MARCH–APRIL 2012
NUMBER 279

TRANSPORTATION RESEARCH BOARD
OF THE NATIONAL ACADEMIES

TR NEWS

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91st Annual Meeting Highlights

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- **Dedicated Truck Lanes: Realizing the Promise**
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The **Transportation Research Board** is one of six major divisions of the National Research Council, which serves as an independent adviser to the federal government and others on scientific and technical questions of national importance, and which is jointly administered by the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. The mission of the Transportation Research Board is to provide leadership in transportation innovation and progress through research and information exchange, conducted within a setting that is objective, interdisciplinary, and multimodal. The Board's varied activities annually engage about 7,000 engineers, scientists, and other transportation researchers and practitioners from the public and private sectors and academia, all of whom contribute their expertise in the public interest. The program is supported by state transportation departments, federal agencies including the component administrations of the U.S. Department of Transportation, and other organizations and individuals interested in the development of transportation.

The National Research Council was organized by the National Academy of Sciences in 1916 to associate the broad community of science and technology with the Academy's purposes of furthering knowledge and advising the federal government. Functioning in accordance with general policies determined by the Academy, the Council has become the principal operating agency of both the National Academy of Sciences and the National Academy of Engineering in providing services to the government, the public, and the scientific and engineering communities.

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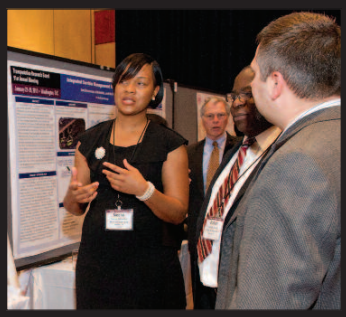
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COVER: Six U.S. Secretaries of Transportation shared personal anecdotes and policy insights at a special session of the 2012 TRB Annual Meeting, a crossroads of research progress and history.

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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In March 2010, the National Highway Traffic Safety Administration asked the National Research Council to review the agency's investigations of unintended acceleration in automobiles and to recommend ways to strengthen the safety oversight of automotive electronics systems. The committee found that the systems offer many opportunities to make driving safer but also present new demands to ensure the safe performance of increasingly complex vehicle technologies.

ALSO IN THIS ISSUE:

COMING NEXT ISSUE

PHOTO: LAURA SANDT, PBIC IMAGE LIBRARY

The planning, design, operation, and maintenance of pedestrian and bicyclist facilities, as well as efforts to integrate these modes into the transportation system, are the focus of feature articles and sidebars in the May–June issue. Articles explore the health benefits of nonmotorized transportation; the business side of bicycling; measuring multimodal mobility; learning from trends in other nations and transferring designs and practices from other nations to the United States; and more.

Cyclist waits in bike box at intersection of Broadway and Fifth Avenue in New York City.

RESEARCH WITHOUT BORDERS

The Growing Role of International Cooperation and Collaboration at the Transportation Research Board

SANDRA ROSENBLOOM, JORGE PROZZI, MARTINE MICOZZI, AND RUSSELL HOUSTON

PHOTO: RISDON PHOTOGRAPHY

Michael D. Meyer *(left)*, Georgia Institute of Technology; TRB Executive Director Robert E. Skinner, Jr.; and Josef Mikulik, Transport Research Centre, Czech Republic, participate in an international research roundtable in 2007. TRB programs are opening avenues of international research across the globe.

Rosenbloom chairs the TRB Executive Committee and serves as TRB's International Secretary; Professor of Planning at the University of Arizona, Tucson, she is on leave for 2012 and working as Director of the Infrastructure Initiative for the Urban Institute in Washington, D.C. Prozzi is Associate Professor, University of Texas, Austin, and Chair of the TRB International Activities Committee. Micozzi is TRB Senior Program Officer, Management, Policy, and International Relations. Houston is Senior Communications Officer, TRB.

As the words of the Disneyland song remind us, "It's a small world after all." This observation applies more today than it did 92 years ago, when the National Advisory Board on Highway Research—later the Highway Research Board (HRB)—was established. Today the organization, renamed the Transportation Research Board (TRB) in 1974, is more international, as measured by the organization's activities, the functions it supports, the composition of attendees at the Annual Meetings and other TRB conferences, the topics of the research presented and published, the cosponsorship of major international transportation events, and the adoption of formal memoranda of understanding (MoUs) with major research organizations in Europe.

The growing international element in much of what TRB does reflects the advantages of collaborative research and the expanding efforts of key stakeholders—such as state departments of transportation (DOTs)—to partner with and learn from colleagues around the world. At least 10 states—from California to Minnesota, from Alaska to Georgia—are collaborating on research projects with governmental or research entities in Europe, the Middle East, and Asia.

Transportation professionals around the globe are in closer contact through advances in transportation, telecommunications, and information technology. Individual researchers, research centers in other countries, and TRB have come to see the similarity of the challenges faced in transportation sectors around the world. The resources available for a comprehensive study of transportation problems are limited, making increased international cooperation and collaboration valuable for conducting research to address the challenges.

This circa-1967 brochure detailed the international research activities of TRB, then called the Highway Research Board—for example, distributing publications in 59 countries and developing cooperative arrangements with more than 40 organizations throughout the world.

Decades of Tradition

Opportunities for Outreach

World events and individuals from outside the United States have played a role in shaping TRB's history from the outset. According to Fred Burggraf and M. Earl Campbell, the primary authors of *Ideas and Actions: A History of the Highway Research Board,1920–1970,* the contributions of research to the war effort during World War I changed America's thinking about the value of research (*1*). The Board built on this new support during its first five years, initiating the Annual Meetings and adopting other mechanisms to facilitate the gathering and dissemination of information.

In 1924, the Board designated "contact men," charged with creating a two-way flow of information between state highway departments and the Board. The inaugural class of university contact men included a non-U.S. researcher at the University of Mexico.

In 1928, Roy W. Crum became director of the Board and three years later started serving as the HRB representative to committees of the Permanent International Association of Road Congresses (PIARC), now known as the World Road Association. According to *Ideas and Actions*,

> In 1941 Director Crum attended the Pan-American Highway Congress in Mexico City. Upon his return, the Executive Committee took note of the opportunity to extend informational service into the neighboring Pan-American states and authorized Mr. Crum to explore the possibility for arranging translations of pertinent publications into Spanish for distribution in Mexico and the Central and South American countries. (*1*, p. 107)

International activities necessarily were curtailed during World War II and in the early postwar years. A dramatic change occurred in June and September 1959, when HRB participated in exchange visits with soils engineers from the Soviet Union. The American Society of Civil Engineers coordinated the exchange, which the National Science Foundation funded. In 1965, the HRB Executive Committee established a Special Committee on International Cooperative Activities in response to requests from highway engineers in other countries for a closer rapport with the Board. Wilbur Smith, who had worldwide consulting interests, was named to chair the committee.

ARCHIVE PHOTO

J. Jakob, Director, Swiss Federal Road Administration, welcomes attendees to a symposium on concrete roads in Bern, Switzerland, in 1973. Active from 1965 to 1976, the TRB Special Committee on International Cooperative Activities gleaned information on research activities abroad and participated in international conferences.

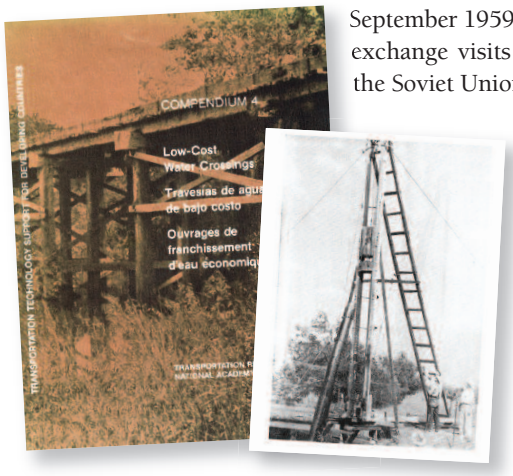
Expanding Contacts

The Special Committee started out with an impressive list of charges, including the expansion of international cooperative activities, the incorporation of translations and research abstracts from major foreign language publications into the Highway Research Information Services automated database, the planning of Annual Meeting sessions to present information on research activities abroad, the participation of staff and committees in international conferences, and the expansion of contacts and exchanges with similar organizations around the world (*1*, p. 108). The committee remained active until 1976.

A brochure produced circa 1967 boasted that the Board was mailing publications to individuals and organizations in 59 countries. The brochure also noted that HRB had established bilateral cooperative arrangements with 22 highway research agencies, 11 universities, and 8 ministries of public works throughout the world for the exchange of publications and research information.

In 1977, under the sponsorship of the U.S. Agency for International Development (USAID), TRB began a special project to enhance rural transportation in developing countries by improving access to information on the planning, design, construction, and maintenance of low-volume roads. Through the three-year project, USAID produced and distributed thousands of compendia and synthesis reports to developing countries around the world.

A double drum winch (*lower right*) is used to power a simple, easily constructed pile driver in an image from *Low-Cost Water Crossings*, a compendium from the Transportation Technology Support for Developing Countries project. TRB produced the publication in 1979 under the sponsorship of the U.S. Agency for International Development.



Multinational Perspectives

In the early 1980s, two Executive Committee task forces studied the involvement of TRB in international activities. The task forces developed recommendations to increase TRB's effectiveness in sharing research results and in receiving information on transportation research from abroad that was applicable to the United States.

Through the efforts of the task forces, the Executive Committee established 12 action items, including the creation of a permanent International Activities Committee. The scope of that standing committee has not changed since its creation in 1983:

> This committee is concerned with the evolution of an international perspective in all facets of all modes of transportation within the scope of the Board. In consultation with staff and volunteer leaders, it shall advise the Executive Committee and Councils on specific actions that will help to achieve that perspective, including implementation of the specific actions approved by the TRB Executive Committee. (2)

Responding to the recommendations from the two task forces, TRB began to reserve spaces for international members on each standing committee to gain multinational perspectives on the committee's area of interest. A committee could expand its membership of 25 by adding up to four seats specifically for international participants; the limit was raised to five in 2007.

New Millennium Initiatives

TRB's international activities continued to expand during the 1980s and 1990s as the organization's portfolio grew. TRB entered the new millennium with an array of international activities that included comparative policy studies, internationally sponsored and cosponsored conferences, international university representatives, cooperative international scanning programs, the international sharing of bibliographic data, an international exchange for the analysis of pavement performance data, loaned international staff and visiting scholars, and more. Many of these activities did not derive from a conscious effort to achieve international scope but as logical outgrowths of shared interests in transportation problems and of the substantial need to address similar transportation challenges jointly.

In its 2002 strategic plan, the TRB Executive Committee included the assessment of opportunities for expanded international activities as an action item. The Executive Committee established a task force to review international activities and connections, assess the need for expanding or redirecting the activities, assess the interest of sponsors, and develop initiatives as appropriate.

Led by Michael D. Meyer of the Georgia Institute of Technology, the task force recommended that the International Activities Committee develop a more strategic approach to identify and achieve interna-

PHOTO: MARK ROSENBERG

Harvey Fineberg *(left)* and Michael McGinnis, Institute of Medicine, meet with Maryvonne Plessis-Fraissard *(right)*, World Bank, at The National Academies' Workshop on Traffic Safety in Developing Nations in 2006.

PHOTO: RISDON PHOTOGRAPHY

Jean-Pierre Médevielle *(left)*, then Secretary-General of the European Conference of Transport Research Institutes (ECTRI); George Giannopoulos, then President of ECTRI; and Robert E. Skinner, Jr. *(right)* display the historic 10-point memorandum of understanding between ECTRI and TRB, signed in January 2006.

Photo: Rsdon Photography

Médevielle *(left)*; Guy Bourgeois *(center)*, then President, Institut National de Recherche sur les Transports et leur Sécurité; and a group of ECTRI representatives participated in TRB's first international research roundtable in 2007.

tional cooperation. The task force also recommended that the Executive Committee appoint a member to serve as International Secretary, and Meyer was named to the post in June 2004.

In response to the task force report, the Executive Committee adopted an international vision statement calling on TRB to look for partnering opportunities wherever possible. In fulfilling this mission, TRB has sponsored a reception for the growing number of international participants attending each Annual Meeting.

Pursuing Partnerships

TRB pursued the plan with speed and vigor, strengthening and formalizing many international relationships, while seeking to expand international partnerships. Working with the European Conference of Transport Research Institutes (ECTRI), TRB fostered technical exchanges and supported young transportation researchers around the globe. As a result, ECTRI and TRB held a formal event in 2006 to sign an historic MoU to develop research partnerships across national borders. TRB hosted its first international research roundtable in 2007, with ECTRI representatives from 14 countries, to share information on common research topics and to explore prospects for research collaboration. ECTRI and TRB collaborate in identifying items that constitute an action plan, renewed every two years.

TRB has worked with PIARC since 1931 but signed a formal MoU in 2007 at the World Road Congress in Paris. As a result, TRB hosted PIARC's Technical Committee on Climate Change and the Environment at a special joint session with TRB's leadership at the 2009 TRB Annual Meeting. TRB commissioned three white papers for the session, exploring the prospects and challenges of climate change adaptation and of mileage-based pricing. Sue McNeil, University of Delaware; Cindy Burbank, Parsons Brinckerhoff; and James Whitty, Oregon Department of Transportation, authored the papers.

TRB built on these international collaborative efforts by working with the American Association of State Highway and Transportation Officials (AASHTO) and the Federal Highway Administration (FHWA) to host a U.S. exhibit at the 2010 PIARC Winter Road Maintenance Conference in Quebec, Canada. In 2011, TRB, AASHTO, and FHWA again sponsored a U.S exhibit at the PIARC World Congress in Mexico City.

Also in 2011, TRB signed an MoU with the Europe-based International Transport Forum, agree-

At its 2007 World Road Congress in Paris, the Permanent International Association of Road Congresses–World Road Association signed a formal Memorandum of Understanding with TRB, cementing a partnership of more than 75 years.

Photo: Martine Micozzi

ing to integrate TRB's online, searchable Transportation Research Information System (TRIS) database with the International Transport Research Database (ITRD). The combined TRIS-ITRD resource, known as TRID, is a multilingual catalogue that includes approximately 1 million transportation research references. TRID supplies researchers with a powerful tool for understanding the scope and magnitude of research under way worldwide on a large number of challenging transportation questions.

Upward Trends

TRB's international impact and outreach have continued to grow and expand, and additional collaborative exchanges and research partnerships are expected between TRB and research organizations around the world. All trends are upwards—in almost every year of the past decade, the number of international participants attending the TRB Annual Meetings has grown (see bar chart, page 9); the participants come to present research findings or to learn about comparable activities in the United States and around the world.

At the HRB 46th Annual Meeting in 1967, 200 of the meeting's 3,311 attendees were from 17 countries outside the United States. In 2006, 1,230 international participants attended the annual meeting—comprising 12 percent of all attendees. In 2012, despite severe economic conditions worldwide, 1,748 international registrants from 70 different countries participated in the Annual Meeting, comprising more than 15 percent of attendees.

Laying the Groundwork

In addition, the International Activities Committee is expanding its long-term international cooperative efforts. Working with ECTRI to implement key activities in the MoU, the committee performed a comprehensive comparative analysis of the similarities and differences in the institutional structures and funding sources in the United States and in the European Union for planning, implementing, and administering transportation research projects.

The report, *European–United States Transportation Research Collaboration: Challenges and Opportunities*, was published in 2009, laying the groundwork for collaboration (3). The report was disseminated widely via the Internet through postings on the TRB and ECTRI websites. In support of ECTRI, France's Ministry of Transport translated and republished the report in French.[1] The International Activities Committee views its role as bringing researchers from around the world together to increase communication, share ideas and research results, and develop research partnerships in multiple transportation arenas.

The committee reflects only a portion of the international presence in TRB, however—many technical standing committees have long had active and committed international members. But the number of international members has grown rapidly in the past decade, in part because of the expanded number of member spaces reserved for international researchers but also because of the global nature of research into key transportation topics.

TRB's nearly 200 standing committees include 771 committee members—almost 13 percent of all formal members—who are international scholars and researchers addressing questions in subject areas ranging from pavement materials to public transit to adaption to climate change. This number is almost four times what it was in 2002, when the total of international researchers serving as formal committee members was less than 200.

Photo: Rsson Photography

Representatives from TRB and the European Commission discussed transportation research collaboration at an informal meeting in 2010.

Photo: ECTRI

Members of an ECTRI working group analyze research infrastructure initiatives that would enhance the exchange of transportation knowledge across international borders.

[1] www.ectri.org/Documents/Publications/Strategic-documents/WG10report_cooperationUE-US_pub_FR.pdf.

Strategic Partnerships

The second Strategic Highway Research Program (SHRP 2), managed by TRB for the National Research Council, supplies another example of the international presence in TRB and of the international collaborative partnerships among researchers addressing major transportation problems. Congress authorized SHRP 2 in 2005 and subsequently extended the authorization to address some of the most pressing research needs in the U.S. highway system: reducing traffic deaths and injuries, rehabilitating aging infrastructure with minimal disruption to travelers, and resolving reliability problems caused by congestion and inadequate capacity. The program is designed to translate research results into professional practice.

The 2009 publication *European–United States Transportation Research Collaboration: Challenges and Opportunities* was translated into French and republished by France's Ministry of Transport.

SHRP 2 has formal MoUs with other nations. Two deputy ministers from the Canadian Transportation Agency have worked on the staff, on-site at TRB, at different times, since the inception of the program. Dutch and French transportation professionals also have contributed to SHRP 2 projects as loaned staff for extended periods (see sidebar, below).

Through an MoU with Finland, TRB is identifying sites suitable for research on the nondestructive test-

Visiting Professionals Bring International Perspective

The second Strategic Highway Research Program (SHRP 2) has benefited from the expertise of professionals from Canada and Europe who are contributing to its mission and building international organizational relationships, collaboration, and integrated methods of research.

Abdelmename Hedhli joined SHRP 2 in 2010 through an agreement between TRB and the French Institute of Science and Technology for Transport, Development, and Networks (IFSTTAR). He focuses on projects to mainstream systems operations and achieve system reliability. These reliability projects include corridor planning, organization and business processes, incident management, geometric design, and intelligent transportation systems. Hedhli says that his work fulfills two goals: to establish relationships with fellow transportation researchers and to gain understanding of transportation research organization in the United States—particularly, TRB's model of volunteer-driven, nonprofit research. Other areas of exploration include the process of research results implementation. A merger of the French National Institute for Transport and Safety Research and the Central Laboratory of Roads and Bridges, IFSTTAR is an example of the reorganization of transportation research in Europe, Hedhli notes.

In their work with SHRP 2, Onno Tool (left) and Abdelmename Hedhli apply their expertise and develop collaborative approaches and exchanges.

A common challenge for Europe and America is how to make the most of limited funds for transportation research, observes Onno Tool, who comes to TRB and SHRP 2 from Rijkswaterstaat in the Netherlands. Tool splits his time between TRB and the Federal Highway Administration, guiding implementation of SHRP 2 reliability products. His goal is to open a two-way exchange of knowledge between Dutch and American researchers, enhanced by face-to-face interaction. The different approaches to research in the two countries—the structured method of this program and the Netherlands' more direct and hands-on style—have much to offer each other, Tool observes.

After more than 32 years with the Nova Scotia Department of Transportation and Infrastructure Renewal (TIR), Ralph Hessian retired as Director of Highway Engineering Services and in 2008 joined SHRP 2 as a visiting professional under an agreement with the Canadian Council of Deputy Ministers Responsible for Transportation and Highway Safety. While with TIR, Hessian had served as the Canadian liaison to the SHRP 2 Safety Technical Coordinating Committee. He now coordinates and manages capacity and travel time reliability research projects and disseminates SHRP 2 program research findings in Canada. Participating in SHRP 2 provides him an opportunity to contribute to new and developing knowledge and to products that advance transportation practice, Hessian affirms.

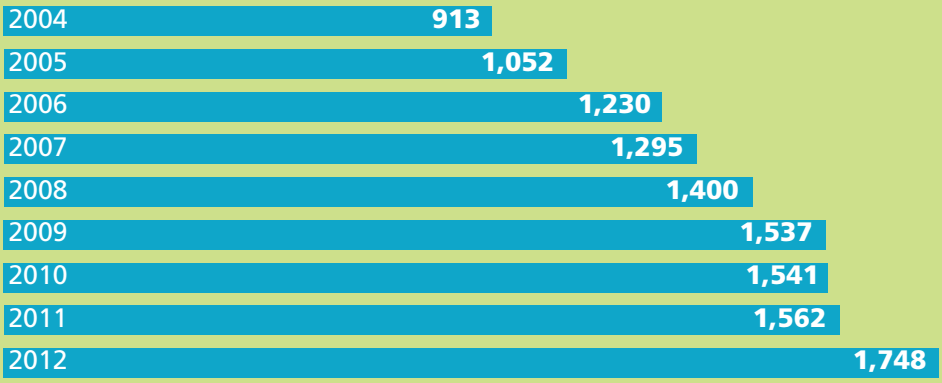
Andrew Horosko began his longtime association with TRB as a visiting researcher with the first SHRP. Horosko returned to serve on the SHRP 2 oversight committee as Deputy Minister of Infrastructure and Transportation in Manitoba, Canada. When he retired in 2009, he took on an assignment to coordinate the six data collection sites in the SHRP 2 naturalistic driving study. An engineer by training and an administrator by practice, Horosko is inspired by the integration of technology and the free exchange of information among SHRP 2 participants. The first SHRP imparted a vision for a positive relationship between transportation professionals in Canada and the United States, he recalls, and he has observed the continued collaborative development under SHRP 2.

