine Demonstration Project in Addison, Maine. The project featured a precast concrete back wall; precast, segmental retaining wall panels; and posttensioning duct pockets in the fascia beam.

PHOTO: KIMBERLY FISHER

Theodore Roosevelt National Park in McKenzie County, North Dakota. Route 10, which runs through the park, was rehabilitated in fall 2009 with funds from the American Recovery and Reinvestment Act; the road had not seen repairs since the early 1980s.

Highway Construction and Materials

With the economy struggling, major capital improvement projects declined, and most state DOTs focused on infrastructure renewal, congestion relief, and safety improvements. The stimulus funding under the ARRA gave a boost to construction activity, and state DOTs with jobs ready to go were able to take full advantage.

With most construction now under live traffic conditions, state DOTs are continuing to explore ways to improve jobsite safety, particularly for nighttime construction, and to minimize inconvenience to the public. A few states have used accelerated bridge construction techniques, ranging from prefabricated components to moving complete new structures into place during a weekend. States are monitoring the Renewal focus area of TRB's Strategic Highway Research Program 2 (SHRP 2), seeking guidance on rapid renewal.

Warm-mix asphalt has caught the attention of several state DOTs. The National Cooperative Highway Research Program (NCHRP) has sponsored a series of projects on warm-mix asphalt, with the latest project investigating performance characteristics, specifically moisture sensitivity.

Many states are considering raising the percentage of recycled asphalt pavement (RAP) in hot-mix asphalt. An NCHRP project is developing more guidance on high-RAP mixes.

More states are trying self-consolidating concrete on structures and are using recycled concrete as base material in pavement systems. Alkali-silica reactivity continues as a concern for some agencies, necessitating routine checks of aggregates.

Geotechnical Engineering

Geotechnical engineers have continued efforts to implement the Load and Resistance Factor Design standards for structural foundations, intelligent compaction, and the geotechnical aspects of design–build. Some of the most noteworthy activities of 2009, however, related to rockfalls.

The American Association of State Highway and Transportation Officials (AASHTO) has yet to approve guidelines for the design, evaluation, and maintenance of rockfall protection systems, such as barrier fences, hybrid drapery, attenuators, draped wire mesh, and draped cable net, or to approve any available products. The recently released European Technical Approval Guideline may eliminate the variations in results from different procedures for testing rockfall barriers and may facilitate comparisons between products.

Cost and performance are essential considerations in selecting rockfall mitigation measures. Washington State DOT has initiated an experimental project to evaluate the cost and performance of four different types of ring nets as a drapery in place of cable nets. The project is expected to provide useful information on installation and field performance.

Colorado DOT implements field testing of various post foundations and mesh and cable net materials for use in rockfall attenuator systems.

PHOTO: TY ORTIZ, COLORADO DOT

PHOTO: TY ORTIZ, COLORADO DOT

The results of Colorado DOT's field testing of rockfall attenuator systems materials were outlined in Transportation Research Circular E-C141.

Flexible rock net is another rockfall mitigation measure in frequent use. Proper design and construction of the post foundations for the nets is critical to performance. Caltrans is reviewing the industry's design and construction standards and is investigating the performance of the post foundations in rockfalls. Colorado DOT tested rockfall attenuators to investigate the durability and performance of several mesh and cable net products, as well as of post foundations.

Highway Operations

Congestion occurs when traffic demand exceeds available capacity. Causes of recurring congestion include insufficient facility capacity and ineffective management of capacity—for example, through poor signal timing. Causes of nonrecurring congestion include work zones, incidents, weather events, special events, and emergencies.

Historically, the solution to recurring congestion has been to construct new highways or to widen highways to increase system capacity. Adding new capacity, however, may not be viable because of constrained resources and other factors. State DOTs increasingly are turning to improvements in systems management and operations as an efficient and cost-effective way to reduce delays, ensure travel-time reliability, and increase air quality.

Pricing alternatives—including high-occupancy toll lanes and facilities with toll rates that vary with the level of congestion—are being considered and implemented to improve system performance and to help address funding shortfalls. The implementation of these options—and of others aimed at reducing greenhouse gas emissions—requires operations measures and intelligent transportation systems.

Many agencies are working to overcome jurisdictional boundaries and to develop a regional perspective and approach to managing and operating the transportation system.

PHOTO: MISSOURI DOT

Transportation Management Center in St. Louis, Missouri.

Infrastructure Preservation

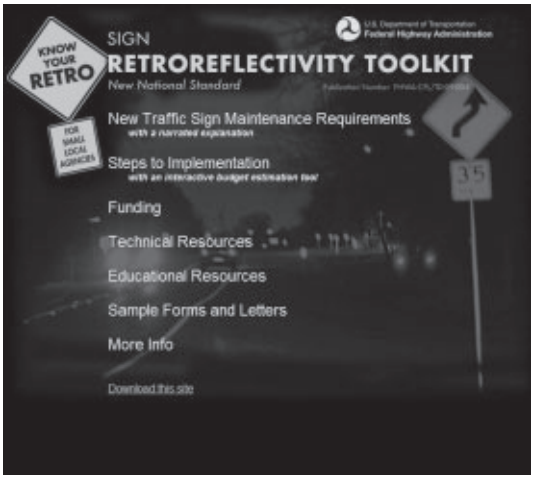
Transportation agencies are applying infrastructure preservation as a management approach, using scientific principles to maintain the functional condition of transportation infrastructure through cost-effective, preventive maintenance actions that safeguard structural integrity and extend performance life. These preventive maintenance actions include treatments for pavements, bridges, roadsides, drainage structures, rest areas, and traffic control systems.

Each dollar invested in applying a preventive maintenance treatment at the appropriate time in the life of a pavement can save $3 to $4 in future rehabilitation costs. The approach applies principles of engineering economics—such as benefit–cost and life-cycle cost analyses—in selecting a preventive maintenance treatment. Agencies report higher benefit–cost ratios for projects selected under effective pavement preservation programs than for projects selected on noneconomic factors.

Many agencies are exploring ways to meet the new national requirement to establish and implement methods to assess and maintain minimum levels of sign retroreflectivity by January 2012. In addition, state DOTs must meet the minimum retroreflectivity requirements for regulatory, warning, and ground-mounted guide signs by January 2015 and for overhead guide signs and street-name signs by January 2018.

Winter maintenance decision support systems (MDSS) are being developed and implemented to integrate and coordinate state force and contractor efforts effectively and efficiently in response to changing storm and traffic characteristics. The goals of MDSS are to provide decision makers with information on the current road conditions, the forecast weather conditions and their effects on the roadways, appropriate treatment scenarios with available resources, and an assessment of the effectiveness of the maintenance treatments.

Indiana DOT expanded its MDSS statewide during the 2008–2009 winter season and reported savings of more than $10 million in material and overtime labor costs. Indiana DOT anticipates an accrual of benefits as it continues to integrate the MDSS into its standard winter operations.



Highway Safety

Highway crash fatalities declined in 2008. Nationwide, in 2007, the total was 41,259 deaths, and in 2008, the total was 37,261. The National Highway Traffic Safety Administration projected an additional decline of 7.0 percent for the first half of 2009.

The respective contributions of safety programs and of changes in traffic volume, however, are unclear. Although economic pressures often are considered a prime contributor to the decline in crashes, specific evaluations indicate that safety countermeasures also are making a contribution. Instead of focusing on remediation at locations with high rates of crashes, agencies increasingly are adopting a systems approach to roadway safety, which appears to be successful.

Evaluations of median cable barrier systems in several states found reductions of up to 90 percent in cross-median fatal crashes. Minnesota discovered that rural, two-lane curve radii of 1,500 feet or less were overrepresented in serious crashes and has targeted countermeasures for specific curves statewide.

PHOTO: DAVID GONZALEZ, MINNESOTA DOT

Minnesota DOT has targeted rural, curved two-lane roads—such as MN TH-3 in Inver Grove Heights, near St. Paul—for safety countermeasures.

States are implementing and updating their Strategic Highway Safety Plans. Some states, such as Alabama, are incorporating new strategies as original goals are met.

The TRB Task Force on the Development of the Highway Safety Manual (HSM), supported by funding from NCHRP, has completed the first edition, to be published by AASHTO in 2010. States are beginning to apply the approaches suggested in the manual; for example, Illinois is developing safety performance functions. An NCHRP project is developing training and implementation programs for the HSM, as is FHWA.

Ports and Waterways

Clean trucks continue to be a focus for major ports around the country. The Houston Port Authority received a $9 million stimulus grant, and the Port of Baltimore received a $3.5 million grant from the Environmental Protection Agency (EPA) to finance clean-truck upgrades. The Port of Virginia received $1 million in stimulus funds to encourage truck-owner participation in a voluntary program. The Port

In August 2009, the U.S. Environmental Protection Agency awarded $3.5 million to the Port of Baltimore for the installation of clean-diesel technology into 142 pieces of diesel-powered equipment used at the port, such as harbor craft, locomotives, dray trucks, and on-dock handling equipment.

PHOTO: MARYLAND PORTS ADMINISTRATION

FINDINGS FROM TRB's 2009 FIELD VISIT PROGRAM

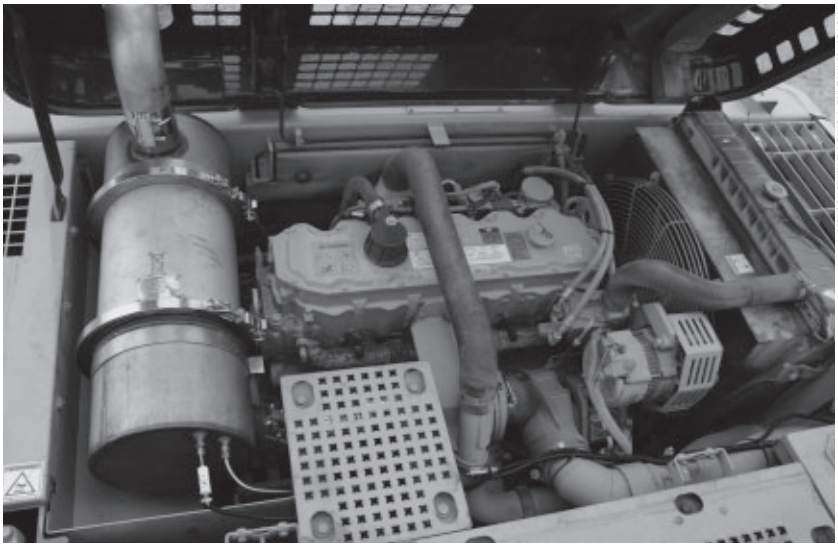


PHOTO: MARYLAND PORTS ADMINISTRATION

Maryland Ports Administration showcased clean diesel equipment at an April 2009 event.