QUICK FACTS

International Participation in TRB

- 70 percent of the people accessing TRID are from outside the United States.
- More than 20 percent of the 30,000 subscribers of the *TRB Transportation Research E-Newsletter* reside outside the United States.
- 771 of TRB's standing committee members—almost 13 percent—are from outside the United States.
- TRB's influence is global—in the past year, nearly 3.5 million visits or approximately 65 percent of all visits to TRB's website, www.trb.org, represented viewers in 216 countries outside the United States.
- The number of international attendees at TRB's Annual Meeting increased by 91 percent from 2004 to 2012 (see chart, below). The 2012 total represents 70 countries.

Number of International Attendees at TRB Annual Meetings, 2004–2012



ing of highway materials and for cooperative research efforts. In addition, other countries are expanding their research efforts to parallel SHRP 2 work; for example, Canada is initiating its own naturalistic driving study, equipping cars to record drivers' movements under various situations to develop highway and in-vehicle safety improvements.

SHRP 2 undertakes its research through competitively awarded, merit-based contracts with researchers. A Swedish group was chosen as the prime contractor on one project, and subcontractors on other projects include researchers from Canada, Denmark, England, and the Netherlands.

The SHRP 2 staff communicates often with researchers around the world who are working on similar problems; some staff members serve on advisory committees for parallel work under way in Europe. In 2011, a SHRP 2 delegation was invited to a conference in China, to present the program's work in infrastructure renewal and traffic safety (see sidebar, page 11).

Addressing Mutual Interests

The international presence in TRB activities and meetings, and TRB's partnerships and collaborations with similar research organizations around the world, result from the recognition that research and analysis can help address the myriad global, common, and local problems productively and effectively:

PHOTO: RISDON PHOTOGRAPHY

Magnus Quarshie *(left)*, Delin Consult; Sampson Asare, University of Virginia; and Adeyemi Fowe *(right)*, Nokia Corporation, converse at the 2012 TRB Annual Meeting. Quarshie and Fowe were among the nearly 1,750 international attendees at the meeting, coming to Washington, D.C., from Ghana and Nigeria, respectively.

A delegation of transportation professors from Lanzhou Jiaotong University in northwest China visited TRB in 2003 as part of a nationwide tour of academic, governmental, and private-sector institutions. Research partnerships allow countries to address global and local problems together.

◆ Global problems—such as climate change attributable to transportation emissions—cannot be addressed in isolation or by any one nation alone. Nations will need to identify and agree on possible corrective actions and work together to implement solutions.

◆ Common problems include safety, congestion, and obsolete or inadequate transportation infrastructure. Although each nation can address these problems independently, working together offers opportunities to use research funds more efficiently while bringing multiple perspectives to bear on the problems.

◆ Local problems may affect only one region, or one country, or the borders between countries. Although the solutions must be local, decision makers in the affected areas can learn from the experiences of other countries. International exchanges allow researchers to share ideas with those who have addressed similar problems or who have conducted research that could be relevant to the needs of local transportation professionals.

In November 2011 TRB held a special workshop for stakeholders and international researchers and participants to begin the development of a new international strategic plan for TRB (see sidebar, page 12). The final elements of the plan are still to be determined, but TRB will continue its nearly century-old goal of promoting and facilitating international research collaborations that address major global and common transportation problems, as well as providing guidance for local solutions.

Asian Transit Agencies Demonstrate Performance Measures for Improved Service

Many public transportation agencies in the United States use performance measures to maximize resources, improve operations and customer service, and meet strategic goals. In 2009, a team of professionals from transit systems throughout the United States visited four areas in Southeast Asia—Hong Kong; Singapore; Kuala Lumpur, Malaysia; and Taipei, Taiwan—to examine how public transportation agencies apply the results of performance measurements. The findings were published in TCRP Research Results Digest 95, *Performance Measurements and Outcomes*.

Team members gained familiarity with each agency's history, political structure, operation, management framework, and performance measurement systems. Among the challenges common to transit agencies in America and Asia are safety, cost control, and continued quality of service; areas of difference include population densities, politics, and levels of investment in transit. The review was organized around a performance measurement model comprising strategy development, specific actions, reporting mechanisms, quality control, agency improvement methods, and strategy refinement.

The team found that the Asian transit agencies followed a model that made customer satisfaction a priority. The agencies established goals and objectives, developed strategies for meeting those objectives, defined performance criteria and targets, measured the progress, and developed inputs for future objectives. The models integrated some standards—such as benchmarking and those of the International Organization for Standardization—but whether these standards were integrated internally or were set by government regulators was not clear. Most performance targets, however, were based on past performance, instead of on specific goals. The research also showed that for most systems, continuous improvement was not always clearly articulated in an organization's strategies.

TCRP Research Results Digest 95 can be accessed at http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_rrd_95.pdf.

Photo: RIOH

Jinquan Zhang, Deputy Director General of China's Research Institute of Highways; Neil Hawks, first Director of SHRP 2; and Charles Fay, SHRP 2 Senior Program Officer, participate in a discussion at the China–U.S. Seminar on Highway Technology.

China–U.S. Exchange Focuses on Highway Renewal and Safety

JAMES W. BRYANT, JR., AND CHARLES R. FAY

In June 2011, a delegation representing the second Strategic Highway Research Program (SHRP 2) participated in the China–U.S. Seminar on Highway Technology in Beijing. SHRP 2 committee members, contractors, and staff specializing in areas of renewal and safety research met with representatives from the Research Institute of Highways (RIOH), part of China's Ministry of Transport, to share research approaches and findings.

SHRP 2 renewal research is advancing tools for transportation agencies to complete highway projects consistently and quickly, while minimizing disruption to the community and producing long-lasting facilities. Renewal research products include the following:

- Advanced technological methods for locating underground utilities, including the tools for selecting the most appropriate technology for a project;
- Procedures to speed the evaluation of designs and the inspection of construction;
- Methods and materials for preserving, rehabilitating, and reconstructing roadways and bridges; and
- Alternative strategies for contracting, financing, and managing projects and for mitigating institutional barriers.

To gain key insights into driving behavior, the SHRP 2 safety program is conducting a study of unprecedented scope and scale. Major highway safety research themes include the following:

- A naturalistic driving study (NDS) involving 3,100 volunteer participants driving instrumented vehicles;
- Collecting roadway data to correlate driving behavior with roadway design;
- Analyzing high-priority safety issues, with a focus on potential countermeasures; and
- Developing a rich database for future research.

The technical exchange opened and concluded with plenary sessions. Two days were devoted to technical breakout sessions; on the third day, participants visited RIOH's testing facilities outside of Beijing. In the opening plenary session, a RIOH representative introduced China's National Road Safety Science and Technology Action Plan, and SHRP 2 staff provided an overview of research in the four focus areas of capacity, reliability, renewal, and safety.

Participants in the breakout sessions on bridge and pavement technical issues discussed the state of highway and bridge infrastructure in China and in the United States. Emerging issues in the design, construction, maintenance, and preservation of pavements and bridges—as well as long-term data archival needs—also were explored.

In the safety-focused sessions, SHRP 2 representatives presented information on the NDS and on the roadway data collection projects supporting highway safety analysis. Other topics included the Highway Safety Manual, highway safety research in the United States, and the U.S. Road Assessment Program. RIOH representatives detailed China's National Road Safety Action Plan, summarized research on human factors in highway safety, and discussed China's road network risk assessment program.

For more information about SHRP 2 renewal research, visit www.trb.org/SHRP2/ Renewal; for information about SHRP 2 safety research, visit www.trb.org/SHRP2/Safety.

Bryant is Senior Program Officer, Renewal, and Fay is Senior Program Officer, Safety, with TRB's Second Strategic Highway Research Program in Washington, D.C.

PHOTO: MICHAEL KODRANSKY

Traffic in Kunming, China. International partnerships can apply research and analysis to address global, common, and local problems productively.

More than ever before, TRB presents individual scholars, transportation organizations, and governmental research agencies around the world with the opportunity to interact at many levels to address mutual interests in transportation in compelling and exciting ways. TRB's network of international activities provides forums for international transportation professionals to work together to create safer, more effective, efficient, equitable, and sustainable transportation systems, meeting the needs of a world that seems smaller even as transportation challenges loom larger.

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3. TRB-ECTRI Working Group on EU–U.S. Transportation Research Collaboration. *European–United States Transportation Research Collaboration: Challenges and Opportunities*. February 2009. http://onlinepubs.trb.org/onlinepubs/general/EU-USResearch.pdf; www.ectri.org/Documents/Publications/Strategic-documents/WG10report_EU-UScooperation_pub_EN.pdf.

Stakeholders Map out Routes for International Collaboration

In November 2011, a group of TRB representatives and stakeholders with international backgrounds and interests convened to identify actions, activities, and initiatives to strengthen international research collaboration. Among the possible initiatives examined were regular international symposia, organized around a topic of broad international interest, and programs for young researchers, in association with other TRB activities or linked to similar programs organized by the European Conference of Transport Research Institutes.

Participants discussed ways to develop connections between TRB standing technical committees and World Road Association committees—matching up interests, anticipating collaborative activities, sharing information, and encouraging teamwork—and to stimulate international participation on all TRB committees. Ideas for facilitating partnerships with international stakeholders included developing research area frameworks, supporting information exchanges among researchers working in the same fields, pairing projects with similar goals and scopes of work, and brokering in-depth collaborations among teams in the United States and abroad working in related areas of research.

Participants also explored the establishment of international research programs—for example, an international cooperative research program that would acquire funding and select research topics and a strategic international research program that would specify research topics before obtaining funding.

Other proposals included the following:

- Conduct outreach to developing countries through capacity-building activities;
- Create an inventory of sister organizations outside the United States as potential partners;
- Designate a group within TRB to follow up on international proposals;
- Develop a mechanism for standing technical committees to provide input;
- Clarify the role and mission of the International Activities Committee; and
- Reexamine and redefine as needed the vision and goals first adopted for TRB international activities in January 2003.

For more information, contact Martine A. Micozzi, TRB, 202-334-3177, mmicozzi@nas.edu.

Transportation: Putting Innovation and People to Work

Transportation's role as an instrument for innovation and economic growth was the focus of the Transportation Research Board's 91st Annual Meeting, January 22–26, 2012, in Washington, D.C. More than 11,000 transportation professionals, scholars, and administrators convened from across the globe, setting an attendance record for the meeting. Approximately 4,000 presentations and 650 workshops and sessions—along with committee meetings, special events, and awards presentations—gave attendees opportunities to network and to share research findings. More than 80 sessions and workshops addressed the meeting's theme, "Transportation: Putting Innovation and People to Work."

In 2012, attendees could browse the Annual Meeting Final Program using an e-reader or tablet as well as the online interactive version and hard copy; a daily e-newsletter allowed participants to access meeting news, photos, and updates on the go. Slides from more than 7,000 presentations at the 2012 and 2011 meetings, as well as videos of more than 80 high-profile sessions, were posted to the searchable Annual Meeting Online portal.

William W. Millar, recently retired as President from the American Public Transportation Association and past chair of the TRB Executive Committee, delivered the 2012 Thomas B. Deen Distinguished Lecture on "Public Transportation: Today and Tomorrow." The featured speaker at the Chairman's Luncheon was Earl Swift, journalist and author of *The Big Roads: The Untold Story of the Engineers, Visionaries, and Trailblazers Who Created the American Superhighways*; the event included a book signing and major award presentations.

Details and highlights appear on the following pages.

1 U.S. Transportation Secretary Ray LaHood (*left*) and Rodney Slater, who served from 1997 to 2001, share perspectives on current and future transportation issues in a dialogue with four other transportation secretaries at the 2012 TRB Annual Meeting.

2 More than 11,000 transportation professionals from 70 countries attended this year's Annual Meeting—a record crowd.

Annual Meeting photographs by Risdon Photography

INTERSECTIONS

1 At the New and Young Attendees Welcome Session, Environment and Energy Section chair Robert O'Loughlin (*right*), Federal Highway Administration (FHWA), shows Gurdas Sandhu, North Carolina State University, sessions of interest in the Annual Meeting program.

2 Robert McGennis, The HollyFrontier Companies, explains the activities of the Asphalt Materials Section at the Welcome Session. Approximately one-third of this year's Annual Meeting participants were attending the meeting for the first time.

3 Marie Launay (*right*), Euro Project Consult, confers with Leigh Blackmon Lane, North Carolina State University, after a meeting of the Transportation and Sustainability Committee.

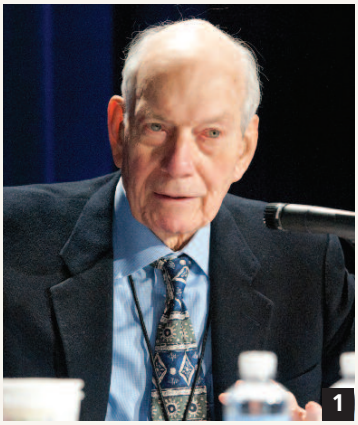
4 After delivering the keynote address at the Chairman's Luncheon, author Earl Swift (*left*) signs copies of his book, a history of the Interstate Highway System.

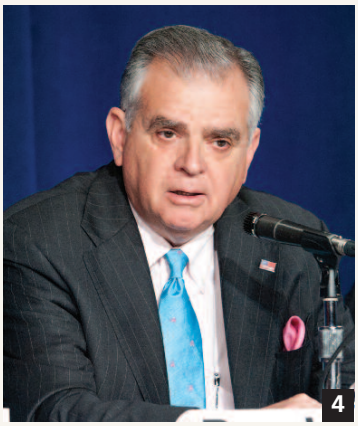
5 The Technical Activities Council oversees the Annual Meeting program.

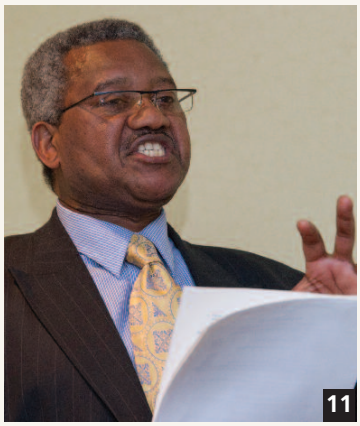
6 Victor Mendez (*right*), Administrator, FHWA, visits the Long-Term Bridge Performance Program booth in the Exhibit Hall and speaks with Krystal Smith, Center for Advanced Infrastructure and Transportation at Rutgers University, and Robert Zobel, FHWA.

7 Amanda DiFiore, QintetiQ, demonstrates a desktop trainer that senses the alertness of locomotive drivers. The Exhibit Hall featured displays from more than 150 organizations, including TRB sponsors.

5 TRB Technical Activities Council *(front row, left to right)*: Steven Silkunas, Johanna Zmud, Harold (Skip) Paul, Council Chair Katherine Turnbull, Mark Norman, Ronald Knipling, Thomas Wakeman; *(back row, left to right:)* Mark Kross, Peter Swan, Peter Mandle, Thomas Kazmierowski, Paul Carlson, Anthony Perl, and Edward Kussy.







SPOTLIGHT ON HISTORY

A panel of U.S. Transportation Secretaries—whose tenures span five decades—gathered before a standing room–only audience to discuss policy challenges and successes during their tenures and to contemplate the future of transportation. The event was moderated by Debra Miller, former Kansas DOT Secretary and former TRB Executive Committee Chair. The panel of Secretaries included

1–6 *(top row, left to right:)* Alan Boyd, 1967–1969; James Burnley, 1987–1989; Andrew Card, 1992–1993; *(second row, left to right:)* Ray LaHood, 2009–present; Rodney Slater, 1997–2001; and Samuel Skinner, 1989–1991.

SESSIONS AND WORKSHOPS

7 Laura Fay, Western Transportation Institute, leads a workshop on Environmental Management of Low-Volume Roads.

8 In his address at the Human Factors Luncheon, Michael Perel examined popular media interpretation and portrayal of transportation safety issues.

9 Audience members listen to a presentation on data mining, part of the Human Factors workshops at the Annual Meeting.

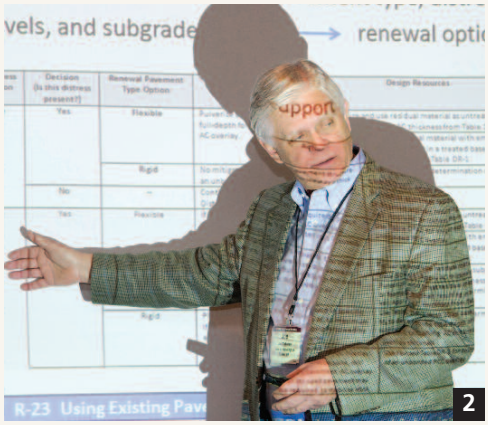
10 Gerardo Flintsch, Virginia Tech, delivers an update on the SHRP 2 continuous deflection study.

11 E. Clive Chirwa, University of Bolton, United Kingdom, presides over a workshop on rollover crashes and crashworthiness.

12 Debra Brisk, Kimley-Horn & Associates, Inc., describes a case study in innovative project delivery under SHRP 2.

SESSIONS AND WORKSHOPS

(continued)



1 Jim Young, Union Pacific, shares the industry perspective at a session on Freight Rail Innovation.

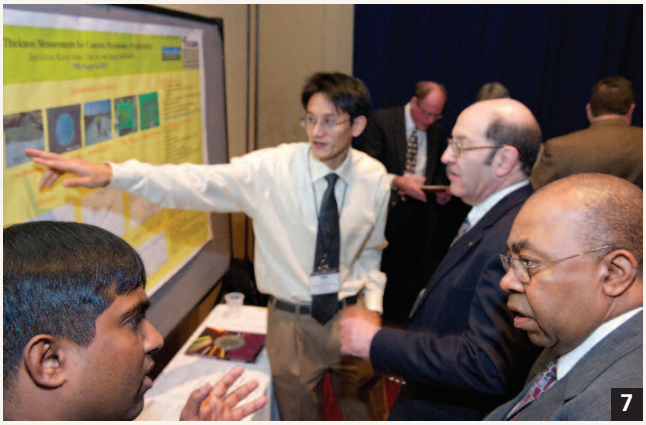
2 Joe Mahoney, University of Washington, presents products from a SHRP 2 project on long-life pavement rehabilitation.

3 Olivia Fonseca, Padilla and Associates, Inc., guides a discussion on Fostering Small Business Participation.

4 A session on Performance of Thin Lifts and Fine-Graded Asphalt Surfaces was led by Timothy Aschenbrener, Applied Pavement Technology, Inc.

5 Reporting on a December conference on critical data needs for decision making, Anne Stubbs, Coalition of Northeastern Governors, explores requirements for successful data delivery.

6 Tom Farmer, Association of American Railroads, participates in a panel discussion on Rail Security.

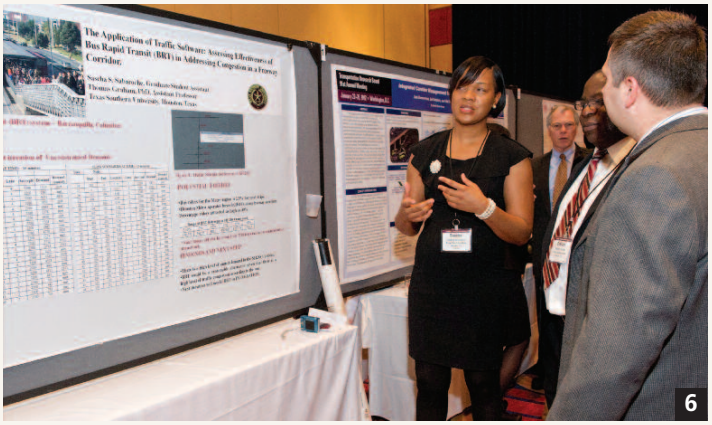


7 Jagan Gudimettla (*foreground, left*) shares research findings on thickness measurements for concrete pavements with Jeffery W. Brown (*foreground, right*), Alabama DOT, while other participants review a poster on intelligent compaction technology research.

8 Nicole van Nes, SWOV Institute for Road Safety Research, Netherlands, details feasibility research for the large-scale European naturalistic driving study PROLOGUE.

9 Stephanie Camay, URS Corporation, explores Economic Impact and Environmental Sensibilities of Ferry Transportation.

10 Daniel Turner, University of Alabama, explains Professional Engineer credentials in a session sponsored by the Young Members Council Task Force.



SESSIONS AND WORKSHOPS

(continued)

1 Mike Willis, Hobbs Straus Dean & Walker, LLP, presents information on tribal contracting at a session on Current Transportation Issues in Indian Country.

2 Aude Hofleitner, University of California, Berkeley (UC Berkeley), discusses findings on a three-stream model for arterial traffic at a session on traffic flow theory.

3 Information technology in aviation was the subject of a presentation by Geoffrey Gosling, Aviation System Consulting, LLC.

4 Anne Ferro, Administrator, Federal Motor Carrier Safety Administration (FMCSA), introduces a session detailing the agency's analysis, research, and technology programs.

5 Erdem Coleri, University of California, Davis, speaks on Accelerated Pavement Testing.

6 Sascha Sabaroche, Texas Southern University, presents research on using traffic software to assess bus rapid transit effectiveness. Sabaroche is a TRB Minority Student Fellow.

7 Michael Darter, Applied Research Associates, Inc., outlines SHRP 2 products at a session on Composite Pavements for New Construction.

8 Richard Dunne (*left*), Michael Baker Corporation, and Malcolm Kerley, Virginia DOT, participate in a workshop on the status of the Long-Term Bridge Performance Program.

9 Joanne Harbluk, Transport Canada, explores the use of detection tasks in assessing distraction.

SESSIONS AND WORKSHOPS

(continued)

1 Michael Townley (*left*), Michigan DOT, and Steven Ziegler, ICF International, use a tablet to test the web-based decision support tool and SHRP 2 product Transportation for Communities—Advancing Projects Through Partnerships.

2 U.S. Rep. Earl Blumenauer (D-Ore.) discusses the Future of the Federal Role in Transportation.

3 Sasha Page, Infrastructure Management Group, Inc., shares insights on the Role of Private Finance in Intercity Passenger Rail.

4 Karin Bauer, MRIGlobal, examines Beginning Analysis of SHRP 2 Naturalistic Driving Study.

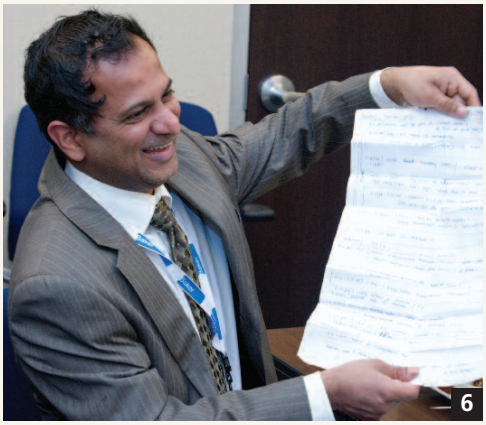
5 Lara Desire, Centre d'Etudes Techniques de l'Equipment, France, presents information on Modeling Pedestrians and Motorized Traffic.

6 Peter Schultz, U.S. Global Change Research Program, demonstrates sea level rise scenarios at a session on Advances in Integrated Analysis of Climate Change Impacts.

7 Alison Conway, City College of New York, shares the freight systems perspective at a roundtable discussion for young members of TRB standing committees.

8 Ed Christopher, FHWA, leads a travel data users forum on Health and Transportation Data Linkages.

9 Andres Sanchez, HDR Engineering, Inc., relates research findings in a session on Encouraging Innovation in Design–Build Through Alternate Technical Concepts.



10 Incoming chair of the Maintenance and Operations Personnel Committee William Bushman (*left*) presents commendation to Kathy DesRoches for having completed her second term as chair.

COMMITTEE MEETINGS

1 Johanna Zmud guides the Special Task Force on Data for Decisions and Performance Measures.

2 Alex Levy, Arcadis-US, Inc., chairs the Ecology and Transportation Committee.

3 Gregory Winfree, Acting Administrator, Research and Innovative Technology Administration (RITA), addresses committee leaders in the Data and Information Systems Section.

4 Michael Browne, University of Westminster, updates the Urban Freight Transportation Committee on the rail impact of the 2012 Olympics in London.

5 Ed Wallingford, Virginia DOT, leads the Waste Management and Resource Efficiency in Transportation Committee through its meeting agenda.

6 Nanda Srinivasan, TRB, shares his own Annual Meeting itinerary with members of the Planning and Environment Group Executive Board.

7 Michael Melaniphy, American Public Transportation Association (APTA), speaks to the Public Transportation Group Executive Board.

8 Kevin Krizek, University of Colorado, helms his final meeting as chair of the Effects of Information and Communication Technologies on Travel Committee.

9 Louis Triandafilou (*left*), FHWA; Kevin Thompson, Arora and Associates; Mary Lou Ralls, Ralls Newman LLC; and Sandra Larson and Ahmad Abu-Hawash, Iowa DOT, listen to presentations to the Structures Collaboration Subcommittee.

PAPER AWARDS

1 The Charley V. Wootan Award recognizes outstanding papers in policy and organization.

2 John Woodrooffe (*left*) and Daniel Blower, University of Michigan Transportation Research Institute (UMTRI), received the Patricia F. Waller Award for their paper, "Tractor-Trailer Rollover Prevention: Effectiveness of Electronic Stability Control Systems." Not present was Paul Green, UMTRI.

3 Eun Sug Park (*left*), Vichika Iragavarapu, Susan Chrysler, and Kay Fitzpatrick, TTI, received the D. Grant Mickle Award for their paper on detection distances to crosswalk markings. They celebrated the award with an homage to the famous crosswalk on the cover of the Beatles album *Abbey Road*. (Photo: TTI)

4 The Pyke Johnson Award honors the outstanding paper on the topic of planning and environment.

5 Ali Maher (*left*) and Thomas Bennert, Rutgers University, won the K. B. Woods Award for their paper examining influences on the performance of warm-mix asphalt.

6 Jocelyn K. Waite, Waite and Associates, was presented with the John C. Vance Award for her paper, "Application of Physical Ability Testing to Current Workforce of Transit Employees."

1 Wootan Award group (*left to right*): Peter Vovsha, PB Americas, Inc.; Technical Activities Chair Katherine Turnbull, Texas Transportation Institute (TTI); Yehoshua Birotker, Jerusalem Transportation Master Plan Team (JTMT); Marcelo Gurgel Simas Oliveira and Jean L. Wolf, GeoStats LP; and Danny Givon, JTMT. Not present was Julie Paasche, NuStats.

4 Xin Ye (*left*), California State Polytechnic University, and Ram Pendyala and Karthik Charan Konduri, Arizona State University, were recipients of the Pyke Johnson Award. Not present was Bhargava Sana, Resources Systems Group, Inc.

The Fred Burggraf Award recognizes authors under age 35:

7 Lei Zhang, University of Maryland, was the recipient of the Burggraf Award for outstanding paper in planning and environment.

8 The Burggraf Award for outstanding paper in public transportation was presented to Jason Lee, San Francisco Municipal Transportation Agency.

MAJOR AWARDS

1 TRB Executive Director Robert E. Skinner, Jr. (*left*), former TRB Executive Director Thomas B. Deen (*second from right*), and 2011 Executive Committee Chair Neil J. Pedersen (*right*) present the Deen Lectureship plaque to William W. Millar, who recently retired after 15 years as President of APTA.

2 In his address at the Chairman's Luncheon, *The Big Roads* author Earl Swift recounted the stories of the people who were key players in the development of the U.S. Interstate Highway System's nearly 47,000 miles of road—thereby shaping the nation's future.

3 The winner of the Roy W. Crum Award was Joseph L. Schofer, Professor of Civil and Environmental Engineering at Northwestern University. He was recognized for his distinguished achievement in transportation research.

4 2012 TRB Executive Committee Chair Sandra Rosenbloom (*left*) presents the Sharon D. Banks Award for leadership in people-oriented transportation initiatives to J. Barry Barker, Executive Director, Transit Authority of River City, Louisville, Kentucky.

5 Adib K. Kanafani, Professor of the Graduate School, UC Berkeley, received the W. N. Carey, Jr., Distinguished Service Award for his contributions to transportation research and to TRB.

Emeritus Awards Honor Long-Term Service

In recognition of their dedication and valuable contributions to technical activities committees, the following individuals received emeritus membership in TRB at the 2012 Annual Meeting:

◆ **Imad L. Al-Qadi**, Sealants and Fillers for Joints and Cracks Committee;
◆ **Edward A. Beimborn**, Public Transportation Planning and Development Committee;
◆ **Paul E. Benson**, Transportation and Air Quality Committee;
◆ **Wayne Berman**, Regional Transportation Systems Management and Operations Committee;
◆ **Edward J. Christopher**, Urban Transportation Data and Information Systems Committee;
◆ **James B. Goddard**, Subsurface Soil–Structure Interaction Committee;
◆ **Charles E. Howard, Jr.**, Statewide Multimodal Transportation Planning Committee;
◆ **Marianne Millar Mintz**, Transportation Energy Committee;
◆ **James Bernard Nevels, Jr.**, Engineering Behavior of Unsaturated Soils Committee;

Patricia Hendren (*left*), Washington Metropolitan Area Transit Authority, presents an Emeritus Membership certificate to Charles E. Howard, Jr., for his service on the Statewide Multimodal Transportation Planning Committee.

◆ **Suzanne H. Sale**, Revenue and Finance Committee; and
◆ **Jay L. Smith**, Tort Liability and Risk Management Committee.

Executive Committee Gains New Leaders

Sandra Rosenbloom, Professor of Planning, University of Arizona, is the 2012 Chair of the TRB Executive Committee. Deborah H. Butler, Executive Vice President, Planning, and Chief Information Officer, Norfolk Southern Corporation, is the 2012 Vice Chair.

An active participant in TRB committees, Rosenbloom currently is on leave from the University of Arizona to direct an infrastructure initiative at the Urban Institute in Washington, D.C. Before becoming Professor of Planning, she was Director of the University's Roy P. Drachman Institute for Land and Regional Development Studies. She is an internationally recognized expert in transportation planning and societal trends in transportation and community development. Rosenbloom is the 2004 recipient of TRB's Roy W. Crum Award and the TRB International Secretary. From 1998 to 2000, she was a member of the Leadership Council of the Urban Land Institute. Rosenbloom received a master's degree in public administration and a Ph.D. in political science from the University of California, Los Angeles (UCLA).

Butler joined Norfolk Southern in 1978; most recently, she was Vice President of Customer Service. She received a bachelor's degree from Agnes Scott College and completed executive education programs at Northwestern University's Transportation Center, the Fuqua School of Business at Duke University, and the Harvard Business School. A trustee of Virginia Wesleyan College, Butler also serves on the Board of Directors of TTX Company, as a Commissioner on the Norfolk Airport Authority, and as past Chair of the National Grain Car Council.

Sandra Rosenbloom (*left*) presents a plaque to Neil Pedersen in recognition of his service as 2011 TRB Executive Committee Chair.

Newly appointed to the Executive Committee are Chris T. Hendrickson, Duquesne Light Company Professor of Engineering and Codirector of the Green Design Institute, Carnegie Mellon University; and Gary P. LaGrange, President and Chief Executive Officer, Port of New Orleans. Reappointed members of the Executive Committee are Adib K. Kanafani, Professor, Graduate School, University of California, Berkeley; and Henry G. Schwartz, Jr., retired Chairman, Jacobs/Sverdrup Civil, Inc.

LAUNCHING RESEARCH CAREERS—Recipients of TRB Minority Student Fellowships (*left to right*): Monica Redhouse, New Mexico State University; Genell Bond, North Carolina A&T State University; Deji Agbale, Florida A&M University; Curtis Bradley, South Carolina State University; Celine Kalembo, Morgan State University; and Edna Cruz, California State Polytechnic University–Pomona. Not pictured are Samrakshak Lamichhane, Howard University; Genna M. Slape, University of New Mexico; and Sascha Sabaroche, Texas Southern University. Now in its third year, this pilot program provides financial assistance for students from historically black colleges and universities and other minority-serving institutions to attend the TRB Annual Meeting and present research. The 2011–2012 fellowships were funded by TRB, the North Central Texas Council of Governments, Parsons Brinckerhoff, the South Coast Air Quality Management District of California, and Stantec, Inc.

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EXECUTIVE COMMITTEE

1 Executive Director Robert E. Skinner, Jr., reports on current TRB initiatives and future endeavors.

2 2011 Executive Committee Chair Neil Pedersen (*right*) guides the Executive Committee through its business agenda. Sandra Rosenbloom (*left*) is 2012 Chair.

3 Deborah Butler, appointed 2012 Vice Chair, addresses the committee.

4 Gary LaGrange, Port of New Orleans, Louisiana, was newly appointed to the Executive Committee in 2012.

5 Also appointed in 2012 was Chris Hendrickson, Carnegie Mellon University.

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The Executive Committee heard presentations on the "silent transporter"—the inland waterway system—that surveyed its economics and infrastructure needs. Delivering policy presentations were

9–12 *(left to right:)* Gerald Galloway, Jr., University of Maryland; James McCarville, Port of Pittsburgh Commission; Richard Calhoun, Cargo Carriers, Grain and Oilseed Supply Chain; and Wesley Wilson, University of Oregon.

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Attending their first meetings since being appointed during 2011 were

6 Joan McDonald, New York State DOT, and

7 Michael Lewis, Rhode Island DOT.

8 Michael Hancock, Kentucky Transportation Cabinet, delivers the rapporteur's summary of Executive Committee policy discussions.

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EXECUTIVE COMMITTEE

(continued)

Executive Committee members reviewed the state of current and future transportation research. Participating in Executive Committee discussions were

1 Barry Wallerstein, South Coast Air Quality Management District;

2 Beverly Scott, Metropolitan Atlanta Rapid Transit Authority;

3 Past Chair Michael Morris, North Central Texas Council of Governments;

4 John C. Horsley, American Association of State Highway and Transportation Officials;

5 Susan Martinovich, Nevada DOT;

6 Paula Hammond, Washington State DOT; and

7 Jim Walker, U.S. Army Corps of Engineers.

8 Stacy Cummings, Federal Railroad Administration, shares the rail perspective.

9 Gregory Nadeau (*left*) and Jeffrey Paniati, FHWA, update Executive Committee members on administration programs.

10 Tim Klein, RITA, discusses progress in transportation technology research.

Also participating in meeting deliberations were

11 David Seltzer, Mercator Advisors LLC;

12 Kelly Leone, FMCSA;

13 Chair of TRB Technical Activities Council Katherine Turnbull; and

14 Marine Board Chair Michael Bruno, Stevens Institute of Technology.


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CALENDAR

TRB Meetings 2012

May

7 Relationship Between the Design and Construction of Rockfall Mitigation Techniques
Redding, California

20–23 8th National Aviation System Planning Symposium
Galveston, Texas

20–25 14th International Conference on Alkali–Aggregate Reactions
Austin, Texas

22–24 14th International Managed Lanes Conference
Oakland, California

23–25 International Society for Asphalt Pavements Symposium on Heavy Duty Pavements and Bridge Deck Pavements*
Nanjing, China

23–25 Making Progress: Transportation Planners and Programmers Turn Ideas into Reality
Denver, Colorado

June

2–8 11th International and 2nd North American Symposium on Landslides*
Banff, Alberta, Canada

4–7 North American Travel Monitoring Exposition and Conference (NATMEC): Improving Traffic Data Collection, Analysis, and Use
Dallas, Texas

12–13 29th International Bridge Conference*
Pittsburgh, Pennsylvania

18–20 North American Transportation Statistics Interchange 2012 (*invitation only*)
Washington, D.C.

19–22 Innovations in Traffic Flow Theory, Highway Capacity, and Quality of Service Symposium
Fort Lauderdale, Florida

20–22 7th RILEM International Conference on Cracking in Pavements
Delft, Netherlands

24–27 4th Urban Street Symposium*
Chicago, Illinois

24–27 Transportation-Related Environmental Analysis, Ecology, and Air Quality Summer Conference
Little Rock, Arkansas

24–28 Equipment Management Workshop*
Mobile, Alabama

26–28 Diagnosing the Marine Transportation System: Measuring Performance and Targeting Improvement*
Washington, D.C.

TBD Future of Road Vehicle Automation Workshop
Irvine, California

July

8–11 TRB Joint Summer Meeting
Irvine, California

8–11 Waste Management and Resource Efficiency in Transportation Summer Workshop
Madison, Wisconsin

8–12 6th International Conference on Bridge Maintenance, Safety, and Management*
Lake Como, Italy

8–12 10th International Conference on Concrete Pavements*
Quebec City, Quebec, Canada

11 Measuring the Transportation System from a Supply Chain Perspective
Irvine, California

11 7th SHRP 2 Safety Research Symposium
Washington, D.C.

12–13 Transportation Knowledge Networks: Broadening the Base Workshop
Irvine, California

14–19 13th AASHTO–TRB Maintenance Management Conference*
Seattle, Washington

15–18 51st Annual Workshop on Transportation Law
New Orleans, Louisiana

17–19 10th National Conference on Asset Management*
Dallas, Texas

17 Economic Census: Uses for the Transportation Community Workshop
Washington, D.C.

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 TRBMeetings@nas.edu. Meetings listed without a TRB staff contact have direct links from the TRB calendar web page.

*TRB is cosponsor of the meeting.

PHOTO: TENNESSEE DOT

Interstate's Path Meets a Surprise Landfill

Innovative Technology and Interagency Cooperation Solve Dilemma in Tennessee

LARRY J. HUGHES, ANN EPPERSON, AND TAMMY KEIM WILLIAMS

Hughes is Senior Geophysicist, EnSafe Inc., Memphis, Tennessee. Epperson is Hazardous Materials Manager, Tennessee Department of Transportation, Nashville. Williams is Project Manager, EnSafe Inc., Nashville.

(*Above:*) I-69 in western Tennessee in the early stages of construction.

According to an often-shared saying, if you want to find all the undiscovered environmental problems in a state, randomly pick a future roadway route—it will run directly through all of them. This was the experience when the Tennessee Department of Transportation (DOT) selected a preliminary route through west Tennessee for Interstate 69—also known as the North American Free Trade Agreement (NAFTA) Superhighway—which runs for 3,150 km (1,960 mi) between Mexico and Canada.

An environmental impact statement (EIS) for the west Tennessee portion indicated the possibility of several landfills on or near the route. Follow-up investigations showed that six landfills lay directly in the path of the projected highway—and for extra measure, the path included a largely unknown World War II–era explosives complex.

These discoveries raised an industry conundrum: in the middle stages of roadway design, when logistical and political constraints make it increasingly difficult to alter a preliminary route, how can transportation professionals deal with environmental surprises and keep a project on schedule and on budget? Are technologies available to fast-track a project past environmental roadblocks? The following account of the approaches taken at one of the problem landfills illustrates some practical answers to these questions.

Teaming Up

I-69 enters southwest Tennessee near Memphis and moves north to Dyersburg, connecting to a segment of I-155, which joins Arkansas and Kentucky. Following standard protocol, Tennessee DOT selected a preliminary route, commissioned an EIS, refined the route, and held public hearings. This process identified no significant environmental issues for the Dyersburg section—also known as Segment of Independent Utility 8—so that Tennessee DOT was able to establish a preliminary right-of-way with minimal impact on neighborhoods and the ecology.

Late in the process, a local citizen voiced concern to the U.S. Environmental Protection Agency (EPA) that the Interstate would cross a toxic landfill near the Dyersburg connection (see Figure 1). The site—subsequently named the JK1 Landfill—had operated in the 1970s, before reporting and regulation, and therefore did not appear in environmental databases. The revelation therefore came as a surprise to Tennessee DOT. With allegations of toxic disposals,

trenching, late-night burials, and spontaneous surface fires, investigation of the landfill was clearly a necessity.

The Tennessee Department of Environment and Conservation (DEC), which had passed along the citizen complaint to Tennessee DOT, shared many of the same data needs at the JK1 Landfill, suggesting a shared approach to the investigation (see Figure 2). The two agencies teamed up to define the landfill geometry, characterize its environmental hazards to site workers, and assess the environmental impacts to nearby residents. Because the route design depended on the findings, a rapid-response investigation was imperative.

Investigative Strategy

The approach first was to learn as much as possible about the site through searches of records and other ready data and then progress to increasingly complex, invasive, and expensive investigations—at each step fine-tuning the next to minimize the time and effort (see Figure 3).

The initial records search assembled a site history from county and state files, historical aerial photos, interviews, and a survey of well-water use in the general area. A site walkover documented evidence of a landfill—for example, stressed vegetation, burned areas, and surface drums.

The initial investigations showed that from 1970 to 1979, the privately operated landfill accepted household waste—such as plastics, glass, garbage, and fabric—as well as a variety of light industrial waste—including molded rubber, demolition debris, scrap metal, soil, flash cubes, and fabric. The material was deposited on top of an undulating terrain and was periodically covered with a thin layer of soil from an adjacent part of the site.

The aerial photos showed shifting patterns of disturbances, either from borrow soil or from fill, but an explanation of the patterns was not evident. Surficial field sweeps indicated at least 138 discarded surface drums, ranging in condition from crushed and empty to intact with contents. Burned material and stressed vegetation were visible in several areas. On-site surface water and off-site springs, ponds, and domestic water wells were potential receptors of contaminants.

According to the site history, the landfill occupied an 18.6-hectare (46-acre) parcel, but several interviewees thought that the fill extended into a larger area north of the parcel. Delineating the edges of fill became a priority.