Authority of New York and New Jersey authorized $23 million to help truckers finance the replacement of more than 600 of the oldest and most polluting trucks serving the port.

The clean-trucks program in Southern California has reduced diesel pollution in San Pedro Bay by 80 percent, two years ahead of the target date. By January 2010, 90 percent of trucks calling at Long Beach and Los Angeles will be clean-diesel trucks or will be powered by clean fuels such as liquefied natural gas.

Texas, Louisiana, Mississippi, and Alabama have launched an initiative, America's Energy Coast, to raise awareness about activities in the Gulf Coast region that support the nation's offshore energy supply. The initiative also is alerting the public that the coastal wetlands are disappearing at an alarming rate of 25 square miles per year. Coastal wetlands absorb carbon dioxide, which is a major cause of global warming; therefore restoration should be a priority for the region and the nation.

In Puget Sound, efforts are being made to reduce the problems associated with marine debris—specifically derelict fishing gear—which has become a major environmental hazard. Stimulus funds are being used to provide jobs for local fishermen and divers to recover nets and gear that litter the Puget Sound ecosystem.

EPA has established a 230-mile zone to control air pollution from ocean shipping; measures involve switching fuels and reducing vessel speeds. Issues have arisen, however, over the effects of fuel switching on engines and on other vessel machinery.

The ports of Morrow and Umatilla on the Columbia River are investing in innovations to move freight to the coast, including construction of a main line rail siding and container yard at Morrow and the launch of a short sea project at Umatilla for barge service down the Columbia and up to Puget Sound.

The Louisiana Department of Environmental Quality has undertaken the first study to measure tank barge emissions. A study for the waterways industry concluded that inland barge transportation

PHOTO: LYNN BETTS, USDA NATURAL RESOURCES CONSERVATION SERVICE

This remnant of a cypress–tupelo wetland in an oxbow in central Mississippi is now part of the Wetlands Reserve Program. Coastal wetlands continue to disappear at the rate of 25 square miles per year.

Photo: Hornblower Cruises and Events

The nation's first hybrid ferry, the Hornblower Hybrid, debuted in San Francisco, California, in December 2008.

has a much smaller carbon footprint than truck or rail, making the case for maintaining and upgrading the inland waterway infrastructure and promoting short sea shipping.

Hybrid power is on the increase in marine transportation. A hybrid ferry was introduced that uses alternative technology to power the vessel and reduces the amount of particulate matter released into the atmosphere.

Rail

The rail story for 2009 can be dubbed "reversals of fortune." Intercity passenger rail, which has languished for years with limited state-funded plans and improvements and limited funding for Amtrak, is in the ascendancy, with $8 billion in stimulus funding available under the ARRA and the promise of more to come—$2.5 billion in the appropriations for fiscal year 2010.

These funds follow the creation of new programs in the Passenger Rail Investment and Improvement Act of 2008. Applications far outpaced the available ARRA funds, for both large high-speed rail corridor programs and for corridor planning and smaller projects. The Federal Railroad Administration will announce the selected projects early in 2010.

In the meantime, many states continue to undertake projects that improve trip times and reliability. For example, a project led by Missouri DOT, working with Union Pacific Railroad and Amtrak, with federal matching funds, has improved passenger and freight services between St. Louis and Kansas City. Many other states, including North Carolina, New York, Illinois, California, and Wisconsin, have invested in improving services in intercity corridors.

At the same time, the rail freight renaissance that has occurred in recent years has experienced drastic declines in traffic volumes because of the economic recession, and questions remain about long-term changes in freight flows, as some rail-dependent industries undergo changes. The lower volumes have relieved pressures on rail system capacity; however, increased intercity passenger services will share freight lines and put new pressure on corridor capacity in many areas.

Many states continue to fund rail freight improvements to support their own economies. For example, Pennsylvania recently announced a total of $24.5 million in capital and transportation assistance grants. Ohio is administering more than $30 million in ARRA funds for rail freight and economic development projects.

Public Transportation

The past year offered financial hope and payoff for long-term capital decisions in public transportation. Transit ridership has continued to increase. The ARRA directed $7.6 billion in 712 federal grants to transit projects. Previous long-term investments and operational changes enhanced services, expanded systems, and improved productivity.

In the West, the Los Angeles County Metropolitan Transportation Authority opened up the 6-mile extension of the Gold Line light rail transit from downtown to East Los Angeles. Seattle opened its 15-mile light rail line to the airport in December. Many systems replaced older equipment with green buses and locomotives.

Steps were taken at state and local levels to address financial issues. New York City, Chicago,

Photo: Tami Heilemann, U.S. Geological Survey

Secretary of the Interior Ken Salazar (*wearing cap*) views the 33,000-acre park on the Cuyahoga Scenic Valley Railroad in Brecksville, Ohio. Ohio is set to receive $23 million from the American Recovery and Reinvestment Act.

PHOTO: LACMTA

Los Angeles County Metropolitan Transportation Authority opened an extension of its Gold Line in late 2009.

and Washington, D.C., considered fare increases. Service cuts were necessary in Cleveland, St. Louis, Chicago, and Orange County, California. Some cities—New Orleans, Savannah, Phoenix, Houston, Dallas–Fort Worth, Los Angeles, and Denver—are turning to the private sector to operate parts of their systems. Philadelphia experienced a short but intense transit strike.

The California Legislature adopted a budget eliminating support for local transit systems by diverting more than $3 billion in constitutional and statutory transit funding to the state general fund; the State Supreme Court, however, denied the action.

Aging infrastructure in older big-city systems is experiencing more stress and chronic underfunding for maintenance and replacement. ARRA funding may help somewhat, but the dynamic remains—heavy use, wear and tear, and systems operating beyond design life.

A tragic accident on the Washington, D.C., Metro Red Line, caused by infrastructure failure involving train control technology, has led to manual operation, more track and circuitry inspections, and caution. In November, U.S. DOT announced plans to propose national safety regulations for subways and light rail transit.

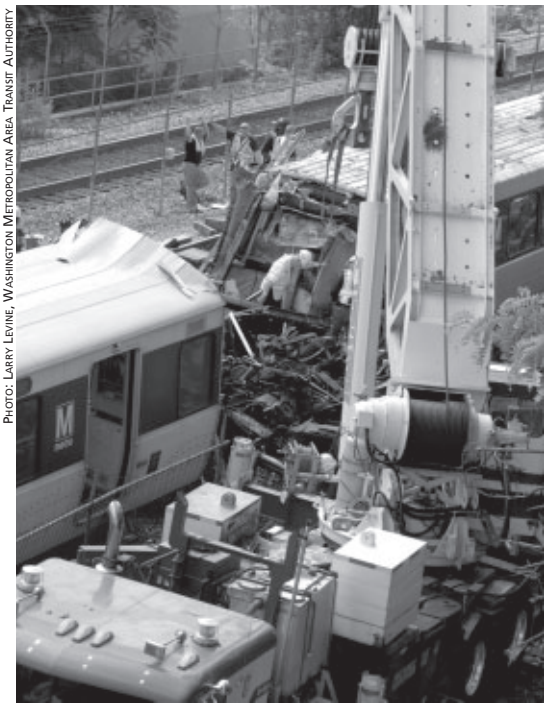


PHOTO: LARRY LEVINE, WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY

Wreckage and debris are removed days after two six-car Red Line trains collided outside of Washington, D.C., in June 2009; nine people were killed, including the operator of the second train—the deadliest crash in Metro's history.

Invaluable Contributions

This sampling portrays some of the many behind-the-scenes advances by dedicated staff at transportation agencies across the country. Their initiatives are supported by a cross-section of colleagues in industry, consulting, contracting, universities, and research.

Despite diminished resources, their combined efforts are yielding progress toward key goals ranging from reducing traffic deaths to improving the environment. Although these efforts may not gain the headlines generated by the latest budget cuts or by short-term reductions in service, their contributions to achieving the longer-term goals of livability and sustainability are invaluable.

Did You Know?

◆ One-third of America's freight flows through Arizona.

◆ "From virtually the moment railroad construction began, South Dakota was inundated with eager home seekers. In 1870 the southern half of the Territory had 11,776 residents. By 1880, only two years into the boom, that number stood at 98,268, while five years later the population had mushroomed to 263,411. During the same period, railroad mileage went from zero to 2,456 miles." (From the South Dakota State Historical Society website, http://history.sd.gov/default.aspx.)

◆ Indiana's statewide deployment of the Maintenance Decision Support System during the winter of 2008–2009 reduced salt costs by $12 million and realized more than $1 million in savings for fuel and overtime. The savings amounts to 27 percent of Indiana DOT's normal total winter budget.

◆ North Carolina DOT opened a rest area on Route 42 that was certified under the standards of Leadership in Energy and Environmental Design—the first such rest area in the country (see photos, page 18). A public website shows the energy and utility savings from the green infrastructure (http://ncdot.technology-view.com/wilkes).

◆ The Vermont Agency of Transportation owns—and leases out—nearly 50 percent of the railroad beds in the state, maintaining the property and some of the bridges.