Noninvasive Technologies

Although drilling can define the extent of a landfill, the procedure can be expensive and sometimes can

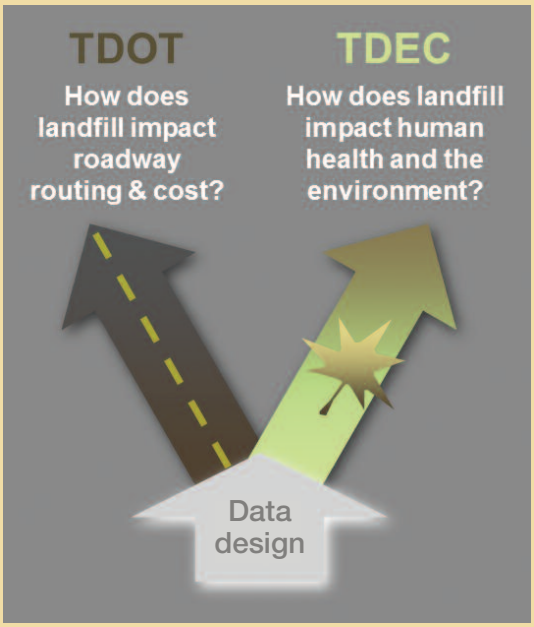
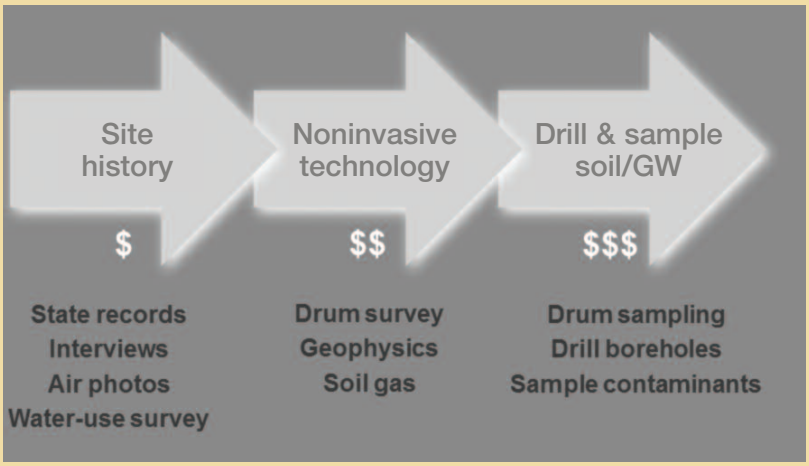


FIGURE 1 (*above*) Project location in northwest Tennessee.

FIGURE 2 (*left*) Two state agencies were able to pursue different objectives through a mutually beneficial investigation design.

FIGURE 3 (*below*) The investigative strategy progressed from simple-and-cheap to complex-and-expensive phases (GW = groundwater).



FDEM data collection at the JK1 Landfill. Geographic Positioning System and FDEM data are collected simultaneously.

risk penetrating into hot spots or into a protective basal confining layer. Starting with noninvasive investigations, such as geophysics and soil-gas sampling, can help focus any follow-up drilling.

Geophysics uses electrical, seismic, or other properties to produce an image of subsurface materials. Geophysics provides high spatial resolution, requires no invasive activities, can provide quick results—sometimes in the field—and is cost-effective. Several dozen geophysical methods are useful in landfill work (see sidebar, below).

With one method, frequency domain electromagnetics (FDEM), a kilohertz-range electrical current is pulsed through an antenna, and the induced electromagnetic field radiates into the ground. As the field interacts with an electrically responsive, buried object, the object emits its own secondary

Geophysics: Looking Beneath the Surface

LARRY J. HUGHES

The ability to peer beneath the skin of the earth—or into engineered structures—offers advantages on transportation projects. Geophysics provides that kind of imaging ability by effectively lighting up the subsurface with seismic or electrical energy or by passively sensing changes in subsurface physical properties. The resulting two-dimensional (2-D), 3-D, and 4-D or time-lapse pictures of subsurface conditions can improve project decisions.

Some of the geophysical methods most useful in transportation include the following:

◆ **Reflection seismic**, which uses an impact source such as a hammer or a dropped weight, produces high-resolution images at a depth range of 3 to 1,000 meters (m) and is most useful for geologic mapping.

◆ **Surface-wave seismic**, which uses a hammer as a simple impact source, maps density contrasts and soil stiffness.

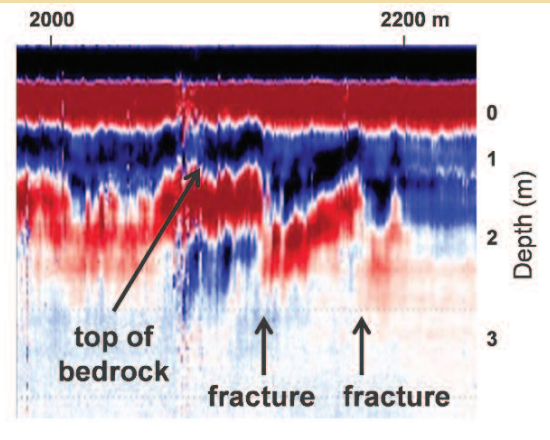
◆ **Refraction seismic**, which also uses a hammer as an impact source, is best suited for mapping the top of bedrock in the upper 20 m.

◆ **Ground-penetrating radar** (GPR) uses high-frequency surface antennas for high-resolution scans of the top 2 m—deeper for sandy or frozen areas—and is useful in investigating pavement and subpavement problems, checking the integrity of concrete surfaces, and mapping shallow bedrock or other geologic features (see Figure A, below).

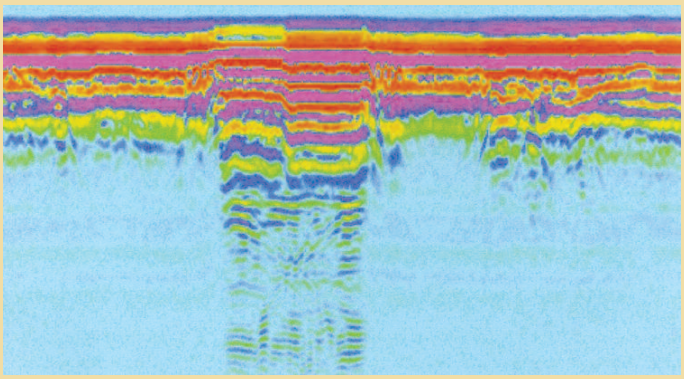
◆ **Resistivity**, which injects current into electrode pairs and measures the voltage responses, is useful in many geologic applications.

◆ **Induced polarization** injects current into electrode pairs and measures the responses at multiple times; it can yield results superior to those from the resistivity method, especially in mapping landfill or clay (see Figure B, next page).

◆ **Frequency domain electromagnetics** uses portable trans-



(a)



(b)

FIGURE A Ground-penetrating radar images of (*a*) two fractures in a shallow karst bedrock and (*b*) a large void beneath a paved surface.

electromagnetic field, which transmits to the surface to be measured as a voltage in a second antenna (see photo, page 28).

The voltages carry two types of information: *conductivity*, a measure of both the soil moisture and the metal content; and *in phase*, a measure of the metal content only. With these parameters, FDEM can identify landfill edges, can map waste segregation, and can pinpoint individual targets such as drums.

The JK1 Landfill work involved 150,000 FDEM data points across 23 line-kilometers (14 line-miles) of precut access trails and required four days of field work. The data showed distinct responses of high and low in phase and high conductivity over known parts of the landfill, with elevated in phase in an irregular pattern generally confined to the property boundary.

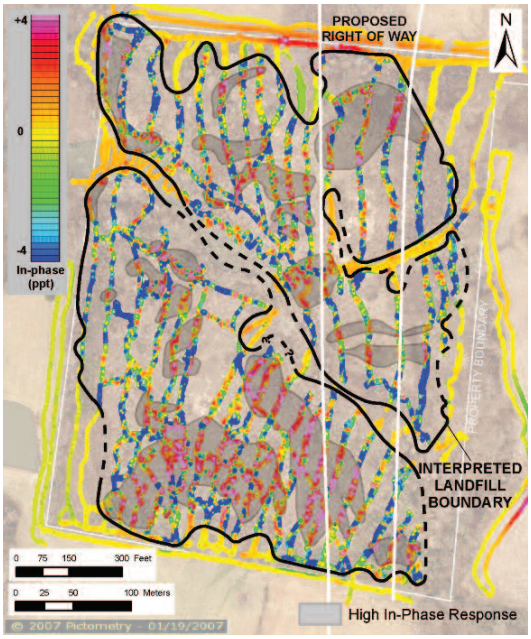


FIGURE 4 FDEM in-phase data, showing areas of anomalous metal response (values deviating from zero) and interpreted edge of the landfill. The white lines enclose the proposed right-of-way.

mitting and receiving antennas and is a quick, simple reconnaissance tool for the top 6 m in large-area scans of changes in soil moisture or metal content.

◆ **Time domain electromagnetics** uses current-pulsed antennas to detect buried metal to depths of approximately 3 m.

◆ **Microgravity**, which senses changes in subsurface density, is especially useful in karst investigations.

◆ **Magnetics** can sense changes in ferrous metal content and is most useful in landfills.

◆ **Spontaneous potential** identifies fluid movement through pore spaces and membranes.

Some classic transportation solutions include the following:

◆ **Subsurface stability**—mapping the top of bedrock, karst features such as voids and sinkholes, bedrock faults, poorly consolidated soil, and perched water.

◆ **Geotechnical**—mapping soil and landfill porosity and stiffness; geophysics does not replace traditional geotechnical methods but helps target drilling locations and fills data gaps between boreholes.

◆ **Environmental hazards**—mapping buried metal and nonmetal objects, including drums and tanks.

◆ **Landfill**—identifying fill material and mapping hot spots and the extent and estimated volume of waste in 2-D or 3-D.

◆ **Buried structures**—mapping old foundations, graves, archaeological sites, and artifacts.

◆ **Road integrity**—mapping voids beneath the roadway, pavement voids and cracks, the condition of rebar, the deterioration of concrete, and bridge scour.

The advantages of geophysics are that it is conducted noninvasively, produces high-resolution data to fill gaps between control points or guide future work, and delivers results within one hour to a few weeks. The work can preview subsurface problems during the early stages of a project, or it can be used at later stages after a problem has been discovered.

Geophysics, however, like any imaging technique, is subject to the laws of physics, and responds to subsurface physical properties that may or may not differ from the properties of interest to an engineer. Bridging this difference requires interpretation, which benefits from ground-truth calibration and requires follow-up confirmation. But as part of a total-solution package, geophysics can save time and money by helping the transportation professional see far more than meets the eye—in places the eye cannot go.

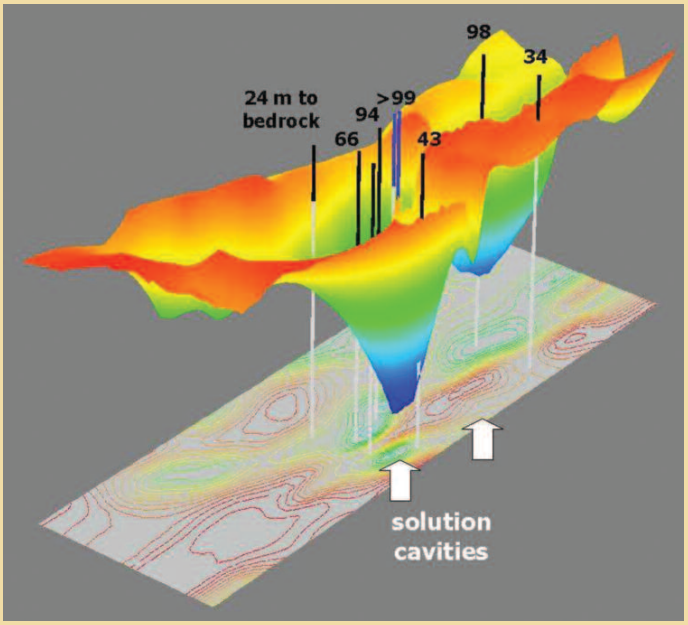


FIGURE B Induced polarization image of two large solution cavities in a karst area. *(Numbers show depth to rock in feet, confirmed by drilling.)*

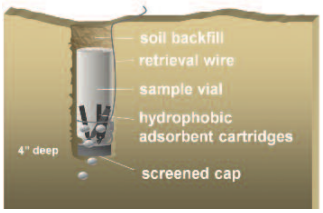


FIGURE 5 Soil-gas collection system.

The in-phase anomalies, generated from the ubiquitous metals in the waste, served as a tracer to map the landfill edges (see Figure 4, page 29). The in-phase data also identified areas of selectively higher metal content, probably the artifacts of changing waste-stream sources. FDEM showed that the landfilled waste did not extend past the property; therefore the scale of the investigation was reduced.

FDEM, however, does not provide three-dimensional (3-D) indications, such as target depth or vertical dimensions. Alternative geophysical methods—such as induced polarization and shallow seismic—are well suited to 3-D landfill mapping and to evaluating such factors as fill stiffness, soil porosity, and karst features, such as sinkholes, caused by subterranean caverns. These capabilities often make additional geophysics a good investment. At this site, however, a high-density drilling program already had been scheduled to evaluate environmental impacts and to map the vertical extent of landfill; additional geophysics, therefore, was not required.

Soil-Gas Sampling

The FDEM results helped in targeting soil-gas sampling, an additional noninvasive test that evaluates soil-entrained volatile gases that rise up through soil or landfill material. Small glass vials containing gas-absorbent cartridges and capped by gas-admitting screens are inserted into shallow holes in the ground to trap rising volatiles (see Figure 5). The containers are retrieved after one to two weeks and are submitted to a laboratory for standard chemical analysis.

Volatile organic compounds (VOCs) or semi-volatile organic compounds (SVOCs) were present in 45 of the 176 soil-gas samples. Predominant were the carcinogen trichloroethene (TCE), various chlorinated solvents, and freon. With a few exceptions, the detections did not correlate with the locations of geophysics anomalies or surface drums; the patterns were isolated and incoherent when plotted on a map. The patterns suggested localized—not widespread—organic contaminants, which could be targeted for follow-up sampling.

Rotosonic Drilling

The information about landfill boundaries, waste segregation patterns, and shallow VOC gases enabled deployment of the drill rig. In landfills, the rotosonic technique has advantages over auger drilling—it does not entangle debris, generates less waste that requires disposal, and provides good sample recovery (see photo, above right).

Rotosonic works by vibrating a toothed casing into the ground, driving down a core barrel within the casing to collect a continuous core sample, then extracting and extruding the sample into a plastic sleeve for analysis. The geologist then can describe the complete stratigraphic column and select an optimal interval to sample for laboratory analysis.

Track-mounted rotosonic drill rig operating south of the landfill. The crew is extruding a sample from a 95-ft geotechnical boring into a flexible plastic sleeve.

Most of the 57 boreholes that were drilled penetrated the waste, terminating in natural soil at the base. The landfill boundaries that were inferred from the drilling agreed substantially with the geophysical interpretation, confirming the geophysically

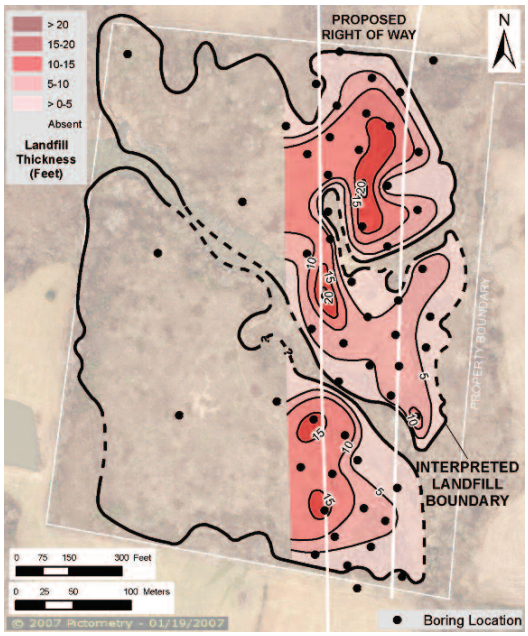


FIGURE 6 Landfill-thickness map (in feet) based on drilling. Irregular thicknesses reflect prefill excavation, varying topography, and juxtaposed depositions of waste and soil.

determined landfill area of 12 hectares (29 acres). Vertical information from the drilling led to construction of a waste-thickness map (see Figure 6, page 30). Combining the geophysics and drilling information, the calculated waste volume within the right-of-way corridor was approximately 65,000 m^3 (85,000 yd^3); this expanded to 110,000 m^3 (144,000 yd^3) if a 100-foot buffer was added to each side of the right-of-way for construction and undercutting. The figures provided upper and lower bounds for waste-excavation options.

Testing for Contaminants

The next task was to determine if the waste was hazardous. The landfill waste at this site, however, was not suitable for representative sampling, because most of the contents were still primary—for example, undegraded plastic, rubber, and glass—and were heterogeneous (see photo, above, right). Laboratory analytical methods are designed for granular soil and water media. Therefore the thin soil layer overlying the waste and the native soil directly beneath were sampled as indirect indicators of hazardous content.

The laboratory tested for a standard suite of contaminants, including metals, VOCs, SVOCs, pesticides, and polychlorinated biphenyls (PCBs), formerly used in transformers. The laboratory-reported concentrations were compared with established regulatory standards; for this project, the benchmark standards included EPA-promulgated or risk-based thresholds for industrial sites.

Samples were taken manually from the surface soil at 15 locations, 10 near surface drums. Five samples had at least one compound that exceeded its benchmark: arsenic, hexavalent chromium, lead, PCBs, and benzo(a)pyrene. The exceedances, however, were generally modest. The absence of VOC exceedances, including TCE, even near the strongest soil-gas TCE anomaly, was noteworthy. This did not negate the isolated soil-gas TCE hits, which could have reflected subsurface contaminant sources that would not necessarily affect the exact spot of a surface sample.

Drum contents, some indistinguishable from soil because of degraded drum conditions, were sampled at 10 locations; three had exceedances for lead and one for cadmium (see photo, right). Although the sampling program was limited, the results did not suggest a severe or widespread problem with surface soil and drums.

Deeper samples, obtained with the rotosonic rig, tested the native, silty-clay soil directly beneath the waste. Only one of the 56 samples had a slight exceedance—for arsenic—but it was within the realm of normal background concentrations; the SVOCs and VOCs were below the benchmarks. The impact of landfill waste on underlying soil appeared to be limited.

Typical rotosonic core of undegraded landfill waste and soil.

Water Testing

Surface water is uncommon at the site, and the groundwater is approximately 90 ft deep. Water contamination therefore was not relevant to the Tennessee DOT road construction. Nevertheless, Tennessee DOT undertook limited sampling to help the state DEC assess the environmental impacts of the landfill. No surface water samples exceeded the EPA benchmarks. Vanadium exceeded EPA benchmarks in a spring sample and in three of four well samples, but the benchmark for the naturally occurring metal is low. None of the water samples showed TCE, although the spring showed a very low level of cyanide.

The limited water testing did not address all of Tennessee DEC's questions about the landfill's impact on groundwater. Additional tests were not in the budget, but the data that were obtained will help Tennessee DEC consider future regulatory and remedial options for the site.

Testing air quality before sampling the contents of a drum.

TABLE 1 Estimated Costs of Construction* (in millions of dollars)

	Option 1 Excavate Right-of-Way	Option 2 Bridge Right-of-Way	Option 3 Move Right-of-Way East
Environmental	5.4	2.1	0
Right-of-Way Purchase	3.6	3.6	5.0
Construction	24.5	32.8	24.5
TOTAL	**33.5**	**38.5**	**29.5**

** Costs are for right-of-way only; a 100-ft buffer would increase costs significantly.*

Where Goes the Roadway?

The roadway construction options were the following:

1. Excavate the landfill and fill to grade along the right-of-way;
2. Bridge the landfill, excavating at supports; and
3. Avoid the landfill by rerouting to the east.

Landfill compaction for the roadway subgrade was not viable because of the unconsolidated nature and type of waste.

Analysis of the data suggested that excavated material could be handled as a special waste for disposal in a Class I nontoxic landfill, with perhaps 1 percent disposed in a hazardous waste landfill. Excavation and disposal are the main drivers of cost in an environmental cleanup.

Table 1 summarizes the estimated environmental, right-of-way, and construction costs associated with each option. Since Options 1 and 2 involved higher costs and perhaps slightly greater risks of schedule delays from unanticipated environmental issues during excavation, Tennessee DOT selected Option 3, moving the right-of-way east of the landfill to avoid it entirely.

Avoiding landfills—although the obvious solution—may not always be feasible. Shifting a roadway to an off-landfill position can be more expensive if the adjacent properties include ecologically sensitive areas or have an impact on neighborhoods and businesses. For example, in the Dyersburg case, the costs of Options 1 and 3 differed by less than 14 percent. A few extra expenses under Option 3—such as additional right-of-way acquisitions or realignment of a stream—could have tilted the choice back to landfill excavation.

Conversely, higher toxic content in a landfill could drive costs the other way. For example, an I-69 crossing of another landfill near Memphis would have cost an estimated $350 million.

Time also can be a factor. For example, if avoiding a landfill takes a route outside an established EIS corridor, having to file a new EIS may cause a significant project delay. State-of-the-art environmental investigation methods can clarify the risks and costs.

PHOTO: TENNESSEE DOT

Construction on I-69 in Union City, Tennessee.

Objectives and Cooperation

Technology applications are not always the key—sometimes a shovel is more effective than an excavator. Yet high technology, when focused on clearly defined objectives and properly sequenced with other tasks, can identify unknown or emerging roadway problems before they become roadblocks.

In addressing road-focused issues, a broader view through interagency cooperation can assess public policy goals more holistically. This provides information valuable to road builders and to environmental stewards, with a net saving of taxpayer dollars. The result is a roadway everyone can share.

Acknowledgment

The authors thank Betty Maness of Tennessee DEC for her review and helpful suggestions.

POINT OF VIEW

Dedicated Truck Lanes

An Innovative Way Forward

KEITH J. BUCKLEW

The author is Director of Multimodal Planning and Programs, Indiana Department of Transportation (DOT), Indianapolis, and Project Manager for the I-70 Dedicated Truck Lanes project. The views expressed in this article are the author's and do not necessarily represent the views of Indiana DOT or of TRB.