◆ The Maryland State Highway Administration (SHA) relied on turtle-scenting dogs to find box turtles in a highway right-of-way before construction. The hunting dogs—Boykin Spaniels and Labrador Retrievers—located and retrieved the turtles for environmental scientists who recorded the size, weight, gender, and other data before relocating the turtles. (For more information, see page 40.)

◆ In another environmental stewardship initiative, Maryland SHA deployed goats and sheep to provide passive vegetation management along a bypass constructed around Hampstead Town in Carroll County. The goal was to protect a wet sedge meadow that contains shrubs preferred by the federally protected bog turtle.

◆ The communities east of Los Angeles have a new and vital transportation link with the opening of the Metro Gold Line extension on November 15, 2009. Eight new stations serve diverse Los Angeles neighborhoods, including the Arts District, Little Tokyo, and Boyle Heights. The rail extension connects the Eastside with downtown Los Angeles, Pasadena, the San Fernando Valley, South Bay, Long Beach, and dozens of points between.

IMAGE: SOUTH DAKOTA HISTORICAL SOCIETY

Railroad construction in South Dakota around 1870 provided the stimulus for population growth; map shows rail routes in the early 1900s.

◆ Virginia's inland port near Front Royal has been the catalyst for approximately 7,000 new jobs since opening in 1989, according to the state's port authority. Connected to seaports by Norfolk Southern railroad, the inland port has drawn 24 companies to the area and has attracted some $600 million in investments.

◆ The logistics sector in Memphis, Tennessee, weathered the economic downturn better than many industries in 2009, largely because of railroad investment. BNSF Railway completed a $200 million expansion of its Memphis intermodal facility, and Canadian National Railway finished a $100 million renovation of its switching facility.

PHOTO: MARYLAND SHA

The Maryland State Highway Administration deployed sheep and goats for passive vegetation control, as part of an environmental plan to protect the bog turtle population in the construction of the MD-30 bypass.

NEW NATIONAL RESEARCH COUNCIL REPORT

Transitions to Alternative Transportation Technologies

A Focus on Hydrogen

ALAN CRANE

The author is Senior Program Officer, Board on Energy and Environmental Systems, National Research Council of the National Academies, Washington, D.C.

The National Research Council (NRC) released a report in late 2008 that estimates the maximum practicable number of hydrogen fuel cell vehicles (HFCVs) that could be deployed in the United States by 2020 and beyond, together with the investments, time, and government actions needed to carry out the transition. HFCVs potentially offer the United States one of the most important ways to reduce both its dependency on oil and its emissions of carbon dioxide (CO_2)—the main greenhouse gas linked to global climate change.

Oil imports and climate change are two of the most difficult issues facing the nation. *Transitions to Alternative Transportation Technologies—A Focus on Hydrogen* estimates the reductions in U.S. oil consumption and emissions of CO_2 that could be expected from a major effort to introduce HFCVs. The report also compares the reductions with the potential impact of the use of alternative vehicle technologies and of biofuels.

PHOTO: SHELL HYDROGEN, LLC

In June 2008, California's first hydrogen refueling station opened in a Shell gasoline forecourt on Santa Monica Boulevard and Federal Avenue in West Los Angeles.

The NRC Committee on Assessment of Resource Needs for Fuel Cell and Hydrogen Technologies (see box, page 30) concluded that the maximum practical number of HFCVs that could be operating in 2020 would be approximately 2 million in a fleet of 280 million light-duty vehicles. The number of HFCVs could grow rapidly in the years after to approximately 25 million by 2030.

Projecting a Transition

The committee was not attempting to predict the future but to develop a scenario based on its estimate of the maximum penetration rate for HFCVs. Assumptions included that technical goals would be met, that consumers would readily accept HFCVs, and that policy instruments would be in place to drive the introduction of hydrogen fuel and fuel cell vehicles through the period of market transition.

The use of HFCVs can achieve large and sustained reductions in U.S. oil consumption and CO_2 emissions, according to the committee, but several decades will be needed to realize the potential long-term benefits. Considerable progress must be made to improve fuel cell costs and durability, as well as the storage of hydrogen on board the vehicle.

The substantial financial commitments and technical progress made in recent years by the automotive industry, private entrepreneurs, and the U.S. Department of Energy (DOE) suggest that HFCVs and hydrogen production technologies could be ready for commercialization between 2015 and 2020. The vehicles are not likely to be cost-competitive, however, until after 2020; by 2050, HFCVs could account for more than 80 percent of the new vehicles entering the fleet.

An accelerated transition to HFCVs would require automobile manufacturers to ramp up the production of fuel cell vehicles at much higher costs than conventional vehicles. In addition, investments

PHOTO: SMUD

Sacramento Municipal Utility District (SMUD) and BP operate a small demonstration hydrogen refueling station near the SMUD headquarters building.

would have to be made to build and operate hydrogen fueling stations while the market for hydrogen was still limited. Substantial government actions and assistance would be necessary therefore to support the accelerated transition to HFCVs by 2020, even with continued rapid progress on technologies for fuel cells and the production of hydrogen.

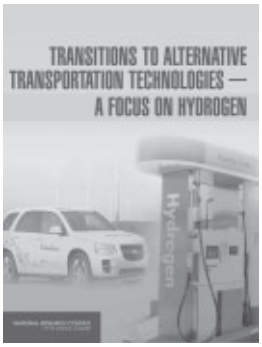
The committee compared HFCVs with conventional vehicles under a scenario of high oil prices that was developed in part by the Energy Information Agency. The incentive for investing in an accelerated transition to hydrogen would be low, unless oil prices are high, whether from resource constraints, geopolitical factors, or emissions policy.

Under these conditions, HFCVs could become competitive with gasoline-powered vehicles in terms of life cycle by 2023, as long as the research and development goals are met and the economies of scale associated with the assumed production rate are attained. Although likely to remain more expensive than conventional vehicles, HFCVs would offer lower operating costs because of their high efficiency.

Costs of Transition

According to the committee's estimates, the government cost to support a transition to HFCVs would be approximately $55 billion from 2008 to 2023. This funding includes $5 billion for a substantial research and development program, $40 billion for the demonstration and deployment of the vehicles while they remain more expensive than conventional vehicles, and $10 billion for the production of hydrogen. Although substantial, these costs compare favorably with ethanol subsidies, which could total $160 billion for the same period.

The U.S. government currently spends approximately $300 million per year for alternative fuels, largely for research and development, primarily by DOE. If 2 million HFCVs are to be on the road by 2020, research and development funding may have to increase by as much as 20 percent in the next several years. Annual government expenditures would have to be much higher to support the commercial introduction of HFCVs—an estimated $3 billion in 2015, increasing to $8 billion in 2023.



Transitions to Alternative Transportation Technologies—A Focus on Hydrogen is available from National Academies Press, www.nap.edu/catalog.php?record_id=12222.

Companion Study Examines Plug-in Hybrid Electric Vehicles

The National Research Council (NRC) has released the prepublication edition of *Transitions to Alternative Transportation Technologies—Plug-in Hybrid Electric Vehicles*, a companion volume to the report on hydrogen fuel cell vehicles. Plug-in hybrid electric vehicles (PHEVs), draw from electricity on the grid, store it in batteries, and switch to an internal combustion engine when the batteries are discharged.

PHOTO: CALCARS.ORG

Lithium-ion battery pack developed by CalCars charges up in a PHEV, a converted Toyota Prius.

The new report from the NRC Committee on Assessment of Resource Needs for Fuel Cell and Hydrogen Technologies reviews the current and projected status of the technologies for PHEVs. The committee considers the factors affecting the entry of PHEVs into the marketplace, including the interface with the electric transmission and distribution system. The report projects a maximum, practical market penetration rate for PHEVs that is consistent with the time frame and factors proposed in the earlier report on hydrogen fuel cell vehicles. The report incorporates PHEVs into the models used in the hydrogen study to estimate the costs and the impacts on petroleum consumption and carbon dioxide emissions.

Transitions to Alternative Transportation Technologies—Plug-in Hybrid Electric Vehicles is available from National Academies Press, www.nap.edu/catalog.php?record_id =12826.

A hydrogen pump located on the campus of the University of California–Irvine, at Jamboree Boulevard and Campus Drive.

After 2023, substantial research and development programs would be required to continue to reduce the costs of the fuel cell vehicles and of hydrogen. In addition, subsidies may be required to induce more people to purchase HFCVs, but the committee did not estimate these costs.

Private industry would invest far more than the government—approximately $145 billion for research and development, vehicle manufacturing, and hydrogen infrastructure over the same period. Hydrogen production and delivery are likely to become profitable well before vehicle manufacturing does.

Fuel Issues

Potential synergies between the transportation sector and the electric power sector may reduce the cost of hydrogen. In the near term, the electrolysis of water can provide hydrogen in areas in which natural gas or other sources are unavailable. In the longer term—that is, after 2025—the cogeneration of low-carbon hydrogen and electricity in gasification-based energy plants may be an option.

The main advantage of a transition to HFCVs is the potential reduction in oil consumption and in emissions of CO_2. Although hydrogen could not replace much gasoline before 2025, the use of gasoline in the light-duty vehicle fleet would decline dramatically during the following 25 years, to approximately one-third of current projections—if the assumptions of the maximum practical case were met. CO_2 emissions would decline almost as much if hydrogen were produced with carbon capture and sequestration or from nonfossil sources.

PHOTO: NATIONAL HYDROGEN ASSOCIATION

A fuel cell car is taken for a demonstration drive at the National Hydrogen Association Conference and Expo in 2009.

The committee also concluded that two alternatives could deliver significantly greater reductions in U.S. oil use and CO_2 emissions than the use of HFCVs could during the next two decades—improved fuel economy for conventional vehicles, including the increased penetration of hybrid electric vehicles; and biomass-derived fuels. The longer-term benefits of these alternative approaches, however, are likely to grow at a smaller rate in the years after, even with continued technological improvements.

In contrast, hydrogen offers greater potential in the longer term. The committee did not consider electric vehicles, plug-in hybrid electrics (see sidebar, page 29), or the increased use of diesel engines, because its resources did not allow an adequate evaluation of the technical, cost, and customer acceptance issues involved.