The network of state and national roadways reflects a legacy of the 20th century. The Interstate Highway System was designed for a low level of vehicle miles traveled (VMT) per day with a traffic mix of up to 10 percent trucks and was built to last 20 to 30 years.

Today, more than 50 years later, the Interstate system's VMT has more than doubled, and trucks weighing 80,000 lb account for 30 to 40 percent of the daily VMT. Pushed by population growth, demographic shifts, and robust consumer demand, this trend is expected to continue and almost double in the next 25 years (*1, 2*), with truck traffic leading the way (*3, 4*).

The increase in truck and automobile volumes has produced congestion and safety problems on many roadway corridors. The efficiency, reliability, and safety of the roadway system are at risk (*5*).

Corridors connecting major metropolitan areas are catalysts for high volumes of freight, are often multijurisdictional, and have national significance as routes for goods movement. The American Association of State Highway and Transportation Officials' (AASHTO's) recommendations for improving the freight system include establishing truck-only toll facilities (*6*). Expanding capacity by segregating trucks from cars offers a solution to the problems of safety and congestion—in short, a better system design will yield better results.

Studying the Concept

In 2007 the U.S. Department of Transportation (DOT) and the Federal Highway Administration (FHWA) selected the I-70 Dedicated Truck Lanes project[1] for the Corridors of the Future Program. A coalition of four states—Missouri, Illinois, Indiana, and Ohio—completed a feasibility study across an 800-mile corridor of I-70. The results supported the operational and financial practicality of dedicated truck lanes (*7*).

[1] www.i70DTL.org.

PHOTO: ADAM FAGEN

Merging traffic on the Brooklyn–Queens Expressway in Brooklyn, New York. Adding lanes to alleviate heavy traffic volumes does not address the safety and congestion problems that occur with increasing numbers of mixed vehicles.

PHOTO: LIBRARY OF CONGRESS PRINTS AND PHOTOGRAPHS DIVISION

PHOTO: WIKIMEDIA COMMONS

The Pennsylvania Turnpike in 1942 (*at left*), not long after its first section was opened, and in 2008 (*at right*). The percentage of trucks traveling the Interstate Highway System has more than tripled from what the highways originally were built to handle.

The concept of dedicated truck lanes emerged from the search for a new roadway design and operating model to reduce congestion, enhance safety, and align transportation networks with the needs of supply chains. In a comprehensive review of the concept, Poole and Samuel analyzed recommended routes for toll truckways, focusing on ways to maximize toll revenue (*8*). Potential truck-only corridors were ranked according to gross truck volume, length of haul, congestion, and use of longer combination vehicles.

A Georgia DOT study recommended against truck-only lanes through metropolitan Atlanta, concluding that the benefits were inadequate in comparison with the costs (*9*). The study did not consider tolling, however, and truck use of the truck-only lanes was optional. Other attempts to develop truck lanes—such as on I-81 in Virginia, the Trans-Texas Corridor, and I-35 in Texas—have not moved past the proposal stage (*10*).

Safety and Congestion

Trucks vary in size and weight; they are designed to transport goods and commodities and to facilitate the performance of services; they behave differently from automobiles. A typical tractor-trailer unit is rated for 80,000 lb of gross vehicle weight (GVW); in comparison, an average automobile weighs less than 4,000 lb. With 20 times the mass, a truck accelerates and decelerates much more slowly than a car. The dissimilar operating characteristics of cars and trucks often contribute to delays, crashes, and other adverse situations in mixed traffic.

In addition, automobile and truck VMT alike have doubled in volume in the past 30 years. Transportation infrastructure investment, however, has not kept pace with the demands of modern supply chains linking regional, national, and global markets.

The conventional solution is to add lanes as traffic volumes increase and levels of service decrease, so that Interstate and other federal roadways expand from four-lane facilities to six and ultimately eight lanes. This approach increases capacity but may not solve the associated problems of safety and congestion that stem from mixing dissimilar vehicle types.

Different operating characteristics and conditions and the disparity in size and weight lead to roadway inefficiency and unsafe conditions. The acceleration and deceleration of trucks and buses, as well as significantly different braking characteristics, contribute to an irregular traffic flow. Larger vehicles occasionally must change lanes to move around slower vehicles or to permit ingress and egress at the facility.

Maintaining and expanding the Interstate highways in the next quarter of a century will prove costly. Although portions have been rebuilt, many have exhausted their original life expectancy and have deteriorated. States can rebuild the roads and can add capacity with new general-purpose lanes to meet demand. Expanding the Interstate legacy design, however, requires building all lanes to accommodate heavy trucks. Vehicle weight directly affects the life cycle of pavements and bridges. A new design that benefits all users with operational efficiency, safety, and economic and environmental advantages therefore should be the goal (*11*).

The conceptual design of dedicated truck lanes requires the involvement of carriers and shippers. Carriers understand the safety aspects, as well as the operational efficiencies to maintain profitability. Also key are engineering decisions about pavement depth and truck ramp design, to ensure that the truck lanes are sustainable, reliable, and safe.

Evaluating Costs

Crashes involving large trucks affect freeway congestion dramatically. Approximately 12 percent of all highway-related fatalities involve large trucks (*4*), and 25 percent of congestion has its source in traffic incidents—predominantly crashes (*3, 12*). Of the benefits that can be realized with dedicated truck lanes, safety is the most significant (*7, 13*).

Although funding appears to be the largest hurdle in moving dedicated truck lanes from concept to reality, a cost comparison against the status quo shows that dedicated truck lanes can be financially feasible. The analysis conducted under the I-70 Dedicated Truck Lanes Feasibility Study employed a business case approach. The study evaluated development of an 800-mile corridor of dedicated truck lanes between Kansas City, Missouri, and the eastern border of Ohio. The study defined the problems as congestion and safety and the solution as dedicated truck lanes; quantified the costs to design, build, operate, and maintain the corridor; estimated the benefits, the return on investment, and the cost avoidance; and assessed the financial feasibility.

The evaluation revealed that the combined costs to design, construct, maintain, and operate a dedicated truck lane facility would be less than or equal to the intangible benefits—public and private—plus the return on investment, including tangible public and business benefits, and the cost avoidance. Intangible benefits include safety and the reduction of delays; tangible benefits include job creation and economic development.

The initial costs to build dedicated truck lanes are higher than for building mixed-traffic facilities, but the benefits in terms of safety, efficiency, and reliability can offset or outweigh the tangible costs (Figure 1, below) (*11*).

Tolling is likely a necessity for funding dedicated truck lanes. For carriers, increased productivity would offset such costs as tolls, fees, and fuel taxes (*8*). The benefits of dedicated truck lanes to passenger vehicles—such as enhanced safety, congestion relief, and an improved traveling experience—suggest that tolls on facilities that feature dedicated truck lanes should extend to passenger vehicles (*14*).

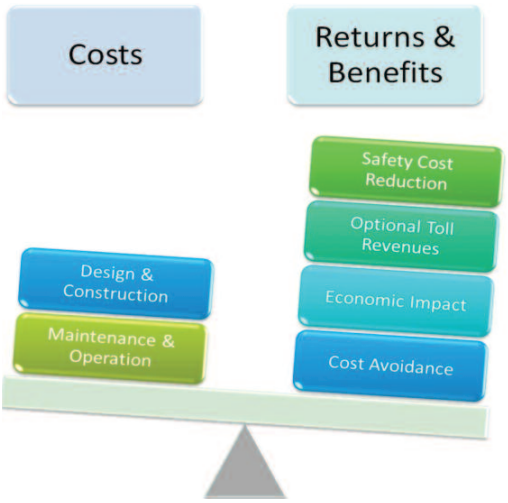


FIGURE 1 Business case methodology.

Evaluation Criteria

A feasibility study should thoroughly analyze several alternatives with various options. Dedicated truck lanes may not be feasible for every corridor. With its high truck volumes, the I-70 corridor could benefit from the reduced congestion and improved safety of dedicated truck lanes; routes with low truck volumes, however, may not gain comparable benefits. The study used the following evaluation criteria:

- Safety—a reduction in crashes and in fatalities, injuries, and damages;
- Congestion reduction—improvement in mobility or levels of service;
- Cost and financial feasibility;
- Economic benefits—business growth and job creation; and
- Environmental impact and carbon footprint—for example, increased fuel efficiency, enhanced air quality, and reduced noise.

Shippers and especially the trucking industry seek improved productivity. In the 30-plus years since the deregulation of the trucking and rail industries in 1980, intermodal rail has achieved 200 percent productivity. Containers have grown from 20 ft to 40 ft in length, and 53 ft is becoming the new standard, often with double stacking. In contrast, the trucking industry has moved from 45- and 48-ft to 53-ft trailers and has increased GVW from 73,000 lb to 80,000 lb—a productivity increase of only 14 percent (*7*). By separating trucks from general-purpose traffic, dedicated truck lanes can allow trucks to haul heavier weights and longer combinations of trailers, providing the private sector with productivity improvements to offset the costs of tolling.

Design and Construction Issues

The design, construction, and operation of dedicated truck lanes raise several issues and problems. The design calls for separate truck interchanges and slip ramps to facilitate efficient and safe ingress and egress. The design, construction, operation, and maintenance of the facility will require public and private investment and perhaps a new approach involving multiple jurisdictions and public–private partnerships, as well as long-term, complex financial arrangements. Crafting such agreements and partnerships is time-consuming and may require state legislation and political action, as well as complex risk-sharing arrangements.

Some right-of-way acquisition will be necessary. Most of the rural portions of the I-70 corridor, for example, have narrow medians and may require expansion into adjacent land. Most of the urban por-

PHOTO: WIKIMEDIA COMMONS

The New Jersey Turnpike features separate lanes for car-only traffic and for mixed traffic. The development of dedicated truck lanes raises issues of cost, design, operation, and maintenance.

tions of the corridor, however, are fully developed, making expansion cost-prohibitive and subject to environmental justice regulations.

The I-70 feasibility study also identified several points along the corridor that could pose environmental challenges. The history of roadway transportation development illustrates that some environmental issues can be readily identified, some are improperly evaluated, and others are discovered later.

Another concern is that roadway bridge design accommodates commercial motor vehicles operating at 80,000 lb GVW. The dedicated truck lanes concept advocates high-productivity vehicles, with a GVW of 97,000 lb, that may include two or three trailers per truck. Roadway pavement can be designed to accommodate heavier loads, but bridge designs and construction to support significant increases in vehicle weight and length will be costly. Heavier weights and longer combination vehicles, moreover, may prompt negative reactions from safety advocacy groups and environmental groups.

Dedicated truck lanes, however, can offer environmental enhancements. Some portions, particularly in rural areas, can be constructed within the right-of-way of an Interstate highway or with minimal adjacent land acquisition. Less congestion means less operating time for trucks and cars, improving air quality. High-productivity vehicles would consume less fuel but move freight farther. On dedicated lanes, trucks could double or even triple the volume of freight, reducing their carbon footprint by more than 50 percent.

Competing with Rail

Some have pointed to railroads as an alternative to dedicated truck lanes. Class 1 railroads have improved at transporting containers and trailers—intermodal freight is the fastest-growing and most profitable segment of the rail industry—and capacity is available for expansion. Shifting freight from truck to rail also has attracted political interest.

The cost structure of railroads differs from that of trucking. Rail has high fixed costs and low variable costs compared with trucking. The rail industry builds its own infrastructure and needs a consistently high density of freight to be profitable. Rail excels at carrying intermodal containers over long-haul routes of 700 miles or more. Most railroads cannot compete with trucks in price and total transit time on routes shorter than 600 miles.

Only on hauls of 600 to 750 miles do rail and trucks compete for transporting finished goods; otherwise, rail and trucks complement each other, and both are needed for goods movement. Trucks are likely to remain the exclusive mode for the short-haul, finished goods market. Data collected for the I-70 Dedicated Truck Lanes Feasibility Study indicated minimal shifts from rail to truck, even with high-productivity vehicles as an option.

Truck Freight Issues

Historically, trucking has been able to adjust capacity to meet demand. Since 2008, however, trucking capacity has shrunk by 14 percent in terms of the numbers of drivers and trucks (*15*). The numbers of those entering the commercial driving profession are not keeping pace with the demand. Moreover, implementation of the Federal Motor Carrier Safety Administration's (FMCSA's) 2010 Comprehensive Safety Analysis may limit the qualified driver base by enforcing medical and safety standards.

Carriers and shippers anticipate changes in FMCSA's hours-of-service regulations, affecting commercial driver productivity. To offset regulatory restrictions, carriers will need more drivers and trucks, adding costs to maintain the capability to move the same amount of freight.

Yet the motor carrier industry already faces shortages of qualified drivers and will need to invest in training commercial operators in high-productivity vehicles. To ensure safety, drivers will need specialized, hands-on training to operate longer and heavier equipment.

High-Tech Solutions

Managed lanes and the use of information technology (IT) and intelligent transportation systems (ITS) could offer efficient and cost-effective solutions to enhance traffic flow and improve safety. Systems could serve to restrict trucks to certain lanes, providing a soft separation between cars and trucks. An ITS network could include variable time options for flexibility in peak periods and during weekends and holidays to manage lanes, toll pricing, and speeds.

Wireless technology could assist ITS solutions by creating virtual dedicated truck lanes along any corridor with significant truck volumes. Managed via IT and ITS, the lanes would reduce the needs for right-of-way acquisition, environmental impacts, and separate truck ramps.

Creating a dedicated truck lane through ITS could reduce costs, especially within urban areas. The systems could incorporate real-time traveler information, electronic tolling, weigh-in-motion, commercial vehicle information systems and networks, truck platooning, and automatic vehicle and freight scanning for safety and security. In short, the systems would serve to multiply capacity within the physical infrastructure.

Funding Mechanisms

Federal funding for roadway projects flows from FHWA to the states, which then determine the project's scope and relative priority. A corridor that links several states would benefit from a single oversight authority, such as a corridor coalition. Users, shippers, and carriers transport goods and commodities across corridors with minimal attention to state boundaries. The integrity of a corridor is important for efficiency and reliability across critical infrastructure to support supply chains.

The dedicated truck lanes concept would lose much of its appeal and value if the project were restricted to a single state. State leadership changes often, and priorities change as a result. A multijurisdictional corridor authority may offer the best way to oversee the development and operation of multistate corridors. Funding for the corridor could flow directly to the corridor authority, separately from federal-to-state funding for highway infrastructure.

Traditional funding mechanisms, however, are inadequate for most new large projects and are inadequate for maintaining corridors. Bold and innovative projects, such as dedicated truck lanes, require bold and innovative financing. Public–private partnerships may be the best approach for large transportation infrastructure projects in today's economy. The optimal mixture of public–private involvement hinges on a project's goals, such as delivery speed, efficiency, innovation, handling varying degrees of uncertainty, capabilities, initial project financing, long-term funding sources, and risk management.

In certain situations, infrastructure investors, such as concessionaires or a consortium of equity funds, could design, build, finance, operate, and maintain a dedicated truck lanes facility for a multijurisdictional transportation corridor. The public sector would focus on mitigating the risks—environmental issues, user fees, political and public support, and other legislative and regulatory concerns. High-volume freight corridors, such as I-70, would provide the consistent revenue and return on investment necessary to attract private investors.

Nova Ordo: A New Way

Although a few studies have been conducted on truck-only or exclusive truck lanes, no operating facilities extend more than a few miles. The next dedicated truck lanes corridor project to be built will be the first and will attract attention and scrutiny (*11*). Studies of truck lanes should focus on specific corridors and on the solutions for congestion and safety problems.

Dedicated truck lanes along a corridor will be a large and significant endeavor. To realize the maximum benefits, all stakeholders must share the vision for the project. A project also can integrate IT and ITS in select sections that have a high density of truck traffic, to enhance system performance. Along with managed lanes, IT and ITS solutions could provide a virtual infrastructure when expansion is not feasible, to achieve the performance and effects of dedicated truck lanes.

The dedicated truck lanes concept should be evaluated with an objective, business case methodology, incorporating public- and private-sector investments and costs. This comprehensive and objective analysis will define the true costs and benefits, tangible and intangible. Dedicated truck lanes may constitute a *nova ordo*, or "new way forward," but with the corollary, *non nova sed nove*—"not new things, but in a new way."

Acknowledgment

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PHOTO: MISSOURI DOT

Truck on I-70 in Missouri. A feasibility study has determined that dedicated truck lanes could reduce congestion and improve highway safety on I-70.

POINT OF VIEW presents opinions of contributing authors on transportation issues. Readers are encouraged to comment in a letter to the editor on the issues and opinions presented.

Performance Management for Organizational Decision Making and Regional Partnerships

HUGH LOUCH

PHOTO: ANDREW BOSSI, FLICKR

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(*Above:*) Currently under construction, the Silver Spring Transit Center in the metropolitan Washington, D.C., area will be a hub for transit, commuter rail, commuter and local bus lines, and other shuttles and bus routes. Complex transportation systems can benefit from performance measurement and management.

Performance measurement and performance management recently have emerged as topics of interest in the transportation community. Performance measurement attempts to understand how a transportation system or an agency that manages a system is performing; performance management links the performance measurement to decision making. In the past decade or more, the Transportation Research Board has sponsored research to define performance measurement and management and to explore related topics.

Two recent research efforts have examined ways that agencies link performance measures to decision making. National Cooperative Highway Research Program (NCHRP) Report 660, *Transportation Performance Management Programs: Insight from Practitioners*, addresses transportation agencies' use of performance measurement and management to support strategic and day-to-day decisions. NCHRP Report 664, *Transportation Network Performance Measurement*, examines the challenges of using performance measures in decisions that cut across jurisdictional, modal, or other boundaries.

Application to Decision Making

Many agencies approach performance measurement by focusing on the measures. Measures developed outside of a strategic framework and disconnected from agency decisions, however, are not likely to provide value for an organization. Performance management moves beyond measuring to considering the relationship between agency goals, performance measures, and investments.

Performance management applies to large and small decisions, but much of the recent discussion has focused on strategic decisions—for example, executives using performance measures to make decisions about the allocation of resources. NCHRP Report 660 examines the strategic and the day-to-day decisions that can benefit from performance management.

Increasing Agency Focus

A review of agencies that have implemented performance management reveals that the practice has helped in focusing on what is most important. Many agencies move to performance management because of external pressures—such as funding or project delivery challenges or the threat of privatization; after this experience, they proceed to implement performance management throughout the organization.

Agencies often discover that performance measures also can help to diagnose emerging challenges. As agencies begin to measure what is most important, the question arises: what is causing the changes in a performance area? Agencies can delve more deeply into the data, examine the causal relationships that underlie performance changes, and gain understanding about how to improve performance. For example, several state departments of transportation (DOTs) have developed predictive models

for their maintenance programs to help demonstrate the relationship between investment levels and performance.

Performance management also provides an agency with material to improve the transparency of decision making. By highlighting challenges and understanding how the strategies and investment choices affect performance, transportation agencies can develop or improve their platform for communicating with employees, with legislatures or commissions, and with the general public.

Engaging with Employees

Although CEOs and other executives have initiated many of the successful performance management programs in transportation agencies, practitioners uniformly note the importance of engaging and motivating employees throughout the organization. Performance management practitioners agree with contributors to the literature in emphasizing the importance of corporate culture. When performance management becomes a tool to punish or challenge employees, the agency's long-term success is not well served. Successful performance management programs find a way to balance staff accountability with the empowerment of staff for critical decision making.

Performance management typically represents new or changing practice for transportation agencies. Keeping staff informed and involved in performance management can provide buy-in and increase the program's effectiveness. Staff who understand how the goals of an organization relate to their day-to-day work are better able to support the goals. As employees understand the purpose of performance management, they can use the tools and techniques for creative problem solving.

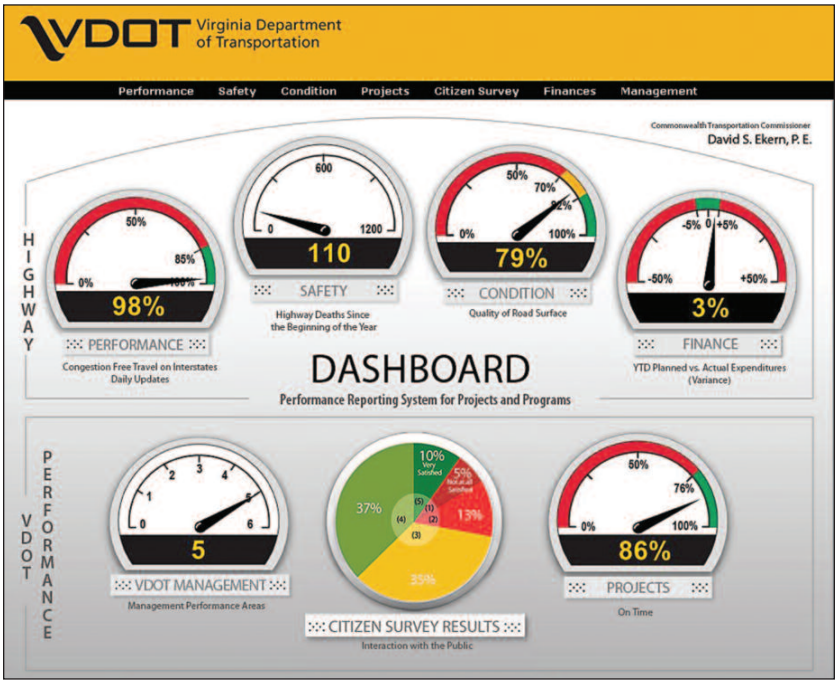
At its core, performance management focuses on the data and information about the relationship between transportation investments and performance. When employees know that performance matters, they have an incentive to search for the solutions that will improve performance.

To engage in creative problem solving, staff need to have the right set of skills. Because performance management relies on data and information, staff need to understand how to collect, review, and manipulate data to understand the performance of the system. Additional analysis tools, such as travel demand models, sketch planning tools, and others, need to be available to staff to sort through the data and understand the implications of investment for performance.

Responding to Customers

Transportation agencies have to make decisions about investments and policies that involve complex technical issues that are not always easy to explain to the general public or others. Successful performance management programs work to balance the technical engineering considerations with customer needs and interests.

Agencies increasingly are linking technical performance measures to customer expectations. For example, engineers' measurements of the ride quality of a road may not relate to the public's perception of what



Transportation agencies such as Virginia DOT and Minnesota DOT have implemented performance measurement reporting methods—Virginia DOT's dashboard *(above)* and Minnesota DOT's scorecard *(left)*. These reports allow stakeholders and users to access and understand current performance.

Performance measures can assist transportation agencies in coming together to work across jurisdictional and state borders.

PHOTO: DANIEL ONES

is acceptable. Through road rallies and similar techniques, some agencies are trying to capture what the public finds acceptable and relate that to technical measures.

Transportation agencies also are focusing on making performance measures understandable to the public—for example, with maps and charts and with clear and intuitive definitions of the measures. Describing performance measures in plain language can ensure public understanding.

Making a Program Last

In the past decade, many transportation agencies have developed performance measurement or performance management programs but have not sustained them. Efforts can bog down under an overly large number of measures, or from a lack of resources to assemble the necessary information, or because the organizational structure removes the effort from the attention of leadership, or for many other reasons.

Agencies that have sustained a program for many years indicate that careful design and subsequent evolution are important. This involves starting with a reasonable number of measures that address the agency's goals at the strategic level and then engaging employees to build the supporting infrastructure.

At the same time, consideration should be given to the consumers of performance management information—the groups and individuals representing constituencies that can support a program. State DOT programs that have lasted have gained support from the state executive branch, as well as interest from legislators.

If the agency's executive leadership changes, employees still can maintain a program or its constituent elements by continuing to apply the measures and to track and report the results. Finally, the public presentation of performance measures creates and engages an audience within the general public.

Improving Network Performance

Many agencies have turned to performance measures to help with decisions that cut across jurisdictions or involve several infrastructure owners or different types of investments. For example, many transportation agencies want to know if investments should favor transit or highway projects, how the state highway system interrelates with local arterials and collectors, how to apportion funds between system operations and expansion, and how to address other challenging issues.

As agencies move from constructing to managing systems, as congestion increases, and as the cost of delivering transportation solutions mounts, agencies need to work together across local, regional, and state jurisdictions; across transit, highway, and nonmotorized modes; and across investment types—such as capital or operations programs. Users of the transportation system do not distinguish who owns what part of the transportation system—they want to move as conveniently as possible between homes, work, recreation, shopping, services, and other locations.

NCHRP Report 664 examines these issues and provides guidance to help transportation agencies work together to address the performance of a multijurisdictional network. The report proposes a framework for considering network performance and a set of scenarios to help transportation agencies incorporate network considerations into the planning process.

Network Partnerships

The framework centers on partnerships among the agencies that collectively make decisions for a transportation network. The partnerships can take many forms, depending on the agencies involved and the relationships already established. The research identified three general methods for establishing partnerships:

◆ **Metropolitan area coordination**. Metropolitan planning organizations (MPOs) and similar regional planning entities play a critical role in organizing priorities and investments that involve several system owners and modes. Although funding limitations and other barriers can make addressing the full range of transportation modes or system owners a challenge, MPOs can consider the entire transportation network and the trade-offs among modes and strategies.

◆ **Peer-to-peer coordination**. With many metropolitan areas growing into one another to create megaregions, MPOs are working together in transportation planning. Similarly, states are working together through corridor coalitions and other

arrangements to address multistate transportation issues—especially freight movements, which often encompass long-distance routes. These kinds of partnerships between peer agencies can benefit from a common set of performance measures to help increase consistency in investment and policy decisions.

◆ **Intra-agency coordination**. Although the report focuses on coordination across agencies, an examination of network performance sometimes requires intra-agency coordination, especially when comparing or combining different types of investments. For example, many state DOTs address capital and operations investments separately. Network performance measurement can enhance coordination across strategies and can find the best approach to address a particular challenge.

Coordinating Measures

The research found that when agencies partnered to measure performance at the network level, no major conflicts emerged between the performance measures already in use at each agency. Many partnerships applied a wider array of measures, addressing issues such as climate change and land use that may not always be part of a typical planning process. Of course, the scale at which the measures are calculated is different. Moving from the project or regional scale to the megaregional, multistate, or similarly larger scale requires examining measures at greater levels of aggregation.

Performance measurement has provided a means to define the objectives of the partnerships more clearly. Performance measures can help establish how the coordinated investments and policies will provide greater benefits to the agencies involved in a partnership. Some issues also lend themselves to larger partnerships, such as freight transportation, which relies on long-distance, multiregion or multistate corridors.

Network analysis based on performance measures is part of a trend among transportation agencies to support transportation programming and investment decisions. Agencies are interested in the most cost-effective strategies to improve performance. Network performance measurement, moreover, can be a useful tool as agencies address issues spanning multiple modes and jurisdictions.

Implementing Practical Programs

As performance measurement and management become recognized as best practices, research can provide examples and models for implementing practical programs. With discussions about performance management now taking place at the national level, approaches that link performance measurement to decision making are a critical research need.

Although all transportation agencies collect data that can measure performance—and many track the measurements—performance management considers how to use the measures in decision making. This requires establishing a strategic framework within which performance measures are used; addressing the range of actors with an influence on transportation system performance, both within an organization and in other organizations; and considering the range of strategies, investments, and policies that contribute to performance.

Within an organization, successfully linking performance measurement to decision making depends on an engaged and motivated workforce that understands the role of performance management. Performance measurement, however, often must look outside of an organization to develop common frameworks for partnerships.

PHOTO: WWW.OKI.ORG

Leaders from the Ohio–Kentucky–Indiana Regional Council of Governments convene at a monthly board meeting to implement solutions for regional transportation issues. Regional and metropolitan planning organizations are essential partnerships in transportation network decision making.

NCHRP Report 660, Transportation Performance Management: Insight from Practitioners, *is posted online at http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_660.pdf; NCHRP Report 664,* Measuring Transportation Network Performance, *is available at http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_664.pdf. To purchase print copies of either title, visit the TRB online bookstore, www.trb.org/Finance/Bookstore.aspx.*

TRB SPECIAL REPORT

The Safety Promise and Challenge of Automotive Electronics

Insights from Unintended Acceleration

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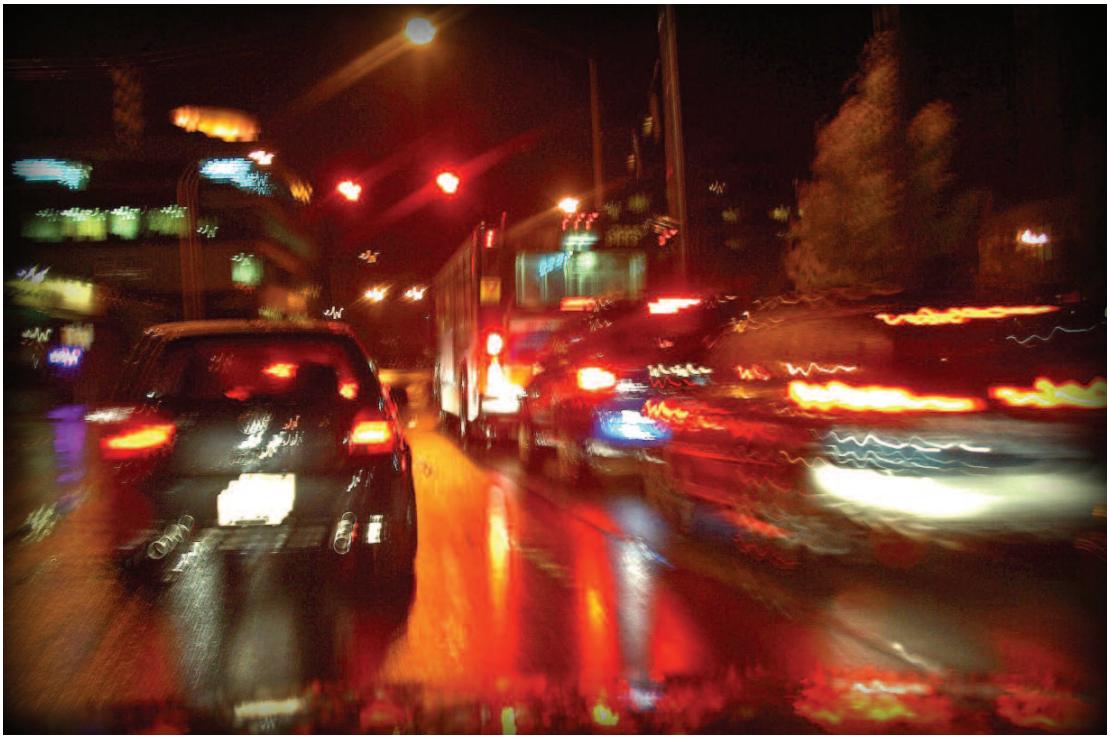

PHOTO: ANDREW E. LARSEN

From summer 2009 through spring 2010, the reports captured national media attention: drivers were claiming that their cars had accelerated unintentionally. The nature of the claims varied. Some involved moving vehicles that did not slow down when pressure on the accelerator pedal was released. Others involved stopped or slowly moving vehicles that sped up abruptly with high engine power. Some drivers described fluctuations in engine idling, hesitation, and shuddering. Others asserted that degraded or failed braking capacity accompanied the unintended acceleration.

Toyota Motor Corporation, whose vehicles were the subject of many of the complaints, issued recalls for millions of vehicles to address accelerator pedals that could be entrapped by floor mats and to fix pedal assemblies that were susceptible to sticking. In the wake of the highly publicized Toyota recalls, many individuals with expertise ranging from human factors to electronics hardware and software offered theories on other possible causes. The electronics in the automobile throttle control system were at the center of many of these theories.

Commissioning Studies

During the peak of the controversy in March 2010, the National Highway Traffic Safety Administration (NHTSA)—the U.S. regulatory agency that oversees federal standards for motor vehicle safety and monitors the fleet for safety defects—enlisted the National Aeronautics and Space Administration (NASA) to conduct an in-depth examination of the Toyota electronic throttle control systems (ETCs), looking for the potential for vulnerabilities in the electronics. NHTSA also requested a National Research Council (NRC) study to review investigations of unintended

acceleration and to recommend ways to strengthen the agency's safety oversight of automotive electronics systems. NRC appointed a 16-member committee of experts under the auspices of the Transportation Research Board (TRB), the Board on Energy and Environmental Systems, and the Computer Science and Telecommunications Board (see box, page 45).

The NRC committee's findings, published in TRB Special Report 308, *The Safety Promise and Challenge of Automotive Electronics: Insights from Unintended Acceleration*, reveal how the electronics systems incorporated into automobiles present many opportunities to make driving safer but at the same time present new demands for ensuring the safe performance of increasingly complex vehicle technologies. The increased demands on safety assurance affect both the automotive industry's development and deployment of electronics systems and NHTSA's fulfillment of its safety oversight role.

The NRC committee recommends that NHTSA give explicit consideration to the oversight challenges that arise from automotive electronics and develop and articulate a long-term strategy for meeting the challenges. A successful strategy would reduce the chances of a recurrence of the kind of controversy that drove NHTSA's response to questions about the relationship between electronics and unintended acceleration. As electronics systems proliferate to provide more vehicle functions, neither industry nor NHTSA can afford such recurrences—nor can motorists.

Investigating Claims

In 2007, NHTSA noted an increase in driver complaints about unintended acceleration in certain Toyota models. NHTSA investigated and attributed the complaints to drivers who inadvertently pressed the accelerator pedal instead of the brake and to pedals that were obstructed by floor mats or that were prone to sticking. NHTSA's investigations did not uncover any reason to suspect faulty electronics in the vehicles' ETCs as the cause. The conclusions led NHTSA to decide against more in-depth investigations of possible faults in the ETCs of the Toyota vehicles that were recalled for pedal entrapment and sticking.

Questions about the decision persisted, however, leading to the requests for the NASA and NRC studies. In its detailed analysis, the NASA team of engineering and safety specialists concluded that vulnerabilities and faults in the ETC did not present a plausible explanation for the high-power unintended acceleration reported in consumer complaints. The NASA investigators confirmed NHTSA's conclusion that the ETC could not disable the brakes or cause the immediate and catastrophic loss of braking capacity, as reported by many of the drivers who had experienced unintended acceleration.

Without evidence of a safety-related defect in Toyota's ETC, NHTSA elected to close its investigation into this system as a suspected cause of high-power unintended acceleration. The agency affirmed its earlier conclusions that cited pedal misapplication, entrapment, and sticking as the likely causes.

Through NASA's work, the causes of unintended acceleration by Toyota vehicles are clearer today than they were in 2010. Nevertheless, whether the technical justification for suspecting electronics systems in this particular instance warranted the attention given, including the commissioning of the detailed NASA study, deserves consideration because of the potential for electronics systems to be implicated in yet other safety issues.

Needed Oversight Capacity

The NRC study focused on how NHTSA can strengthen its regulatory, research, and defects investigation programs to meet the safety assurance and oversight challenges that arise from the expanding functionality and use of automotive electronics. The committee gave special consideration to NHTSA's responses to the concerns about errant electronics as a possible cause of reported cases of unintentional acceleration. The committee examined NHTSA's initiatives and reviewed the programs more generally, and examined the agency's effectiveness in overseeing the safe performance of automotive electronics.

The committee found NHTSA's decision to close the investigation justified, citing the agency's initial investigations, corroborated by follow-up analyses of thousands of consumer complaints, examinations of event data recorders in vehicles suspected to have crashed because of unintended acceleration, and the findings from the NASA study. The committee raises concern, however, that NHTSA could not answer convincingly the questions about the safety of the electronics systems that some had associated with unintended acceleration.

ETCs are simple and mature technologies com-

Photo: David Sadler

In 2007, when NHTSA investigated the unintended acceleration of some models of Toyota vehicles, driver error and pedal obstruction were determined to be the likely causes.

Photo: Wade Bartlett, Wikimedia Commons

Downloading information from an event data recorder after a crash. The increased use of electronics systems in automobiles creates opportunities to improve performance and safety, as well as to diagnose and remedy problems.

pared with the newer electronics systems in development. The deployment of more complex and interacting electronics systems increases the prospect that vehicle electronics will be suspected and possibly implicated in unsafe vehicle behaviors.

The committee recommends actions that can help NHTSA prepare for the needed capacity to detect possible defects in complex electronics systems, assess the causes, propose remedies with confidence, and make prudent decisions about when to seek technical assistance from outside experts, such as NASA.

Safety Assurance Challenges

The committee noted that electronics systems are critical to the functioning of the modern automobile. Proliferating and increasingly interconnected electronics systems are creating opportunities to improve vehicle performance, safety, and reliability, and to address system safety and cybersecurity. By introducing many new vehicle capabilities and changing many familiar driver interfaces, electronics systems present challenges for system design. Through site visits to several automotive manufacturers, the committee learned about the many processes built into product design, development, and manufacturing to ensure that electronics systems function safely and interact effectively with drivers.

Nevertheless, with the growth of automotive electronics, NHTSA's Office of Defects Investigation (ODI) can expect to devote an increasing amount of time and resources to recognizing and investigating potential defects involving electronics systems and to assessing the corrective actions proposed by manufacturers for recalls involving these systems. Failures associated with electronics systems may be related to software programming, dual and intermittent electronics hardware faults, and electromagnetic disturbances—these may not leave physical evidence to aid investigations into observed or reported unsafe vehicle behaviors.

Similarly, the contributing causes of many errors by drivers using or responding to new electronics systems may not leave a physical trace. The absence of physical evidence has complicated investigations of incident causes—such as the causes of unintended acceleration—and may become more problematic for ODI as the number, interconnectivity, and complexity of electronics systems grow.

A challenge facing NHTSA is to further the use and effectiveness of electronics technologies to aid safe driving and mitigate hazardous behaviors—and to ensure that the technologies perform as intended. NHTSA regularly updates a multiyear plan that explains the rationale for its near-term research and regulatory priorities. The plan, however, does not address strategic considerations, such as developing new capabilities for the regulation, research, and surveillance and investigation of defects related to the safety of the electronics-intensive vehicle.

Standards and Expertise

As vehicles become more dependent on electronics systems for critical functions, NHTSA's regulatory, research, and investigation programs will need to keep pace with the safety demands. The committee's recommendations are intended to support the industry's efforts to ensure the safe performance of vehicle electronics systems and to strengthen NHTSA's ability to identify and respond to safety problems arising from deficiencies in the systems.

The committee recommends that NHTSA become more familiar with and engaged in standard-setting and other efforts involving industry, to strengthen the means by which manufacturers ensure the safe performance of electronics systems. Through such cooperative efforts, NHTSA can extend its understanding of how manufacturers seek to prevent safety problems and can help agency personnel gain technical knowledge about the electronics systems being added to vehicles and the strategies manufacturers use to ensure

A General Motors study in 2003 tested forward collision warning and adaptive cruise control technology. The NRC study committee recommended that NHTSA collaborate with industry in human factors research to examine system capabilities and interface design.

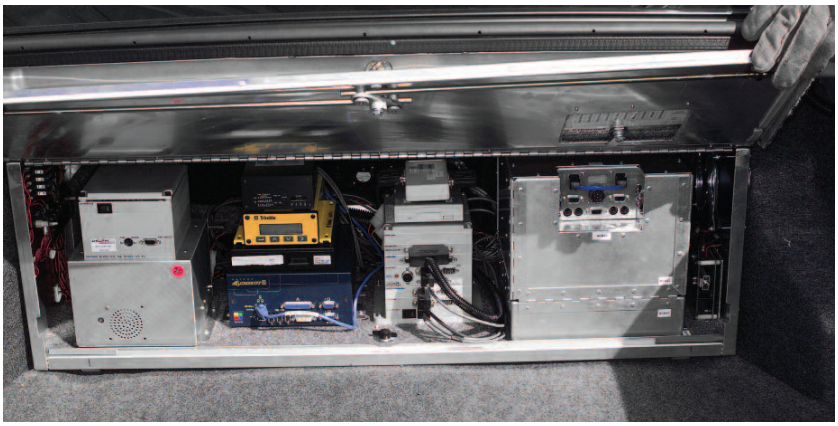

Photo © General Motors

safe operation. The committee recommends that NHTSA collaborate with industry in conducting human factors research to inform manufacturers' decisions about the design of system interfaces that enhance safe performance by the driver.

To obtain access to additional technical expertise, the committee recommends that NHTSA convene a standing technical advisory panel comprising individuals with backgrounds in the disciplines central to the design, development, and safety assurance of automotive electronics systems, including software and systems engineering, human factors, and electronics hardware. NHTSA would consult the expert panel on technical matters that arise in any of the agency's vehicle safety programs, including regulatory reviews, defect investigations, and research needs assessments.

The committee recommends that NHTSA undertake a comprehensive review of the capabilities that ODI will need in monitoring and investigating safety deficiencies in electronics-intensive vehicles. The review should consider the use of agency research to strengthen ODI's capabilities, particularly the detail, timeliness, and analyzability of consumer complaints and early warning data that are important in defects surveillance and investigation.

The committee recommends that NHTSA strive to make electronic event data recorders commonplace in all vehicles; these can assist ODI investigators in determining the causes of vehicle crashes. The utility and feasibility of equipping vehicles with more advanced recording systems that can log a range of data deserve further study.

Strategic Planning

The committee concludes that NHTSA needs to give explicit consideration to how developments in automotive electronics are creating new safety challenges that will necessitate changes in the scope, direction, and capabilities of agency regulatory, research, and defect investigation programs. Accordingly, the committee recommends that NHTSA initiate a strategic planning effort to identify the safety challenges arising from vehicle electronics and to develop an agenda for meeting the challenges.

The committee states that the planning should be (*a*) prospective in considering the safety challenges arising from the electronics-intensive vehicle, (*b*) introspective in considering the implications of these challenges for NHTSA's vehicle safety role and programs, and (*c*) strategic in guiding critical decisions concerning the most appropriate regulatory approaches and the associated requirements for research and resources.

The committee further recommends that NHTSA's next three-year plan include the development and completion of the strategic plan as a priority. NHTSA should communicate the purpose of the planning effort, define its development and implementation in accordance with the committee's advice, and establish a definite schedule for completion. The plan should be made public, because it will guide key policy decisions—from budgetary to legislative—that will determine the scope and direction of the agency's vehicle safety programs.

The long-term importance of strategic planning is obvious: the technological transformation of the automobile will continue, and being prepared is preferable to reacting to the safety concerns that will arise. The committee observes that NHTSA researchers are working with the automotive industry, universities, and other government agencies to examine crash avoidance concepts, such as vehicle-to-vehicle and vehicle-to-infrastructure communications systems. These systems will enable greater vehicle autonomy and necessitate advances in vehicle electronics well beyond the systems now being deployed. Ongoing strategic planning will position NHTSA to meet the safety demands likely to accompany technological advances.