Durable Policy Actions

The committee noted that the greatest benefits will come from a portfolio of research and development technologies that would allow the United States to achieve deep reductions in oil use—nearly 100 percent by 2050 for the light-duty vehicle fleet. Achieving this goal, however, will require significant new energy security and environmental policy actions, in addition to technological developments.

Broad policies to reduce oil use and CO_2 emissions—for example, through carbon taxes—will be useful but are unlikely to facilitate the rapid introduction of HFCVs. Early HFCV costs will be too high to overcome without direct, targeted support. A competitive and self-sustaining HFCV fleet is possible in the long term but will require hydrogen-specific policies in the nearer term. These policies must be substantial and durable to assure industry that the necessary long-term investments can be made safely.

Committee on Assessment of Resource Needs for Fuel Cell and Hydrogen Technologies

Michael P. Ramage, NAE, ExxonMobil Research and Engineering Company (retired), *Chair*
Rakesh Agrawal, NAE, Purdue University
David L. Bodde, Clemson University
David Friedman, Union of Concerned Scientists
Susan Fuhs, Conundrum Consulting
Judi Greenwald, Pew Center on Global Climate Change
Robert L. Hirsch, Management Information Services, Inc.
James R. Katzer, NAE, Massachusetts Institute of Technology
Gene Nemanich, ChevronTexaco Technology Ventures (retired)
Joan Ogden, University of California, Davis
Lawrence T. Papay, NAE, Science Applications International Corporation (retired)
Ian W. H. Parry, Resources for the Future
William F. Powers, NAE, Ford Motor Company (retired)
Edward S. Rubin, Carnegie Mellon University
Robert W. Shaw, Jr., Aretê Corporation
Arnold F. Stancell, NAE, Georgia Institute of Technology
Tony Wu, Southern Company

NEW NCHRP REPORT

Communicating the Value of Transportation Research

JOHANNA P. ZMUD, JULIE L. PAASCHE, MIA ZMUD, TIMOTHY J. LOMAX, JOSEPH L. SCHOFER, AND JUDY MEYER

J. P. Zmud is President, Paasche is Senior Associate, and M. Zmud is Research Director, NuStats, LLC, Austin, Texas. Lomax is Research Engineer and Regents Fellow, Texas Transportation Institute, Texas A&M University, College Station. Schofer is Professor and Associate Dean, Robert R. McCormick School of Engineering and Applied Science, Northwestern University, Evanston, Illinois. Meyer is Owner, Public Information Associates, Allen, Texas.

Research plays a critical—and growing—role in the national transportation debate. Transportation research is vital for improving mobility, building better roads, providing safer conditions for drivers and pedestrians, and increasing the service life of bridges.

For example, issues of funding and finance dominate the discussion of surface transportation in the United States. Two national commissions have addressed the topic, and the U.S. Government Accountability Office recently added transportation financing to the list of high-risk areas for oversight by Congress. The ongoing dialogue and debate at the federal, state, and local levels point to the need for robust transportation research programs and for compelling ways to communicate the value of that research for solving transportation system problems.

Communicating the value of transportation research can be difficult. Although most people conceptually grasp the value of research and its results, they do not make the direct connection to the need for research funding—particularly for innovations or new technologies that may take years to develop. Decision making and budget cycles proceed in the here and now.

Communication Matters

The value of transportation research is measured in terms of the good it does—or can do. Although technical research reports provide quantifiable results, the information can be complex and not easily understood. Communication is a key for furthering the transportation research agenda—to tell the story of how society can benefit from the research in ways that decision makers, elected and appointed officials, the media, and the public can understand and appreciate.

Communicating value requires more than presenting quantifiable statistics and dollar amounts. The task is to translate the benefits into understandable terms. A National Cooperative Highway Research Program (NCHRP) project has developed NCHRP Report 610, *Communicating the Value of Transportation Research—Guidebook,* which presents a blueprint for integrating communication into research programs. The blueprint is designed for use

The devastating and tragic collapse of the steel deck truss bridge in Minneapolis, Minnesota, in August 2007 (*left*, four days after) and its rapid and effective replacement (*right*, 13 months later) are objective examples of the need for federal and state transportation research programs that solve problems today for tomorrow's users.

FIGURE 1 Elements of the communication process.

by state and federal transportation officials, research managers, and others in the transportation research community (see sidebar, below).

The guide contains practical advice on how to communicate the results and the return on investment from research programs to diverse audiences—including Congress, state lawmakers, and other decision makers. The approach highlights the importance of integrating communication from the onset of research planning—during the proposal stage, when key communication objectives can be established. The guidance is based on an empirical examination of communication efforts to promote federal and state investments in various transportation research programs.

Decision makers assess the value of transportation research in terms of the perceived worth of the expected outcomes. A skillfully applied communication process markets that value effectively. Successful communication links researchers and results with their intended audiences by strengthening and channeling the flow of information throughout the research process. The elements of the communication process can be represented as a funnel (see Figure 1, this page).

How the Guidebook Is Organized

Extensive research and examination of best practices in communication, within and outside of the transportation community, informed NCHRP Report 610, *Communicating the Value of Transportation Research—Guidebook*. The research assembled practical tips, a model process, case studies, and examples of good communication methods that all transportation researchers can use. The guide is organized into four chapters and two appendixes to explain the process:

Chapter 1: Signs of Good Communication Practices presents seven indicators drawn from best practices inside and outside of the transportation community.

Chapter 2: The Communication Process explores the key steps for planning, talking about, writing, and creating the context, strategy, and content, and choosing the appropriate channels—media and contacts—and style.

Chapter 3: Planning and Evaluating Your Research Communication presents ways to understand how target audiences will hear the message.

Chapter 4: Putting It All Together: Communicating to Specific Audiences provides examples of how to communicate with audiences that matter: research peers, transportation policy and program officials, legislative leaders and staff, the news media, and the public.

Appendix 1: Transportation Case Studies illustrates good communication practices though experiences from seven transportation research projects.

Appendix 2: Nontransportation Best Practices summarizes the approaches of four organizations that have excelled in communicating the value of research.

Getting Started: Five Steps

The communication process funnel demonstrates that communicating the value of research is a multilayer challenge. The upper layers of context, strategy, and content—representing what to say—are as important for focus as the lower layers of communication channels and style—representing how to say it.

1. Context

The context in which communication takes place—including the problem to be addressed by the proposed research—influences communication strategy, content, channels, and style. Communication takes into account historical, social, political, and cultural considerations in responding to a particular situation. For example, transportation research programs that originate in legislation often raise issues about public visibility and about trade-offs with other programs that perhaps are more popular. Learning what the audience deems politically, publicly, and technically acceptable is critical.

2. Strategy

Strategies for communicating value depend on an ability to understand the audience and the purpose of the message. The goal is to influence perceptions of value; therefore the strategy must begin with a clear understanding of the people to be influenced and their priority concerns—also called their value profiles. A value profile identifies the criteria the audience will use to evaluate the exchange of information—how the target audience determines, defines, and expresses value.

Effective research programs often recruit communications professionals to assist in conveying the value of research.

3. Content

The content of the message depends on the context and the strategy. Selecting accurate and appropriate content is critical. If the content is inappropriate, the audience is likely to dismiss the communication; if the content is too complex, the audience will disregard it; if the content is inaccurate, the communication loses credibility. Determining the appropriateness of the content involves considering the target audience, its values, and the action to be advocated.

4. Channels

Communication channels are the modes or pathways through which the content is delivered. There are four basic channels: printed or published materials; oral channels—that is, personal contacts; broadcast media, such as radio, television, and videos; and the Internet and other computer-based modes. Some channels are well-suited for particular contexts or audiences—choosing the appropriate channel for the message and the audience is a key tactical decision.

5. Style

Style is the packaging of the communication, serving as the physical wrapping or features that distinguish one communication activity from another. The most visible aspects of packaging—the physical features such as design, layout, color, and typeface—may affect the perception of value. The thickness of a report, the arrangement of images and text on a website, the folder for presenting fact sheets—the physical packaging immediately influences every encounter between a member of the audience and the transportation research advocate. Packaging also is an important consideration for oral or face-to-face communication. Speakers who lack good communication skills have difficulty reaching the target audience and influencing perceptions.

Communication is continuous. Advocating support for a single research project or program usually takes an extended period. Within this time frame, opportunities arise to learn, adapt, and improve. The effort or approach calls for continuous reassessment of the context, as well as of the strategy, content, channels, and style.

Signs of Good Practice

The guidebook examines best practices in communicating the value of research by reviewing successful research projects and programs inside and outside the transportation community. Several characteristic objectives emerged among the most effective efforts:

- **Involve communications professionals**. Tailor the communication to the audience, the message content, and the channel of communication.
- **Understand the audience.** Identify the target audience and research its characteristics and interests.
- **Demonstrate a tangible benefit.** Connect the audience to a tangible benefit. What does the target audience value? How does the target audience express those values?
- **Recognize that timing is relevant.** Understand the current mood and concerns of the audience or constituents.
- **Build coalitions.** Enlist the support of credible and effective champions and allies.
- **Build two-way relationships.** Give and gather information.
- **Tailor the packaging.** Produce packaging that is appropriate to the purpose and to the audience in design, layout, and color.

NCHRP Report 610, *Communicating the Value of Transportation Research—Guidebook*, is available from the TRB online bookstore, www.trb.org/bookstore; to view the book online, go to http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_610.pdf. The contractor's final report on the research associated with NCHRP Project 20-78, which produced the guidebook, was published as Web-Only Document 131, http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_w131.pdf.

PHOTO: VIRGINIA DOT

One of the projects highlighted in NCHRP Report 610 is the preservation of the historic Hawthorne Street Bridge in Covington, Virginia, by Virginia DOT and the Virginia Transportation Research Council.

The guidebook presents these key lessons from detailed case studies, along with examples of good practice from successful research projects and programs, some from outside the transportation community.