Acknowledgments

Also serving as National Research Council staff to the study committee were Alan Crane, Senior Scientist, Board on Energy and Environmental Systems; Jon Eisenberg, Director, Computer Science and Telecommunications Board; and Mark Hutchins, Program Officer, TRB.

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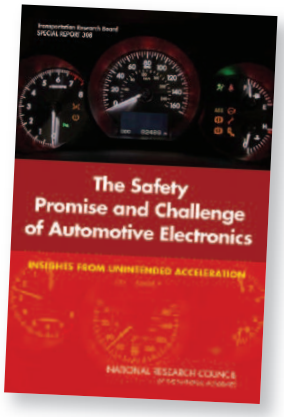

TRB Special Report 308, *The Safety Promise and Challenge of Automotive Electronics: Insights from Unintended Acceleration*, is available from the TRB online bookstore, www.trb.org/bookstore; to view the book online, go to http://onlinepubs.trb.org/onlinepubs/sr/sr308.pdf.

Surface Resistivity Measurements for Quality Assurance Pave the Way to Savings in Louisiana

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The permeability of the concrete determines whether a structure will have a long service life free from corrosion of the structural steel. Concrete permeability depends on the ratio of water to cementitious materials (w/cm), total cementitious content, aggregate gradation, and the amount of supplementary cementitious materials (SCMs) in the mix.

Many engineers rely on the permeability specifications for portland cement concrete pavements and structures to ensure long service life. Most prefer the Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration (ASTM C1202). Until recently, this was the only test that quickly determined the resistance of concrete to chloride ion penetration. Surface resistivity measurements, however, have advanced and can generate rapid results for chloride permeability. Florida, for example, allows the use of a surface resistivity device that correlates well with rapid results for chloride permeability as one step in the acceptance of a concrete mix design.

The surface resistivity device has four pegs. A current is applied across the outside pegs and the potential resistivity is measured between the inside pegs. The test result is displayed in kilohm-centimeters (kΩ-cm). The distance between the pegs affects the results of the test.

Problem

The Bridge Design Section of the Louisiana Department of Transportation and Development (DOTD) is transitioning statewide to load and resistance factor design (LRFD) for reinforced concrete structures. This change in design procedures requires testing more samples for permeability to ensure adequate protection against corrosion. The personnel hours for subjecting these samples to the rapid chloride permeability test, as required, were estimated in the tens of thousands per year.

Solution

The Louisiana Transportation Research Center (LTRC) therefore investigated the use of a surface resistivity device for the quality assurance and acceptance of structural concrete. The surface resistivity meter is user friendly. Louisiana DOTD conducted the research to expand on the results obtained in Florida for the surface resistivity meter at very high and very low w/cm ratios. The surface resistivity device provided a cost-effective alternative to the rapid chloride permeability test and assisted the department in the transition to LRFD.

The surface resistivity device was evaluated on concrete produced in the laboratory and in the field. The peg distance was fixed at 1.5 in. (3.81 cm) for all samples.

Concrete samples were produced in the laboratory from five mixtures at three different w/cm ratios (0.35, 0.50, and 0.65) to gain a range of permeability values. The mixtures were tested for surface resistivity and for rapid chloride permeability at 14, 28, and 56 days.

Field-cast specimens from the Twin Spans and Caminada Bay Bridge projects also were tested for surface resistivity and rapid chloride permeability at 28 and 56 days. In addition, laboratory samples from an ongoing study of ternary cementitious combinations—with up to 90 percent SCM content—were tested at 28 and 56 days. The study tested approximately 150 unique mixtures.

The LTRC laboratory's surface resistivity measurements correlated well (R^2 = 0.87) with rapid chloride permeability measurements across a wide range of permeability values, sample testing ages, and concrete mix designs (Figure 1, page 47). The regression equation in Figure 1 expresses the correlation between the 28-day surface resistivity (x) and the 56-day rapid chloride permeability (y).

The American Association of State Highway and Transportation Officials (AASHTO) recommends correlation with the ranges shown in Table 1 (page 47), delineating classes of chloride penetrability. Suitable correlations were found between the 14-day and 28-day surface resistivity values and the 56-day rapid chloride permeability values.

The 28-day to 56-day correlation was implemented, to eliminate the need for a set of acceptance samples produced in the field. The surface resistivity test is conducted on cast samples, and the same samples then were tested for compressive strength.

The surface resistivity meter identified differences

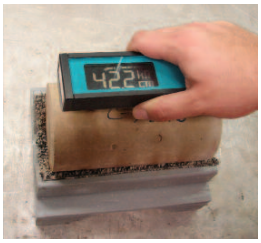


Photo: LTRC

Surface resistivity test being conducted.

in w/cm ratios. Researchers at LTRC developed a precision statement using eight mixtures—two sets of three samples for each mixture—and 17 operators. The single operator coefficient of variation (COV) of a single test result was 2.2 percent, and the multi-laboratory COV of a single test result was 3.9 percent.

With the results from this study, Louisiana DOTD developed the Test Method for Surface Resistivity Indication of Concrete's Ability to Resist Chloride Ion Penetration (DOTD TR 233-11). A specification was prepared to incorporate the surface resistivity test into Louisiana DOTD's standards and specifications.

Application

Louisiana DOTD published the new specification in 2012 but already had changed its permeability testing procedures for quality assurance to reflect the new specification. The department developed and implemented a statewide training program on the proper use of the surface resistivity meter.

The surface resistivity meter has been used to accept the concrete placed for the LA-1, Caminada Bay, and Twin Spans Bridge projects. Concrete for the Twin Spans and Caminada Bay Bridge projects was accepted from compressive strength results and from surface resistivity results. The surface resistivity results, sampled from every lot and tested at 28 days, were compared with the classes shown in Table 1; all three projects met the classification of very low permeability.

Benefits

Every year, Louisiana DOTD tests an average of 480 lots for quality assurance on projects constructed within the state. As the new permeability specifications are implemented statewide, this number is expected to increase by several orders of magnitude.

The ASTM C1202 test equipment costs $18,000, and the surface resistivity meter costs $2,800. The complete ASTM C1202 testing requires 8.0 personnel hours; in contrast, the surface resistivity test requires 0.33 personnel hour.

TABLE 1 Louisiana DOTD Surface Resistivity and Permeability Classes for 4-x-8-in. Cylinders

Permeability Class	56-Day Rapid Chloride Permeability Charge Passed (coulombs)	28-Day Surface Resistivity (kΩ-cm)
High	>4,000	<12
Moderate	2,000–4,000	12–21
Low	1,000–2,000	21–37
Very Low	100–1,000	37–254
Negligible	<100	>254

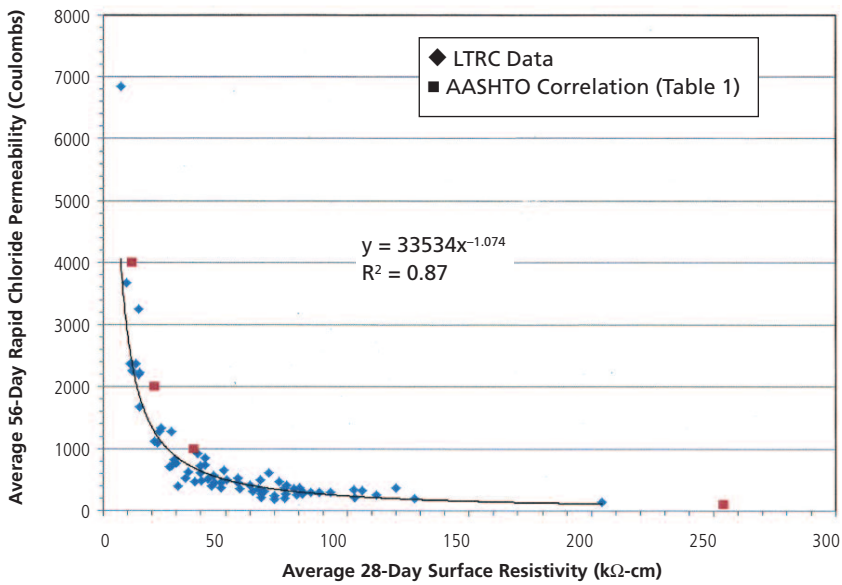


FIGURE 1 Relationship between the average 28-day surface resistivity test results and the average 56-day rapid chloride permeability test results.

The savings in technician costs in the first year can pay for 10 additional resistivity meters for the district laboratories and the central materials laboratory. The preliminary cost–benefit analysis shows that implementing surface resistivity measurements in lieu of rapid chloride permeability tests can save Louisiana DOTD approximately $101,000 in personnel costs for testing 480 lots in the first year.

The cost savings associated with contractor quality control testing are even greater. Contractors send approximately 3,000 ASTM C1202 samples to an independent laboratory for testing at a cost of $500 per sample—for the testing only. The estimated cost savings of $1.5 million to the contractors should indirectly benefit the department.

The estimated combined savings for Louisiana DOTD in the first year of implementation total about $1.6 million. The research project cost $103,000—a cost–benefit ratio of more than 15. The preliminary analysis shows that the department can save a significant amount of money by switching to the newer, faster surface resistivity test method.

For additional information, contact Tyson D. Rupnow, Concrete Research Engineer, Louisiana Transportation Research Center, 4101 Gourrier Avenue, Baton Rouge, LA 70808; 225-767-9148; Tyson.Rupnow@la.gov.

Resources

Technical Report: www.ltrc.lsu.edu/pdf/2011/fr_479.pdf.
Test Method: www.dotd.la.gov/highways/construction/lab/testproc/tr_233_final.pdf.
Training Video: www.ltrc.lsu.edu/videotraining/Resistivity/Resistivity.swf.

EDITOR'S NOTE: Appreciation is expressed to Inam Jawed and G. P. Jayaprakash, Transportation Research Board, for their 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).

Thomas J. Kazmierowski

Ontario Ministry of Transportation

In his more than 30 years as an engineer with the Ontario Ministry of Transportation (MTO), Thomas J. Kazmierowski has earned international recognition in the field of sustainable pavement design, rehabilitation, and management. Drawn to the ministry's professional training program, Kazmierowski joined MTO after graduating from the University of Toronto with an honors degree in civil and geotechnical engineering in 1976. He began as a project engineer and has held progressively senior and managerial positions in foundation, geotechnical, pavement, and materials engineering and infrastructure management.

In 2007, Kazmierowski became manager of the Materials Engineering and Research Office, guiding the development and implementation of innovative material and construction specifications and standards for bituminous and concrete mixtures, soils and aggregates, and pavements and foundations. Under his direction, staff evaluate and implement new technology, conduct research, monitor trials and test sections, and carry out laboratory correlation and special testing programs.

"We already are using tools that allow us to quantify the environmental benefits of various pavement materials and construction techniques, so that we can incorporate these sustainable benefits into our decision-making process."

Kazmierowski has seen the vast changes in pavement engineering firsthand in the past three decades. He observes that the outsourcing of program delivery from design to construction and maintenance has redefined MTO, which now focuses predominantly on auditing and providing oversight. The introduction of innovative technologies has required managers to adapt their methods of contract delivery and technology transfer to staff, clients, and stakeholders.

"We have had to come up with new ways of doing business," Kazmierowski comments. "Moving from method specifications to end result specifications to performance specifications and warranty contracts is a good example—working together to take advantage of the industry's expertise to deliver a quality product." Successful collaboration between MTO, academia, and the pavement industry has resulted in improvements in design, product quality, and product performance delivery.

"Ontario produces some of the highest-quality pavements in North America—a look at our life-cycle cost models tells you that we have some of the best-performing, longest-lasting rigid and flexible pavements on the continent," he affirms.

Kazmierowski has an abiding interest in sustainable transportation systems—an area he expects will become increasingly prominent in the future of pavement technology. "We already are using tools that allow us to quantify the environmental benefits of various pavement materials and construction techniques, so that we can incorporate these sustainable benefits into our decision-making process," he notes, adding that many of these tools have highlighted the importance of using reclaimed materials and state-of-the-art recycling technologies.

He has been a longtime champion of in-place recycling and, in 2008, received the Charles R. Valentine Award for Excellence in Cold Recycling from the Asphalt Recycling and Reclaiming Association.

Other sustainable pavement technologies receiving attention include warm-mix asphalt and pavements incorporating crumb rubber from scrap tires and roofing shingles, as well as portland limestone cements, pervious concrete pavements, reclaimed concrete aggregate, and supplementary cementing materials from industrial by-products. MTO recently constructed a series of test trials of long-life pavements, built to withstand fatigue and rutting.

"Long-life pavements play a role in sustainability because you are carrying out fewer rehab treatments and keeping materials in place for a longer time—both of which help reduce energy consumption and emissions," Kazmierowski explains.

Since his first published paper in 1985, Kazmierowski has authored or coauthored more than 100 technical papers, including 15 papers published in the *Transportation Research Record: Journal of the Transportation Research Board*. Research honors include two best paper awards at the International Conference on Managing Pavement Assets, in 2001 and 2008, as well as two Gilchrist Medals for best technical paper, awarded by the Transportation Association of Canada (TAC), in 1990 and 1995. In 2010, he received TAC's Distinguished Service Award.

Chair of the TRB Design and Construction Group, Kazmierowski is a member of the Technical Activities Council. In 2009, he was named emeritus member of the Pavement Rehabilitation Committee, which he originally joined in 1990. He chaired the Pavement Management Systems Committee from 2000 to 2006 and the Pavement Management Section from 2006 to 2011. He also served on the Pavement Maintenance Committee and the Task Force on Roadway Pavement Preservation.

Paula L. Schwach

Federal Transit Administration

As regional counsel for the U.S. Department of Transportation's Federal Transit Administration (FTA), Paula L. Schwach is responsible for transit-related legal issues in Iowa, Kansas, Missouri, and Nebraska, as well as for addressing matters in real estate, joint development, transit-oriented development, and infrastructure finance throughout the United States. In 1999, she issued the legal opinion for the first loan guarantee transaction under the Transportation Infrastructure Finance and Innovation Act of 1998 (TIFIA)—a loan guarantee for up to $600 million for the Washington Metropolitan Area Transit Authority.

Schwach also represented FTA in the funding for the Eagle P3 commuter rail project, a public–private partnership in Denver, Colorado, under the Regional Transportation District's FasTracks transit program. In 2010, she was the FTA lead advising on the financing of the $2 billion multimodal Transbay Terminal Center project in San Francisco, California. The transaction became the prototype for tax increment funding—capturing the value of tax revenue increases from transit-oriented development to help pay for transportation improvements. Also that year, Schwach played a pivotal role in structuring the loans for the Denver Union Station project, the first major rail infrastructure project to combine financing from TIFIA and the Federal Railroad Administration's Railroad Rehabilitation and Improvement Financing Program. Before these transactions, she issued legal opinions for Tren Urbano, a fully automated rapid transit line in Puerto Rico, and for New York's Staten Island Ferry project.

"The goal of the work is to leave behind a tangible product that meets the needs of its users and that will outlast an individual's short stay in a given position."

"The goal of the work is to leave behind a tangible product that meets the needs of its users and that will outlast an individual's short stay in a given position," Schwach observes. This philosophy has formed the core of her career—from working on the first housing finance agency loan-to-lenders programs for the state of Missouri, to demolishing an uninhabitable public housing project, to leading a TIFIA project team.

Schwach graduated from Missouri State University with a bachelor's degree in political science and received a master's degree in urban affairs from the Center for Urban Programs at St. Louis University, where she was a U.S. Department of Housing and Urban Development Public Housing Fellow. Schwach received a Juris Doctor degree from the University of Missouri at Kansas City; as a law student, she published papers with land use law expert Robert Freilich and received American Jurisprudence Awards for her work in property and environmental law.

Before she began practicing law, Schwach worked as a senior housing and community development officer for the City of Kansas City, Missouri. She designed redevelopment programs, coordinated neighborhood infrastructure improvements and housing rehabilitations, and served on the loan committee for two neighborhood nonprofits. She also was a loan officer with the Jackson County State Bank and a development officer for the Missouri Housing Development Commission.

"TRB is helpful because of willing practitioners who share so selflessly of their knowledge and experience during the annual law forum and through valuable compilations on transportation law topics," Schwach notes. She has been a member of the TRB Transit and Intermodal Transportation Law Committee since 2007 and has served on TRB Annual Meeting panels on topics such as joint development, transit-oriented development, leveraged leases, and payment and performance bonds.

Schwach advises new lawyers and law students to follow their interests, find cutting-edge programs they are passionate about, and to offer their services—even if it means taking on more work. "New programs provide a unique opportunity to shape program design, policy, and the inevitable rules that follow the maturation of a program," she comments.

Active in civic life, Schwach is president of the City Council for the City of Westwood Hills, Kansas. As council president, she rewrote the city's land use ordinances and is working to develop a funding program for infrastructure maintenance. She is president-elect of the League of Women Voters in Johnson County, Kansas, a position that helps her keep current on local governmental issues. She recently edited the league's position paper summaries on subjects such as the form of county government and on local perspectives of issues such as natural resources, mental and physical health, and poverty. Schwach is a past board president of the Mattie Rhodes Counseling and Art Center and a former board member and chair of the Legislative Issues Committee of the Association for Women Lawyers of Greater Kansas City.

Photo: Rsson Photography

Representing Washington State DOT, Leni Oman (*third from left*) and Washington State Transportation Secretary Paula Hammond (*center*) receive first prize at the 2011 Communicating with John and Jane Public competition. (*Left to right:*) Planning and Environment Group chair Mark Kross; Technical Activities Council chair Katherine Turnbull, Texas Transportation Institute; Public Involvement in Transportation Committee Chair Jennifer L. Weeks, Parsons Brinckerhoff; Terri Parker, Missouri Highways and Transportation Commission; and Stephanie Camay, URS Corporation.

Identifying Models for Transportation in Emergencies

Worldwide events such as terrorist attacks and natural disasters have raised the awareness of the vital roles of emergency response management and of transportation during emergencies. Communities that are prepared for emergency situations have transportation plans that are accessible and fully understood by the public. In 2011, TRB's Planning and Environment Group used its annual Communicating with John and Jane Public competition to find models for how communities prepare for transportation during emergencies; how these plans are communicated to the public; and whether disabled groups, the elderly, and those without automobile access are considered in the planning efforts.

The Washington State DOT communications team received top honors for its comprehensive portfolio of emergency communications strategies and products for inclement weather. In the fall and winter of 2010 and early 2011, as a volley of unseasonably heavy, widespread snow and ice storms hit a region unaccustomed to snow and ice, Washington State DOT used traditional tools—such as live radio reports—and cutting-edge technologies—including blogs, social media, smart phone applications, and Skype—to ensure that travelers were prepared and informed.

The Metropolitan Transit Authority of Harris County, in Houston, Texas, received an honorable mention for its communications strategy for regional evacuations—particularly of citizens with functional and access needs—and other emergency situations. Honorable mentions also went to the New York City Office of Emergency Management for its Notify NYC, a multimedia source for information about emergency events and city services that has enrolled approximately 70,000 subscribers, and to the Mid-Ohio Regional Planning Commission, for a framework that allows the region's various emergency preparedness plans to coordinate with a regional strategy.

For more information on the contest, including 2012 contest rules and procedures, contact Stephanie Camay at stephanie.camay@urs.com or visit the TRB Public Involvement in Transportation Committee's website at https://sites.google.com/site/trbcommitteeada60. The theme for 2012 is transportation governance and finance.

COOPERATIVE RESEARCH PROGRAMS NEWS

Methods, Metrics, and Strategies for Livable Transit Corridors

In 2009, the U.S. Departments of Transportation (DOT) and Housing and Urban Development and the U.S. Environmental Protection Agency formed the Partnership for Sustainable Communities. The partnership established six livability principles: providing more transportation choices; promoting equitable, affordable housing; enhancing economic competitiveness; supporting existing communities; coordinating and leveraging federal policies and investment; and valuing communities and neighborhoods. The role of transit development in fostering livability is a topic for continuing exploration.

CFA Consultants has received a $350,000, 18-month contract (Transit Cooperative Research Program Project H-45, FY 2011) to develop a framework for assessing the livability outcomes of transit corridor planning and decision making. The framework will address the six livability principles, as well as practical planning and implementation strategies, to enhance livability in transit corridors.

For further information, contact Dianne S. Schwager, TRB, 202-334-2969, dschwager@nas.edu.

SECOND STRATEGIC HIGHWAY RESEARCH PROGRAM NEWS

Testing Tools to Enhance Transportation Planning

Transportation for Communities: Advancing Projects Through Partnerships (TCAPP) is a web-based decision-support tool, launched for testing in January 2010. Developed under the capacity focus area of the second Strategic Highway Research Program (SHRP 2), TCAPP provides detailed information to facilitate a collaborative, integrated transportation planning process. TCAPP also offers a framework for practitioners to introduce capacity research topics—ecologically based planning, performance measurement, developing a vision, and expediting project delivery—into the individual decisions that comprise the planning process. This year, capacity topics include greenhouse gas, freight, and public–private partnerships.

In response to suggestions from pilot test teams, a redesigned TCAPP was released at the 2012 TRB Annual Meeting. The new interface offers multiple ways to connect to relevant information from the main page, and the question-and-answer format guides users to specific features:

◆ The **Decision Guide**, represented as file folders, contains extensive information on partner roles, tools and data, case studies, and questions to support decision making.