Taking Communication Seriously

Communication must be integral to the research process, not an add-on after the research concludes. Ongoing communication assembles a network of researchers, decision makers, and other stakeholders and ultimately builds lasting relationships.

A serious approach may involve working with communication professionals to craft and deliver messages to different audiences, building the communication skills of researchers, and providing resources to support and enhance the communication capacity within the research team itself. Resources may include printed materials, such as communication manuals and guides; workshops and forums to share best practices and review communication processes; and programs to provide researchers with funds to improve or expand communication to target audiences.

Ongoing communication builds a bridge between researchers, decision makers, and stakeholders. Not all transportation researchers can excel as effective communicators. Research teams can bring in communication professionals to assist with planning, to monitor the ongoing communication, and to engage in a dialogue with key audiences throughout the process.

Quoting the Value of Research

"A recent demonstration of accelerated bridge construction research in Utah saved almost $1 million in construction costs and over $3 million in road user costs," notes a new brochure (*right*), *Transportation Excellence Through Research*, published by the American Association of State Highway and Transportation Officials (AASHTO). Developed by the AASHTO Research Advisory Committee's (RAC) Task Force on the Value of Research, the publication provides senior executives and decision makers with key messages reinforcing the value of transportation research.

The text cites proven results—for example, "By applying its research on managing pathogens related to animals killed on the road, the New York State Department of Transportation (DOT) has solved a major environmental problem and saved millions of dollars in disposal costs." The brochure also quotes Pete Rahn, Director of the Missouri DOT, on the value of research: "Transportation research is about finding better ways to get the job done. Good research is an investment, with a payoff that helps us deliver better systems and services." The AASHTO RAC brochure can be viewed or downloaded at http://research.transportation.org/Documents/NCHRPBrochureWEB.pdf.

Working in tandem, the National Cooperative Highway Research Program (NCHRP) has launched the *Impacts on Practice* series of brochures to communicate the tangible benefits of its research program and projects (*below*). The series provides a snapshot of ways that state DOTs have deployed NCHRP research results to save time and money and improve the operations and safety of their transportation systems. The series of brochures is available online at www.trb.org/NCHRP/NCHRPImpactsonPractice.aspx.

RESEARCH PAYS OFF

Developing and Implementing a Rockfall Management System and Mitigation Program for Tennessee

VANESSA C. BATEMAN

The author is Civil Engineering Manager, Tennessee Department of Transportation, Nashville, and chairs the TRB Exploration and Classification of Earth Materials Committee.

As rock cuts along Interstates and highways age, weather, and become unstable, the risk of rockfall increases. Many rock cuts owned by transportation agencies were built before the development of design standards for rockfall catchment. Consequently, many rock cuts have inadequate or nonexistent catchment areas. A transportation agency therefore needs a systematic way to manage the hazards of rockfalls.

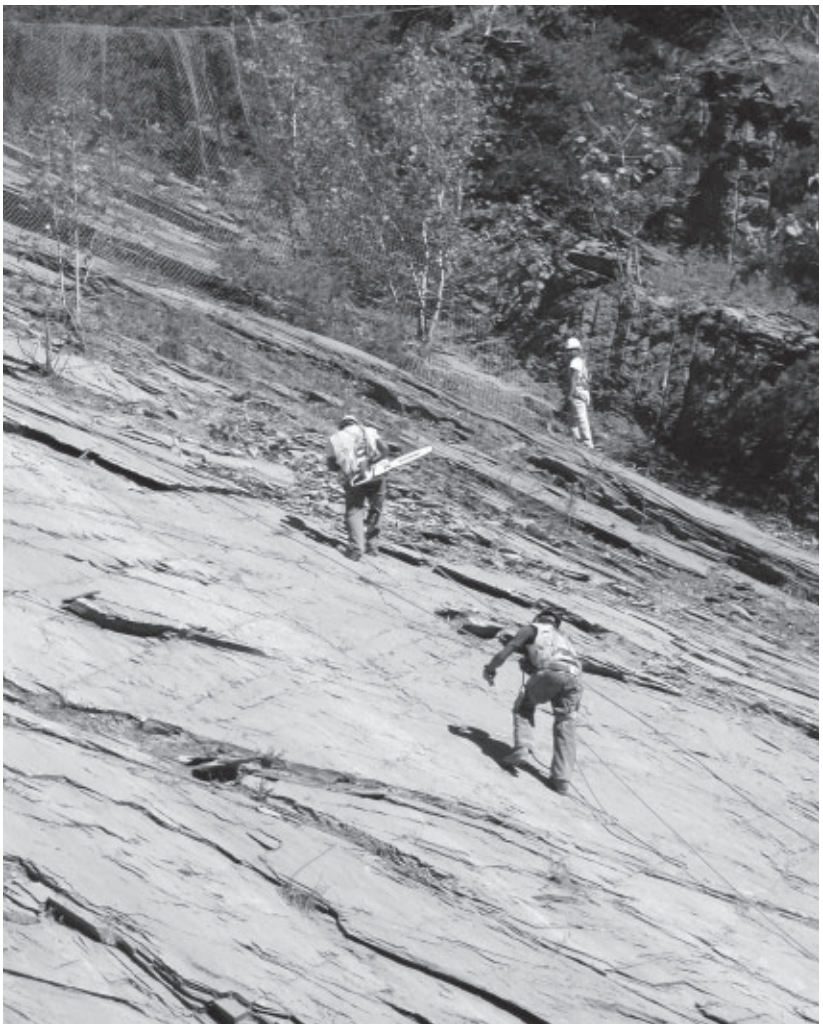


PHOTO: HARRY MOORE

Rockfall mitigation work in progress—workers assess a site in Cocke County, Tennessee, for initial vegetation removal and scaling operations. Tennessee DOT has moved from a reactive to a proactive approach to rockfall management.

Problem

Rockfall management at the Tennessee Department of Transportation (DOT) historically was reactive—that is, rockfall maintenance problems and catastrophic failures drove the remediation responses (*1*). This haphazard approach did not make the best use of resources, and no mechanism was in place to approach the problem on a statewide basis.

Rockfall sites could not be compared within or across maintenance districts, and no map showed all sites statewide. Tennessee had an unknown number of problem sites that presented an unknown level of hazard; moreover, the state had no systematic program to rate the hazards, to estimate costs, or to let mitigation projects.

Solution

Multidisciplinary Approach

Tennessee therefore initiated a research project to develop a hazard rating system for the state and to produce a statewide map of sites. A rockfall database integrated into web-based geographic information systems (GIS) was developed to display, analyze, and prioritize rockfall hazards. Researchers developed field data collection forms, both paper and electronic, which linked to the rockfall database via PDAs—that is, handheld mobile computers. Tennessee DOT developed a training program and manuals to assist geotechnical personnel in implementing the system.

Principal investigators from Tennessee DOT, the University of Tennessee, and Virginia Tech led the multidisciplinary research team, which had backgrounds in civil engineering, geological engineering,

and geology. The team developed the initial hazard rating system and database, piloted it in five counties, and then refined the rating system, field procedures, and database before mapping the rest of the state.

Photologs from the Tennessee DOT Roadway Information Management System made possible a virtual driving tour along every mile of state roadways, looking for potentially hazardous rock cuts. Potential sites were noted and verified in the field, and new sites were added during the field work (*2*).

Rating Sites

Initially, sites were rated as A, B, or C according to the Rockfall Hazard Rating System (RHRS) developed for Oregon DOT and the Federal Highway Administration (*3, 4*). At A-sites, a rockfall has a high potential for reaching the roadway and affecting traffic; B-sites have a moderate potential hazard; and C-sites have a low potential hazard.

All A- and B-sites were located. All A-sites were further analyzed with the Tennessee RHRS, which produces a detailed hazard rating. The Tennessee RHRS includes identification of the rockfall failure modes expected at a site, such as planar, wedge, topple, differential weathering, or raveling. The Tennessee RHRS also requires such data as cut height and length, average daily traffic, roadway width, decision sight distance, rockfall history, ditch effectiveness, presence of water, geologic failure mode, and the extent of the potential failure area, expressed as a percentage of the slope surface area.

All of this information determines the Tennessee RHRS score, which has a maximum of 800 points. Sites with a score above 350 are classified as priority. Of the 1,950 sites statewide, almost half—963 sites—were classified as A and received a Tennessee RHRS analysis (Figure 1, below). Thirty-six of the A-sites were rated high priority, with scores of 500 or more.

After the initial research was complete, Tennessee DOT added a Rockfall Closure Impact (RCI) rating and initial cost assessments for the sites. The RCI rates a site according to average daily traffic, potential disruption to traffic, roadway blockage time, length of the detour around the blockage, and facility degradation.

Applications

In 2008, Tennessee DOT used the rockfall hazard inventory, database, GIS map, photographs, and other data to launch a rockfall mitigation program. The following sites with high scores on the Tennessee RHRS, high RCI scores, and high assessments of mitigation costs were let in three contracts:

- The first contract, for $780,000, was to mitigate 0.3 mile of highway in Campbell County, where a rockfall recently had occurred on I-75. Mitigation measures involved the installation of a rockfall fence at the base of the slope on the edge of the paved shoulder.
- The second contract, for $1.2 million, was to mitigate 0.5 mile of I-40 in Cocke County near the North Carolina border. Mitigation measures involved the installation of a rockfall fence, draped wire mesh, and a hybrid wire mesh system to reduce significantly the risk of a rockfall impacting traffic.
- The third contract, for $537,000, was to mitigate 0.65 mile of I-440 in Nashville in Davidson County. Mitigation measures involved scaling and trimming the slope to remove loose, overhanging, and unstable rock; cleaning and regrading the catchment ditch; and installing a rockfall fence as needed.

Benefits

The three-year research effort cost $1 million in addition to the routine work related to rockfalls. Although it is too early yet to quantify the financial benefits of the research, recovering the investment and savings is a realistic expectation, based on past experience of road closures, property damage, fatalities, and inconvenience to motorists.

The Rockfall Management System has allowed Tennessee DOT to approach rockfall issues as a statewide problem and to apply resources in a ratio-

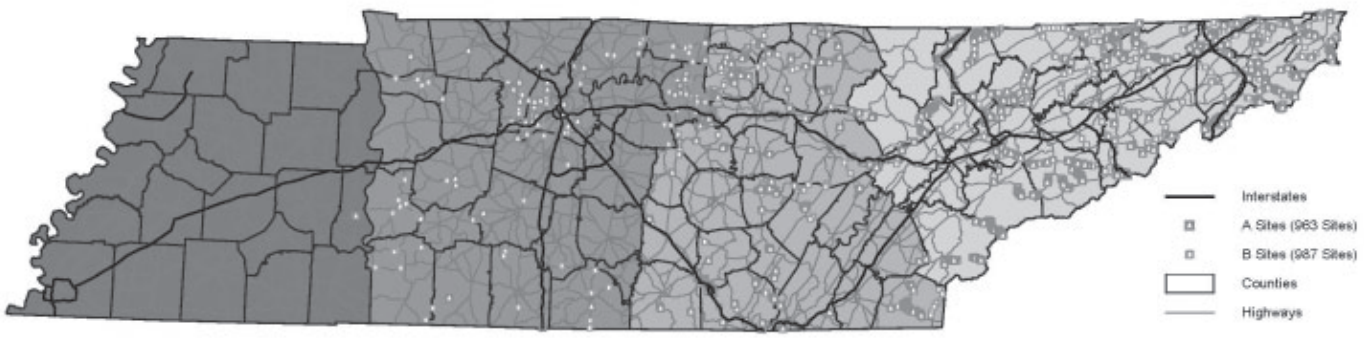


FIGURE 1 Rockfall sites in Tennessee: state routes, U.S. highways, and Interstates.

nal way. Personnel can compare the hazard ratings of sites, the costs of mitigation, and the potential effects on the traveling public. Tennessee DOT has expanded the results from the research to incorporate preliminary cost estimates and RCI scores; along with the Tennessee RHRS scores, these constitute the selection criteria for prioritizing mitigation projects.

With the interactive maps, Tennessee DOT personnel can display site data according to a variety of criteria and can add or modify sites as conditions change. The database information about rockfall sites is updated periodically and as needed. The database gives Tennessee DOT staff instant access to all data, photographs, Tennessee RHRS scores, and related reports before mobilizing to a rockfall site.

The GIS maps clearly identify areas within corridors that have a high concentration of rockfall sites. This information is valuable in the cost–benefit analyses for roadway widening, improvements, or relocations.

Tennessee DOT plans to expand the database and web-based GIS to other geohazards such as sinkholes, landslides, and settlement areas, and to store the electronic data and the interactive map in a central location. The statewide map and system developed under this research project have allowed Tennessee DOT to implement a new management program and to improve tools, enhancing staff efficiency and ensuring safer roadways for motorists.

For more information, contact Vanessa C. Bateman, Civil Engineering Manager, 6601 Centennial Boulevard, Nashville, TN 37243-0360 (615-350-4133; Vanessa.bateman@state.tn.us).

PHOTO: HARRY MOORE

Scaling and vegetation removal in progress at the Cocke County rockfall site.

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EDITOR'S NOTE: Appreciation is expressed to G. P. Jayaprakash, Transportation Research Board, for his efforts in developing this article.

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).

Robert L. Wilson

Arkansas State Highway and Transportation Department

As chief counsel of the Arkansas State Highway and Transportation Department's (HTD) legal division, Robert L. Wilson advises the Arkansas State Highway Commission, the Arkansas HTD Director, and others in the department on legal matters. The Legal Division covers a range of cases, such as contracts, torts, taxes, workers' compensation, eminent domain, and equity. Wilson also supervises the division's legal staff. He has worked for Arkansas HTD since 1977, when he started as a staff attorney preparing and trying cases under the direction of the chief counsel.

A notable case under Wilson's tenure as chief counsel was *Arkansas State Highway and Transportation Department v. Miles Adams*, in 1989. In the case, a contractor's bid was rejected because he omitted one item—a gate with an approximate value of $2,000—on a bid of $7,859,992.31. The next-lowest bid was approximately $112,000 higher than the bid of the complaining contractor. The trial court agreed with the contractor, who argued that the omission was a minor error and that the Arkansas State Highway Commission should not have rejected the bid; however, the Arkansas Supreme Court reversed the trial court and ruled that rejection of the bid for the omission was not arbitrary. It also stated that protecting the integrity of the bid process may be more important than saving money on a single project.

"*Arkansas State Highway and Transportation Department v. Breshears* has been cited in numerous published and unpublished opinions as the leading case on temporary disability."

According to Wilson, the landmark *Arkansas State Highway and Transportation Department v. Breshears* in 1981 was "a classic case of losing the battle but winning the war." Previously, the Arkansas Workers' Compensation Commission routinely awarded temporary benefits to injured workers based on their healing period; in *Breshears*, the Arkansas Supreme Court reversed the practice of the commission and maintained that for unscheduled injuries, temporary compensation is based on the disability period rather the healing period—it did allow the award to the claimant to stand, however. "*Breshears* has been cited in numerous published and unpublished opinions as the leading case on temporary disability," notes Wilson.

A longtime Arkansas resident, Wilson attended Peake High School in Arkadelphia and in 1971 graduated with a degree in political science from Oauchita Baptist University, also in Arkadelphia. After graduation, Wilson worked as foreman at the Aluminum Company of America in Bauxite, Arkansas. He also served the U.S. Army as 1st Lieutenant in the Transportation Corps at Fort Sill, Oklahoma; he was platoon leader and unit commander of the Personnel Control Facility in-processing unit.

In 1974, Wilson began to study law at the University of Arkansas School of Law in Fayetteville and received a Juris Doctor degree in 1977. Before starting his career at Arkansas HTD, Wilson represented low-income clients in civil cases with Legal Services of Northeast Arkansas.

Wilson's career is a testament to focus and hard work. In this vein, he advises young colleagues starting out in the transportation legal profession: "The keys to success in the workplace are persistence, loyalty, dedication, and hard work."

Wilson has an active record of service at TRB. Last year, he was appointed chair of the Transportation Law Committee, which he had served since 1990. He has been a member of the Legal Resources Group since 1989. He was a member of the Contract Law Committee from 1989 to 1992, and chaired the committee from 1992 to 1998. From 1996 to 2009, Wilson was a member of the National Cooperative Highway Research Program (NCHRP) Project Panel for Legal Problems Arising Out of Highway Programs. This continuing project, established in 1968, has produced the eight-volume *Selected Studies in Transportation Law*; of particular interest to transportation legal professionals is Volume 1, *Construction Contract Law,* Wilson notes. The project also releases reports under NCHRP's *Legal Research Digest* series.

"My association with TRB has allowed me to make business contacts with attorneys and other transportation professionals," Wilson observes. "I particularly enjoy attending the annual TRB legal workshops. I am unaware of any other organization that sponsors such events for transportation attorneys." NCHRP publications are essentials in his library, he comments.

In April 1986, Wilson published "Ethics and the Public Professional" in *Right of Way* magazine. He is a member of the American Association of State Highway and Transportation Officials' Subcommittee on Legal Affairs. He is licensed and in good standing with the State of Arkansas; the U.S. District Courts of Arkansas; the U.S. District Court for the Eastern District of Wisconsin; the U.S. Court of Appeals, 8th circuit and D.C. circuit; and the U.S. Supreme Court.

William H. Moorhead

TRAMMCO, LLC

William H. (Bill) Moorhead has changed his career trajectory approximately once every 7 years. This is based on two premises, he explains: "One, if I haven't learned it in that time, then I probably can't; and two, after 7 years, it's time to try something new, or else you get rusty." The result is a long and diverse career inventing, patenting, and marketing products in the field of rail transit infrastructure.

Born in New York City, Moorhead studied mechanical engineering at the University of Virginia Engineering School and Worcester Polytechnic Institute and served in the U.S. Naval Reserve as a construction mechanic. After working with Mack trucks for several years, Moorhead began work in 1959 as a draftsman at Kershaw Manufacturing Co., a manufacturer of railway maintenance-of-way (MOW) work equipment in Montgomery, Alabama. At Kershaw, Moorhead quickly moved up to chief engineer and over the next several years managed the development of products such as the Tie Injector, which brought high-speed tie renewal capability to railroads, and saw a four-fold increase in the company's business.

"Most agencies and practitioners are reluctant to be the guinea pig; the fact that someone has successfully gone before may accelerate the use of worthwhile research in the operating community."

In 1967, Moorhead started his own company designing MOW equipment; notable achievements included a redesign of most of the product line for Railway Track-Work Co. of Philadelphia, Pennsylvania. Moorhead changed tracks in 1974 to work at D. W. Hallberg Co., a firm representing manufacturers, as vice president of sales and engineering. "It was a very interesting time, as you must learn about many things to sell them successfully," Moorhead remembers.

In 1981, Moorhead became president of SRS America, Inc., the U.S. division of Swedish Rail Systems AB. Among the new rail infrastructure concepts he introduced to the North American market were concrete switch ties for a crossover; clearance measuring that incorporated a sophisticated photogrammetric method, a special rail car, and laboratory processing; and the Switch Exchanger, a set of equipment that could lift a turnout out of the track and quickly install a new one.

The next step was, once again, entrepreneurship. With his wife, Alice, Moorhead founded Iron Horse Engineering Co. in 1985. It started out as a manufacturer's representative firm and consultancy, but by 1989, Iron Horse specialized in the design and production of MOW and construction equipment. Moorhead's design of a top-down method of constructing concrete nonballasted (slab) track—the PIP-Fast System, which stands for pour-in-place fasteners—was adopted by Amtrak to replace all the platform tracks at Chicago Union Terminal. "Iron Horses," as the PIP-Fast System tracks were known, soon became the industry standard and continue today.