◆ **Applications** of the Decision Guide allow users to take small steps toward larger improvements.

◆ **What's new in TCAPP?** shows how the Decision Guide links to an integrated ecological planning process.

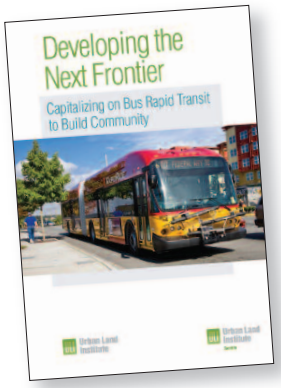
◆ **What can TCAPP do for me?** is a brief video illustrating the approach through the words of a Minnesota DOT project manager, who describes how TCAPP was applied to support a project.

◆ **How does TCAPP work in the real world?** highlights the successful use of the corridor planning application by Washington State DOT.

◆ The **TCAPP Connect** forum allows users to engage with peers on topics of interest and to share lessons learned.

TCAPP will continue to evolve in response to new topics, regulatory changes, and the interests of the user community. To learn more about TCAPP, see http://transportationforcommunities.com.

SHRP 2 is administered by TRB to advance innovative methods to plan, renew, operate, and improve safety on America's highway system. For more information, visit www.trb.org/shrp2.



Land Use Planning for Bus Rapid Transit

By 2013, RapidRide, an arterial bus rapid transit (BRT) service, will expand to six lines covering 64 miles of high-use corridors in King County, Washington. A recent study, conducted under a partnership between the Urban Land Institute (ULI) Seattle; King County Metro Transit; the cities of Seattle and Shoreline, Washington; and the ULI–Curtis Regional Infrastructure Project, recommends ways to maximize land use and plan for development along the corridor.

A series of studies on BRT service in Kansas City, Missouri; the Twin Cities in Minnesota; and Cleveland, Ohio, revealed the potential for arterial BRT to focus market demand for development. Stations placed less than 1 mile apart allow the entire BRT corridor, rather than individual stations, to become an economic development unit. According to the study, BRT can create a unifying brand to be applied in several areas: along a corridor, on a transit line, and in local neighborhoods.

Recommendations include land use planning for entire corridors instead of individual stations; encouraging a sense of local identity and ownership in stakeholders; and promoting the value of the BRT system as an integral part of a community, not just a transportation service.

For more information, visit http://seattle.uli.org/Community Building/Bus Rapid Transit Initiative.aspx. To access the report, see http://seattle.uli.org/Community Building/~/media/DC/Seattle/Seattle Docs/ULI Seattle BRT Report.ashx.

Crashes Costlier Than Congestion: AAA Report

The annual societal cost of traffic crashes is more than three times the annual cost of traffic congestion, according to estimates in a recent AAA report. The study, conducted by Cambridge Systematics, notes that traffic crashes killed 33,808 people in the United States in 2009.

Using 2009 Federal Highway Administration crash cost data and congestion figures for the areas studied in the Texas Transportation Institute's *2010 Urban Mobility Report*, researchers calculated a total cost of $300 billion for crashes in the areas studied, compared with total congestion costs of $98 billion in 2009.

In every city studied, the costs of crashes per person far outweigh the costs of congestion per person. For all cities, crashes cost $1,522 per person per year while congestion costs $590. The disparity in costs is particularly marked in cities with populations of less than 500,000, where crashes cost nearly $1,500 more per person than congestion.

To see the full report, visit http://newsroom.aaa.com/wp-content/uploads/2011/11/2011_AAA_CrashvCong Upd.pdf.

INTERNATIONAL NEWS

Auto Rickshaws and Sustainable Transportation

In India, the production of auto rickshaws—three-wheeled, motorized cabin cycles often used as taxis—has doubled between 2003 and 2010, according to a recent report from the World Resources Institute. Nationwide, auto rickshaws make more than 229 million passenger trips per day—a figure expected to double by 2031. Researchers Akshay Mani, Madhav Pai, and Rishi Aggarwal investigated the function of auto rickshaws in promoting the use of public transportation and in reducing private motor vehicle trips in cities. Their findings emphasize a need for regulatory reforms to support fleet-based dispatch services, as well as for vehicle reforms to address road safety and emissions.

The number of auto rickshaws in India's cities ranges from 15,000 to 30,000 in smaller areas and up to 150,000 in large cities such as Mumbai; the vehicles account for up to 20 percent of daily motorized road trips in the cities of Banglaore, Mumbai, Pune, and Rajkot. For pedestrians, auto rickshaws are the second safest form of motorized transportation, after buses. Because of vehicle design and the mixed flow of traffic in Indian cities, however, researchers note that occupant safety remains a concern.

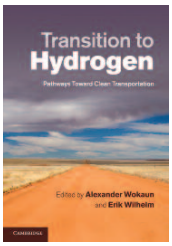
The high concentration of particulate matter less than 10 microns (PM_{10}) in Indian cities is an environmental and public health issue, and auto rickshaws that run on two-stroke engines are significant contributors to PM_{10} emissions. According to the report, reforms also should address vehicle emissions.

For the full report, visit www.embarq.org/en/sustainable-urban-transport-india-role-auto-rickshaw-sector.

Photo: The Commons

An auto rickshaw based in Calangute, Goa, India.

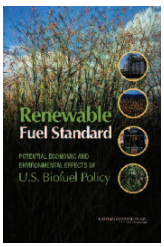
Transition to Hydrogen: Pathways Toward Clean Transportation



Edited by Erik Wilhelm and Alexander Wokaun. Cambridge University Press, 2011; 272 pp.; $110; 978-05-2119-288-0.

A comprehensive and objective guide to understanding hydrogen as a transportation fuel, this book examines the economic, environmental, safety, and health effects of a variety of vehicle technologies. Research issues in hydrogen and transportation—with a focus on light-duty vehicles—are considered in the context of competing technologies, the larger energy sector, and the overall economy.

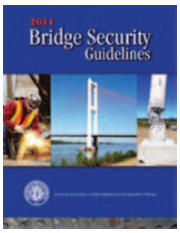
Renewable Fuel Standard: Potential Economic and Environmental Effects of U.S. Biofuel Policy



National Research Council. National Academies Press, 2011; 250 pp.; $68; 978-03-0918-751-0.

A National Research Council study committee examines the economic and environmental consequences of the increased biofuels production mandated by the Renewable Fuels Standard as amended in 2007 by the Energy Independence and Security Act. The report describes biofuels produced in 2010 and those projected to be produced and consumed by 2022, reviews model projections of the relative impact on land prices, discusses potential environmental harm and benefits, and addresses barriers to fulfilling the consumption mandate.

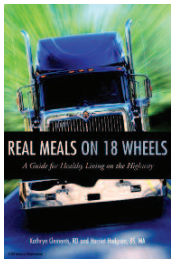
Bridge Security Guidelines, 1st Edition



American Association of State Highway and Transportation Officials (AASHTO), 2011; 68 pp.; AASHTO members, $70; nonmembers, $84; 978-15-6051-521-0.

The September 11, 2001, terrorist attacks on the United States caused bridge engineers to confront a new form of extreme event design—design for events induced by man. This volume offers guidance on bridge design for extreme man-made events. Research is presented on the response of concrete bridge columns subjected to blast loads, as well as on blast-resistant design and on guidelines and analytical models of blast load distribution.

Real Meals on 18 Wheels: A Guide for Healthy Living on the Highway



Kathryn Clements and Harriet Hodgson. Published by author, 2011; 112 pp.; $13.95; 978-14-5648-380-7.

Many commercial drivers are familiar with the challenge of maintaining a healthy lifestyle on the road. This guide, developed by a registered dietitian and a health writer, contains information to help truckers and other long-distance drivers make informed health choices. Presented are the fundamentals of meal planning, basic nutrition information, drivers' real-life experiences, and strategies for lifestyle changes.

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

TRB PUBLICATIONS

Costs of Alternative Revenue-Generation Systems
NCHRP Report 689

Presented is a framework for analyzing the direct costs incurred in generating revenues to support federal-aid and state highway construction, operations, and maintenance. The report uses the framework to estimate unit costs for fuel taxes, tolling, vehicle-miles-of-travel fees, and cordon-pricing schemes.

2011; 127 pp.; TRB affiliates, $47.25; nonaffiliates, $60. Subscriber categories: finance; policy.

Guidebook for Successful Communication, Cooperation, and Coordination Strategies Between Transportation Agencies and Tribal Communities
NCHRP Report 690

Using an easily adaptable approach, this report presents guidelines to help departments of transportation and tribal communities work together to complete transportation projects on tribal lands. Included are case studies illustrating successful practices.

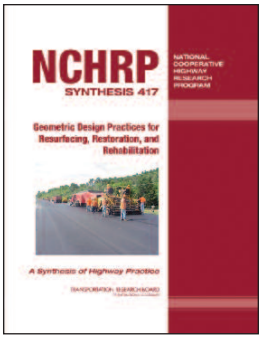
2011; 113 pp.; TRB affiliates, $42.75; nonaffiliates, $57. Subscriber categories: administration and management; society.

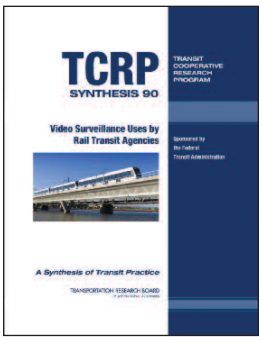
Mix Design Practices for Warm-Mix Asphalt
NCHRP Report 691

This report explores a mix design tailored to the unique material properties of warm-mix asphalt technologies, with a goal of producing mixtures that have strength, durability, and performance characteristics similar to those of hot-mix asphalt.

2011; 101 pp.; TRB affiliates, $40.50; nonaffiliates, $54. Subscriber categories: highways; materials.

TRB PUBLICATIONS *(continued)*





Decision Making for Outsourcing and Privatization of Vehicle and Equipment Fleet Maintenance
NCHRP Report 692

A framework for analyzing the outsourcing and privatization of vehicle and equipment fleet maintenance is presented, supplemented with case studies. The report includes forms and templates for analysis and documentation.

2011; 58 pp.; TRB affiliates, $34.50; nonaffiliates, $46. Subscriber categories: maintenance and preservation; vehicles and equipment.

Guide for Implementing a Geospatially Enabled Enterprisewide Information Management System for Transportation Agency Real Estate Offices
NCHRP Report 695

This report offers guidance and a logical model for implementing a geospatially enabled, enterprisewide information management system for right-of-way offices.

2011; 48 pp.; TRB affiliates, $39.75; nonaffiliates,$53. Subscriber categories: administration and management; data and information technology; finance; highways.

Performance of Corrugated Pipe Manufactured with Recycled Polyethylene Content
NCHRP Report 696

Specifications are proposed for corrugated drainage pipe manufactured with recycled high-density polyethylene (HDPE) drainage pipe containing recycled HDPE, and formulations of virgin and recycled HDPE.

2011; 144 pp.; TRB affiliates, $45; nonaffiliates, $60. Subscriber categories: highways; materials; bridges and other structures.

Design Guidelines for Increasing the Lateral Resistance of Highway–Bridge Pile Foundations by Improving Weak Soils
NCHRP Report 697

Guidance for strengthening soils to resist lateral forces on bridge pile foundations is presented in this report, along with computational methods for assessing soil-strengthening options through finite-element analysis of single piles and pile groups.

2011; 108 pp.; TRB affiliates, $42.75; nonaffiliates, $57. Subscriber categories: bridges and other structures; design; geotechnology.

Application of Accelerated Bridge Construction Connections in Moderate-to-High Seismic Regions
NCHRP Report 698

This report addresses connection performance in accelerated bridge construction components in medium-to-high seismic regions and offers suggestions for further research.

2011; 54 pp.; TRB affiliates, $32.25; nonaffiliates, $43. Subscriber categories: highways; bridges and other structures.

Geometric Design Practices for Resurfacing, Restoration, and Rehabilitation
NCHRP Synthesis 417

Comprising a literature review and survey of state transportation agencies, this synthesis documents the state of the practice for resurfacing, restoration, and rehabilitation projects on nonfreeway roads.

2011; 101 pp.; TRB affiliates, $40.50; nonaffiliates, $54. Subscriber categories: highways; design.

Developing Production Pile-Driving Criteria from Test Pile Data
NCHRP Synthesis 418

State transportation agency pile-driving criteria are examined, including the various methods of training, the levels of experience, and the rates of acceptance of new technologies and pile-testing approaches.

2011; 66 pp.; TRB affiliates, $36.75; nonaffiliates, $49. Subscriber categories: highways; geotechnology.

Practical Resources for Recruiting Minorities for Chief Executive Officers at Public Transportation Agencies
TCRP Report 148

This report provides strategies and resources for transit agencies to recruit and retain minorities for chief executive officer positions, assesses the industry's recruitment processes, and outlines the benefits of diversity.

2011; 43 pp.; TRB affiliates, $30.75; nonaffiliates, $41. Subscriber category: administration and management.

Video Surveillance Uses by Rail Transit Agencies
TCRP Synthesis 90

Passenger rail agencies' use of electronic video surveillance technology on board rail cars and along rights-of-way is explored in this synthesis.

2011; 79 pp.; TRB affiliates, $39.50; nonaffiliates, $52. Subscriber categories: public transportation; safety and human factors; security and emergencies.

TRB PUBLICATIONS *(continued)*

Use and Deployment of Mobile Device Technology for Real-Time Transit Information
TCRP Synthesis 91

This synthesis examines the use and deployment of real-time transit information on mobile devices. It explores the technology and resources required to generate and disseminate information, the characteristics of the information, and the role of mobile messaging in communications strategies.

2011; 78 pp.; TRB affiliates, $36.75; nonaffiliates, $49. Subscriber categories: public transportation; data and information technology.

Impact of Jet Fuel Price Uncertainty on Airport Planning and Development
ACRP Report 48

This report helps airport operators and planners measure the impact of jet fuel price changes on supply and demand for commercial air service. Included are background research, a computer model, and a user manual.

2011; 61 pp.; TRB affiliates, $42; nonaffiliates, $56. Subscriber category: aviation.

Improved Models for Risk Assessment of Runway Safety Areas
ACRP Report 50

Research is presented on aircraft veer-offs, declared distances, the engineered material arresting system, and a risk approach for consideration of obstacles in the runway safety area. An interactive risk analysis tool is included on CD-ROM.

2011; 168 pp.; TRB affiliates, $54.75; nonaffiliates, $73. Subscriber categories: aviation; safety and human factors.

Risk Assessment Method to Support Modification of Airfield Separation Standards
ACRP Report 51

This report provides guidance on modifying standards when design criteria for separations between taxiways and taxi lanes and other fixed or movable items cannot be met.

2011; 136 pp.; TRB affiliates, $45; nonaffiliates, $60. Subscriber category: aviation.

Wayfinding and Signing Guidelines for Airport Terminals and Landside
ACRP Report 52

This report offers tools to help passengers find their way in and around airports—roadways, parking areas, curbside and ground transportation areas, and terminals. The guidelines include tips for developing a wayfinding strategy and for using technology and visual displays.

2011; 244 pp.; TRB affiliates, $54; nonaffiliates, $72. Subscriber category: aviation.

Airport Self-Inspection Practices
ACRP Synthesis 27

By examining airport practices successfully implemented by regional Federal Aviation Administration personnel, this synthesis provides insight into common airport self-inspection practices: training; inspecting; reporting discrepancies and findings; follow-up, resolution, and close-out; and quality control.

2011; 111 pp.; TRB affiliates, $42.75; nonaffiliates, $57. Subscriber categories: aviation; maintenance and preservation.

Investigating Safety Impacts of Energy Technologies on Airports and Aviation
ACRP Synthesis 28

This synthesis explores the impacts of interference from energy technologies on the physical, visual, and communications systems of airports and aviation, focusing on the effects of solar photovoltaic panels and farms, concentrating solar power plants, wind turbine generators and farms, and traditional power plants.

2011; 39 pp.; TRB affiliates, $30.75; nonaffiliates, $41. Subscriber categories: aviation; energy; security and emergencies.

Feasibility of a Consolidated Security Credential for Persons Who Transport Hazardous Materials
HMCRP Report 6

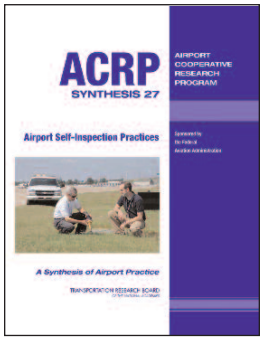
This report reviews options for consolidating several security credentials into a single credential for all transportation modes, evaluates the credentialing system, and identifies the elements of the credential vetting processes.

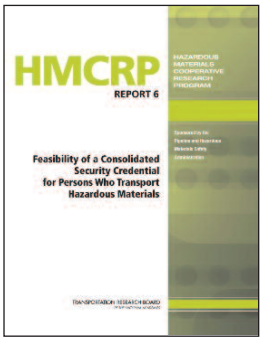
2011; 76 pp.; TRB affiliates, $39; nonaffiliates, $52. Subscriber categories: marine transportation; motor carriers; freight transportation; policy.

Soil Mechanics 2011
Transportation Research Record 2212

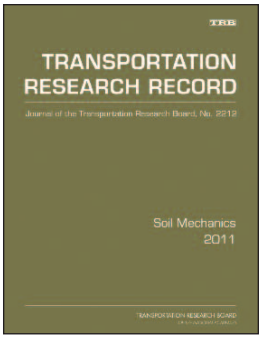
Research is presented on the acceptance of geomaterials, water jetting to mitigate defects in drilled shafts, field testing a batter pile group foundation, geosynthetic-reinforced soil abutments on soft soil, cement-treated base materials with a high content of reclaimed asphalt pavement, and other topics.

2011; 130 pp.; TRB affiliates, $49.50; nonaffiliates,





TRB PUBLICATIONS *(continued)*



$66. Subscriber category: geotechnology and pavements.

Highway Safety Management; Safety Workforce Development; School Transportation
Transportation Research Record 2213

The papers in this volume address such topics as sustainable safety, road safety policies, managing safety in traffic analysis zones, mitigating real-time hazards on urban expressways, traffic safety training for local agency staff and officials, and school travel mode choice.

2011; 104 pp.; TRB affiliates, $44.25; nonaffiliates, $59. Subscriber category: safety and human factors.

Aviation 2011
Transportation Research Record 2214

Addressing and benchmarking variations in airport demand, the effect of disruptions on airline industry service quality and market share, simple sensors for measuring service times and counting pedestrians, and the impacts of the Eyjafjallajökull volcanic eruption in 2010 are among the topics explored in this volume.

2011; 151 pp.; TRB affiliates, $52.50; nonaffiliates, $70. Subscriber category: aviation.

Information Systems, Geographic Information Systems, and Advanced Computing 2011
Transportation Research Record 2215

The 12 papers in this volume examine an enterprise information management system for transportation right-of-way activities, identifying transit alignments, location privacy policy, multidimensional data mining of traffic anomalies, earthwork computation methods, and other topics.

2011; 61 pp.; TRB affiliates, $45.75; nonaffiliates, $61. Subscriber category: data and information technology.

Transit 2011, Vol. 1
Transportation Research Record 2216

Research is presented on subjects such as transit bus emissions, regularity of service, passenger flow patterns, measuring and controlling subway fare evasion, contactless bank cards as fare media, ferry systems, and intermodal services for special events.

2011; 181 pp.; TRB affiliates, $55.50; nonaffiliates, $74. Subscriber categories: public transportation; administration and management; passenger transportation.

Transit 2011, Vol. 2
Transportation Research Record 2217

Authors present research on the impact of gasoline prices on transit ridership; real-time transit information; sky train ridership in Phnom Penh, Cambodia; a web-based transit trip-planning system; mobile transit information; and other topics.

2011; 167 pp.; TRB affiliates, $52.50; nonaffiliates, $70. Subscriber categories: public transportation; planning and forecasting; passenger transportation.

Transit 2011, Vol. 3
Transportation Research Record 2218

The 10 papers in this volume explore yield-to-bus electronic warning signs on transit buses, reserved bus lanes, a life-cycle cost tool for transit buses, high-coverage point-to-point transit, accessible transportation and the built environment on college campuses, and more.

2011; 97 pp.; TRB affiliates, $41.25; nonaffiliates, $55. Subscriber categories: public transportation; passenger transportation.

Transit 2011, Vol. 4
Transportation Research Record 2219

Research is presented on topics that include managing trams and traffic at intersections with hook turns, context-sensitive design concepts for streetcar electrification, rail transit safety, unrestricted shared rail use, and electric power supply for commuter rail.

2011; 103 pp.; TRB affiliates, $44.25; nonaffiliates, $59. Subscriber categories: public transportation; passenger transportation; rail.

Maintenance and Preservation of Structures and Equipment
Transportation Research Record 2220

The papers in this volume examine identification and tracking of highway bridge maintenance, the effects of concrete mix on the initiation of reinforcement, corrosion and chloride threshold level, bridge maintenance in New York City, and more.

2011; 98 pp.; TRB affiliates, $44.25; nonaffiliates, $59. Subscriber categories: maintenance and preservation; bridges and other structures; vehicles and equipment.

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INFORMATION FOR CONTRIBUTORS TO

TR NEWS

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

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

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

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

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

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

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

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

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

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

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