In 2000, the couple sold the Iron Horse product line, and Moorhead began consulting. He is currently principal of TRAMMCO, LLC, of Smithfield, Virginia, and his practice provides construction and installation advisory support and training and consulting capacities for equipment and product design. Moorhead has consulted for projects in the United States and abroad.

Moorhead stresses the need for research on rail transit infrastructure, which he fears is deficient for reasons that include time constraints, a lack of science-based best practices, and the sensitivity of transit properties to outside review of their design and maintenance standards.

"The TRB Transit Cooperative Research Program's (TCRP's) ongoing relationship with the Transportation Technology Center, Inc., in Pueblo, Colorado—through Project D-07—has been a boon to getting many vexing problems researched and remediations suggested," Moorhead comments. But it is important, he adds, that TCRP and other research programs support all types of research—especially involving infrastructure issues.

Agencies and practitioners should be open to having their practices objectively investigated or to sharing the benefits of such an investigation with the larger research community, Moorhead emphasizes. "Most agencies and practitioners are reluctant to be the guinea pig; the fact that someone has successfully gone before may accelerate the use of worthwhile research in the operating community."

Moorhead became involved with TRB in 1991, when he was invited to serve on the Railroad Track Structure System Design Committee; he became committee chair in 1994. Moorhead has been a member of the Rail Transit Infrastructure Committee since 2000 and is currently its secretary. He also serves on the TCRP Project Panel that is updating TCRP Report 57, *Track Design Handbook for Light Rail Transit*. Other professional affiliations include the American Public Transportation Association, the American Railway Engineering and Maintenance-of-Way Association, and the American Concrete Institute.

NEWS BRIEFS

PHOTO: MARYLAND SHA

Bog turtle equipped with radio telemetry, used to determine the protected amphibian's home range movements, during the preliminary planning for construction of a road bypass.

Maryland Goes High-Tech and Low-Tech to Protect the Environment

When the Maryland State Highway Administration (SHA) built a 4.5-mi bypass to relocate MD-30 around the town of Hampstead in Carroll County, the presence of the federally protected bog turtle (*Glyptemys muhlenbergii*) within the project area presented the opportunity for highway design flexibility and environmental stewardship. During the preliminary road planning period, radio telemetry was used to determine the home range movements of the bog turtle—research transmitters were placed on approximately 30 turtles at two locations. The turtles' movements were recorded to make sure that the new road would be at a safe distance from the habitat and would not have an adverse impact on the turtles' daily movements. The research efforts led to a successful partnership between Maryland SHA, federal and state regulatory agencies, the Town of Hampstead, and Carroll County; the project gained approval for construction.

The environmental stewardship commitments have continued. Maryland SHA is implementing a wildlife habitat management plan that includes acquisition and protection of vital wetland and upland habitats for the bog turtle, with covenants, plats, and deed restrictions that will provide permanent protection for these habitats. Included in the plan is a passive strategy to set back vegetative succession; because the bog turtle prefers a wet sedge meadow with some shrubs, the site has been left fallow for shrubs and small trees to grow.

The traditional approach to vegetative management—especially for a large, construction-oriented organization—is to use manpower, equipment, and chemicals, but according to Maryland SHA environmental analyst Bill Branch, the challenge was to protect a unique and fragile ecosystem inhabited by a federally protected species.

Maryland SHA implemented a grazing strategy, deploying a herd of 40 goats and sheep to provide a more passive method of vegetation management. A local farmer provides for the delivery, care, and health of the livestock and removes them from the area at the end of the season.

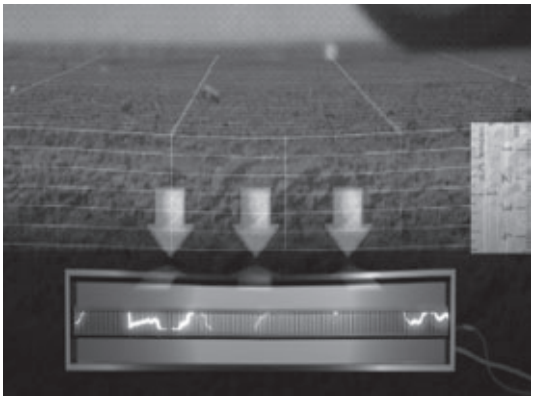
Farm fencing at the 8-acre site contains the farm animals and limits entry by people and pets. The fencing and livestock have been well-received by the adjacent neighborhood and are popular with local children. Maryland SHA's stewardship effort has been recognized by the Federal Highway Administration as an exemplary ecosystem initiative.

INTERNATIONAL

Generating Electricity from Traffic

Traffic may provide a new source of electricity—a generator developed by an Israel-based firm can produce electrical energy from the movement of cars on roads. The system—the Innowattech Piezoelectric Generator, or IPEG™—enables the conversion of the mechanical energy produced by the movement of passing vehicles, trains, and airplanes into electrical energy.

The system relies on piezoelectric generators and a harvesting module that transfers the electrical energy to accessories along the road or directly into the electric grid. The system can be installed under the surface of roads, railways, or runways.



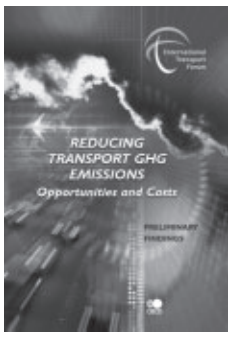
Piezoelectric generators are embedded under the top layer of asphalt on roads.

Piezoelectric generators harvest the energy produced by some materials when they undergo deformation. When a vehicle passes over a road, the road deforms vertically, and usually the road surface absorbs the thermal energy produced. Embedded under the top layer of asphalt or concrete on roads and airport runways—or between the rail and crosstie on a railway—IPEGs convert part of the thermal energy that ordinarily would go to waste into electrical energy. Compression stress causes shortening deformation in the generators and in the asphalt layer covering them; the deformation of the generator and the shortening of the embedded piezoelectric rods generate charges on the piezoelectric electrodes that become the source for the electrical energy.

According to Innowatech, the energy-generating potential for a road 1 km in length with approximately 600 heavy trucks passing through a single lane for 1 hour is 200 kWh; for a 1-km railway track bearing approximately 250 wagons per hour, the potential energy is 120 kWh. Electric energy produced by IPEGs can be used in roadside applications or accessories—such as lighting, speed cameras, communication signs, billboards, or sensors—or can be transferred to the electric grid. Local applications would require smaller IPEG installations, but electric-grid energy transfer installations would cover a larger area.

For more information, visit www.innowattech.co.il.

Cutting Emissions from Transportation



The International Transport Forum (ITF) has released a report on cost-effective policies for reducing greenhouse gas (GHG) emissions from transportation. Preliminary findings, published in *Reducing Transport GHG Emissions: Opportunities and Costs,* indicate that policies must encourage low-carbon innovation in industry and must guide vehicle purchasing decisions for consumers.

Stringent long-term fuel economy standards are the most effective way to cut road vehicle emissions, according to the report, and standards work best when set at least 10 years in advance. Also recommended are tax incentives for purchases of low-emissions automobiles and an examination of whether to continue low taxes and subsidies for automobile fuels under tough standards for fuel economy.

To see the preliminary findings of the ITF report, visit www.internationaltransportforum.org.

RENEWAL PROJECTS UPDATE—Michael Heitzman (*standing*) outlines a nondestructive testing project that identifies delamination, or splitting, between layers of hot-mix asphalt pavement. Heitzman's presentation was part of a workshop on the Integration and Implementation of Second Strategic Highway Research Program (SHRP 2) Pavement-Related Research. At the workshop, November 17–18 at the National Academy of Sciences headquarters building in Washington, D.C., contractors presented updates on SHRP 2 Highway Renewal projects, such as the development of continuous deflection sensors, modular pavement technology, and pavement preservation.

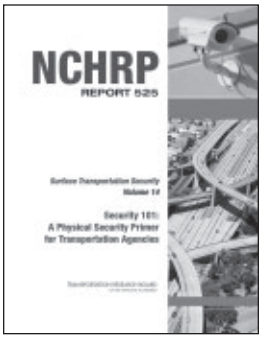
EN ROUTE REVIEW—Diane Boone (*center*), Center for Advanced Aviation System Development of The MITRE Corporation, speaks at a meeting of the review committee for the En Route Air Traffic Control Complexity and Workload Model, December 16 at The National Academies' Keck Center in Washington, D.C. The committee is providing an expert review for the Federal Aviation Administration of methodologies and modeling capabilities for post facto analysis of en route sector capacity and position-to-traffic.

GHG REDUCTION DISCUSSION—The Committee for a Study of Potential Energy Savings and Greenhouse Gas Reductions from Transportation gathered at the Keck Center Friday, December 18, to discuss issues related to the potential for transportation-related energy savings and greenhouse gas (GHG) reductions. The committee reviews policies and strategies for improving fuel economy for passenger and freight vehicles across all modes, and considers the safety, economic, transportation finance, and environmental consequences of energy-saving measures in its analysis.

BOOK SHELF

Pavement Management 2009, Volume 2
Transportation Research Record 2094
In this volume's 15 papers, authors explore full-scale and accelerated pavement testing, strength and deformation characteristics of pavement sections, pavement–vehicle interaction, and pavement friction and skid resistance.

2009; 143 pp.; TRB affiliates, $46.50; nonaffiliates, $62. Subscriber category: pavement design, management, and performance (IIB).



Pavement Management 2009, Volume 3
Transportation Research Record 2095
This collection contains research on such subjects as top-down cracking prediction for airfield pavements, tie bar design in concrete pavements, thermal stresses of thick airport concrete pavements, a permanent deformation model of asphalt mixtures, perpetual pavement responses to moving wheel loading and contact stresses, truck traffic inputs for mechanistic–empirical pavement design, quieter hot-mix asphalt pavements, the effect of axle load spectrum characteristics on pavement performance, the influence of active fillers on the properties of recycled mixes with foamed asphalt, the profile analysis of the Arizona Specific Pavement Studies 5 project, and more.

2009; 152 pp.; TRB affiliates, $45; nonaffiliates, $60. Subscriber category: pavement design, management, and performance (IIB).

Traffic Safety: Roundabouts, Trucks, Older Drivers, and Traffic Law Enforcement 2009
Transportation Research Record 2096
Roundabouts, truck lane restrictions, sleep apnea and driving performance, the effect of horizontal curvature on truck crashes, roadside tire debris, occupational road safety programs, the safety impacts of truck speed limiters, the influence of driver safety programs on older drivers, the effects of speed photo-radar enforcement on work zone speed, the impact of driving-while-intoxicated checkpoint enforcement techniques on traffic operations, and a legal approach to reducing crashes caused by red-light running are some of the topics covered in this volume.

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.*

2009; 107 pp.; TRB affiliates, $42.75; nonaffiliates, $57. Subscriber category: safety and human performance (IVB).

Freight Systems 2009
Transportation Research Record 2097
Presented are 15 papers on subjects such as backhaul opportunities using telematics data, transportation impacts of collection and delivery points, time-dependent demand for truck parking facilities along a federal highway, microsimulation of off-hour delivery policies in urban areas, freight generation models, scheduling of cranes in port container terminals, the impact of land bridges on port market areas, free trade agreement effects in the Mediterranean region, the effect of intermodal terminals on the highway system, improving the safety of dangerous goods transport, and risk analyses of hazardous materials transportation by rail.

2009; 135 pp.; TRB affiliates, $46.50; nonaffiliates, $62. Subscriber category: freight transportation (multimodal) (VIII).

Integrating the Priorities of Transportation Agencies and Utility Companies
SHRP 2 Report S2-R15-RW
Current practices, opportunities for enhancement, and anticipated barriers for integrating utility and transportation agency priorities in highway renewal projects are examined in this SHRP 2 report. Thirteen best practices that span the project life cycle are explored, and a plan for future research in the field is outlined.

2009, 100 pp. Available in electronic format only: http://onlinepubs.trb.org/onlinepubs/shrp2/shrp2_S2-R15-RW.pdf.

Security 101: A Physical Security Primer for Transportation Agencies
NCHRP Report 525: Volume 14
Designed as an introductory-level reference to enhance transportation managers' and employees' knowledge of security concepts, guidelines, definitions, and standards, this primer covers the major components of an effective security program at the conceptual level: risk management and risk assessment, plans and strategies, physical security countermeasures, security and other personnel, infrastructure protection, and homeland security. With a focus on physical security—an integral part of an all-hazards approach to preparedness—this report can be used as an introduction to the extensive literature; additional sources of information are identified in the appendixes.

2009; 212 pp.; TRB affiliates, $49.50; TRB nonaffiliates, $66. Subscriber categories: planning and admin-

istration (IA), operations and safety (IV), aviation (V), public transit (VI), rail (VII), freight transportation (VIII), marine transportation (IX), and security (X).

Acoustic Beamforming: Mapping Sources of Truck Noise
NCHRP Report 635
This report explores the acoustic beamforming technique—an elliptical array of more than 70 microphones and data acquisition software to measure noise levels from a variety of sources on large trucks, including the engine, tires, mufflers, and exhaust pipes—to pinpoint and measure noise from heavy truck traffic. The results validate the feasibility of beamforming technology, offer insight into the distribution of truck noise sources, and provide input to the design and testing of quieter pavements and noise barrier systems.

2009; 79 pp.; TRB affiliates, $36.75; TRB nonaffiliates, $49. Subscriber categories: energy and environment (IB) and highway and facility design (IIA).

Real-Time Traveler Information Systems
NCHRP Synthesis 399
Traveler information systems—which may be operated by public or private agencies—include telephone support phone numbers, Internet dissemination sites, notices and alerts sent to in-vehicle or handheld devices, and field devices that inform travelers en route. This synthesis gathers and presents information on the state of the practice of real-time traveler information delivery—the needs and expectations of travelers, the current status of a variety of traveler information systems in the United States, available and emerging data sources, and business models for sustaining traveler information.

2009; 62 pp.; TRB affiliates, $32.25; TRB nonaffiliates, $43. Subscriber categories: highway operations, capacity, and traffic control (IVA) and safety and human performance (IVB).

Assessment of Hybrid–Electric Transit Bus Technology
TCRP Report 132
In this report, decision-making guidelines are combined with a comprehensive life-cycle cost (LCC) model that assists transit managers in evaluating, selecting, and implementing hybrid–electric technology in transit buses. The model, contained on an accompanying CD-ROM, compares total LCCs across several cost categories for up to six different purchase scenarios.

2009; 77 pp.; TRB affiliates, $44.25; TRB nonaffiliates, $59. Subscriber category: public transit (VI).

Safety Management Systems for Airports, Volume 2: Guidebook
ACRP Report 1: Volume 2
Of interest to airport managers—particularly those certified under 14 CFR Part 139—this guidebook examines the components and interactions of an airport safety management system (SMS) and offers guidance in planning, implementation, and operation. Also provided is detailed information on how to carry out the SMS processes. This volume supplements the first volume of ACRP Report 1, which provides an overview of SMS and explains how a systems approach to safety management can benefit airport safety and business. Developed in coordination with the Federal Aviation Administration before the agency issued final guidance on SMS implementation at airports, this guidebook does not address any subsequently issued FAA directives.

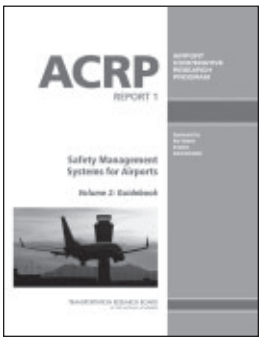
2009; 166 pp.; TRB affiliates, $45; TRB nonaffiliates, $60. Subscriber category: aviation (V).

Approaches to Integrating Airport Development and Federal Environmental Review Processes
ACRP Synthesis 17
When an airport sponsor fails to consider environmental issues during the airport planning process, delays in FAA environmental decision making processes are likely, because FAA cannot meet its National Environmental Policy Act obligations with the data available. This synthesis explores practices used by airport sponsors, FAA planners, and environmental specialists to integrate airport planning efforts and the FAA's environmental review process, and uses surveys and case studies to highlight successful practices for airport operators, planners, and environmental documentation managers.

2009; 34 pp.; TRB affiliates, $28.50; TRB nonaffiliates, $38. Subscriber category: aviation (V).

Institutional Arrangements for Freight Transportation Systems
NCFRP Report 2
An examination of 40 guidelines based on lessons learned from successful and promising institutional arrangements, this report helps agencies and industry representatives work together to improve and invest in the freight transportation system. Appendices such as a literature review, workshop material, detailed case studies, and an interview guide are included on an accompanying CD-ROM.

2009; 59 pp.; TRB affiliates, $39.75; TRB nonaffiliates, $53. Subscriber categories: planning and administration (IA); highway operations, capacity, and traffic control (IVA); rail (VII); freight transportation (VIII); and marine transportation (IX).



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25–26 Offshore Wind Energy Projects
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25–26 Workshop on Control and Electrification of Highway Vehicles: Integrating Concepts and Infrastructure Need
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28–30 Road Safety on Four Continents Conference*
Abu Dhabi, United Arab Emirates

April

12–16 1st International Conference on Pavement Preservation*
Newport Beach, California

27–29 High-Speed and Intercity Passenger Rail Systems and Strategies Joint Rail Conference*
Urbana, Illinois
Elaine King

May

2–5 American Public Transportation Association Bus and Paratransit Conference*
Cleveland, Ohio

5–7 1st International Conference on Nanotechnology in Cement and Concrete
Irvine, California

9–12 Innovations in Travel Demand Forecasting 2010
Tempe, Arizona

13–14 Innovations in Pricing of Transportation Systems: Workshop and Conference*
Orlando, Florida

19–20 Toward Better Freight Transportation Data: A Research Road Map
Irvine, California

19–21 Transportation Finance: Forging a Sustainable Future—Now
New Orleans, Louisiana

30–June 2 Safety and Mobility of Vulnerable Road Users: Pedestrians, Motorcyclists, and Bicyclists*
Jerusalem, Israel
Richard Pain

June

2–4 TRANSED 2010: 12th International Conference on Mobility and Transport for Elderly and Disabled People*
Hong Kong, China

2–5 4th International Symposium on Highway Geometric Design*
Valencia, Spain

3–5 GeoShanghai 2010 International Conference*
Shanghai, China

6–10 Environment and Energy in Transportation Summit*
Raleigh, North Carolina

8–10 Joint Conference of Harbor Safety Committees and Area Maritime Security Committees*
Jersey City, New Jersey

21–24 North American Travel Monitoring Exposition and Conference (NATMEC): Improving Traffic Data Collection, Analysis, and Use
Seattle, Washington
Thomas Palmerlee

29–July 1 Marine Transportation System Research and Technology Coordination Conference*
Irvine, California
Joedy Cambridge

July

11–14 TRB Joint Summer Meeting
Minneapolis, Minnesota

11–14 49th Annual Workshop on Transportation Law
Newport, Rhode Island

11–15 5th International Conference on Bridge Maintenance, Safety, and Management*
Philadelphia, Pennsylvania

August

23 Asset Management in a World of Dirt*
Oklahoma City, Oklahoma
G. P. Jayaprakash

September

4 Pavement Performance Data Analysis Forum
São Paulo, Brazil
A. Robert Raab

15–17 International Conference on Sustainable Concrete Pavement Technologies: Practice, Challenges, and Directions*
Sacramento, California

October

10–13 9th National Conference on Access Management*
Natchez, Mississippi

24–27 19th National Rural Public and Intercity Bus Transportation Conference
Burlington, Vermont

25–27 6th International Conference on Visualization in Transportation
TBD
Richard Pain

26–27 Using National Household Travel Survey Data for Transportation Policy Decisions
Washington, D.C.

December

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

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.

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INFORMATION FOR CONTRIBUTORS TO

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◆ 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.

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