TR NEWS

NUMBER 272 JANUARY–FEBRUARY 2011

3

11

34

COVER: PenAir Grumman Goose, an amphibious aircraft, arrives at Akutan Airport in Alaska's Aleutian Islands. TRB partnership visits and contacts gather and share information and developments in every state. (Photo: Rebecca Cronkhite, Alaska Department of Transportation and Public Facilities)

TR NEWS

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

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

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

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

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

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

ALSO IN THIS ISSUE:

COMING NEXT ISSUE

A feature article in the March–April 2011 *TR News* examines the problem of young impaired drivers, including the effect of underage drinking laws on alcohol-related fatal crashes. Two other features report on innovative approaches applied in the reconstruction of an expressway through St. Louis, Missouri, and the construction of a crosstown expressway in Oklahoma City. Photographic highlights present a sampling of the array of topics and speakers at sessions, workshops, exhibits, and events from TRB's 90th Annual Meeting—which set a new attendance record.

TRB 2010 Executive Committee Chair Michael R. Morris and Executive Committee member Beverly A. Scott (*lower right*) deliver an informal pep talk to students from TransTech Academy, Cardozo Senior High School, Washington, D.C., at the 2011 Annual Meeting.

INVESTING IN THE TRANSPORTATION LEADERS OF TOMORROW

The University Transportation Centers Program

Editor's Note: This feature article was assembled by staff at the Research and Innovative Technology Administration, working with staff at competitively selected University Transportation Centers. For acknowledgments of the contributors, see page 10.

The ATLAS is a massive, 70-ton machine—its name expresses its powerful utility. The Accelerated Transportation Loading ASsembly tests the limits of some of the world's strongest, most advanced transportation materials. Pavement systems designed to withstand hundreds of thousands of landings by commercial aircraft or rail ties engineered to carry the massive hauls of freight trains are subjected to immense pressures to gauge their durability. The data from ATLAS help engineers design materials that will define transportation now and in the future.

ATLAS is more than a marvel of engineering—it is an example of the cutting-edge work under way at universities across the country through the University Transportation Centers (UTC) program. Managed by the Research and Innovative Technology Administration (RITA), in partnership with the Federal Highway Administration (FHWA) and the Federal Transit Administration (FTA), the UTC program has a dual mission:

- To conduct innovative transportation research and
- To train and educate transportation professionals.

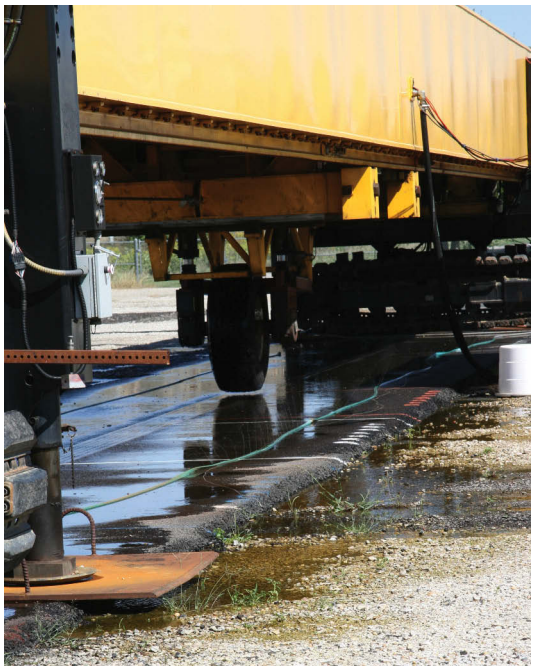
The ATLAS is located at the University of Illinois' Advanced Transportation Research and Engineering Laboratory facility, 15 miles north of Urbana (*1*). It exemplifies the state-of-the-art technology necessary to create a modern, resilient transportation system that will endure for generations.

RITA is working to ensure that U.S. transportation research and education investments effectively address national priorities and produce solid results for all Americans. This effort involves partnering with the academic community at 136 colleges and universities participating in the UTC program, to advance multidisciplinary transportation research and to educate the next generation of transportation professionals.

"UTCs capture the spirit of ingenuity and innovation that drives American progress," notes RITA Administrator Peter H. Appel—"bright minds working together to find solutions that inspire and change the world for the better."

At the 2011 TRB Annual Meeting, RITA Administrator Peter H. Appel (*left*) held an informal discussion for students interested in transportation careers (*photo above*). Along with developing research across transportation modes, the UTC–RITA partnership also educates and supports up-and-coming professionals.

Researchers at the University of Illinois' Advanced Transportation Research and Engineering Laboratory (ATREL) employ the behemoth ATLAS to conduct strength and durability tests on high-use pavements for airports or railways.



Encouraging Collaboration

UTCs focus on issues aligned with the priorities of the U.S. Department of Transportation (DOT) and work with regional, state, and local agencies to find solutions to the transportation issues affecting their communities. The project selections and products are peer-reviewed, and the results are shared through the TRID[1] (formerly the Transportation Research Information Services) and Research in Progress[2] databases—housed on the Transportation Research Board (TRB) website—and through other forums that encourage collaboration. During the past three years, UTC colleges and universities have completed a range of activities (see table, below).

[1] http://trid.trb.org.
[2] http://rip.trb.org.

TABLE 1 UTC Performance Measures, 2006–2009

Total number of UTC research projects	1,455
Total number of UTC research reports published	1,267
Total number of UTC presentations on ongoing and completed research	2,212
Total UTC students involved in transportation research	6,730
Total transportation-related master's degrees awarded	4,826
Total transportation-related PhD degrees awarded	489
UTC transportation seminars, symposia, and distance learning classes presented	3,004
Number of transportation professionals participating in UTC transportation seminars, symposia, and distance learning classes	142,272
Number of Research in Progress UTC projects	1,907
Number of UTC TRID entries	1,677
Total dollars of research funded ($ millions)	$169.2

U.S. DOT funding for UTC programs represents only a fraction of the financial support received by participating institutions for transportation research and education. Responsible for providing 100 percent matching funds, UTCs are inherently collaborative entities. The centers are encouraged to partner with other transportation stakeholders in pursuing local, regional, state, and national goals. The partnerships ensure that each federal dollar invested in a UTC is leveraged toward the highest possible return in value for the transportation system.

Partners for Solutions

Each year, state transportation agencies prioritize projects, programs, and services to accommodate budget constraints and limited resources. This balancing act has implications for the operation, development, and maintenance of transportation systems. At the same time, the American Recovery and Reinvestment Act and the Transportation Investments Generating Economic Recovery grants are financing transportation projects nationwide—increasing demand for expertise across transportation disciplines. This challenging environment highlights the relevance of UTCs and the value of state partnerships with universities and colleges.

UTCs offer cooperative research and technology transfer that can help achieve the goals of State Planning and Research programs. Following are examples of UTC collaborations with state transportation agencies to address local and regional issues.

Road Safety Resource

The Center for Advanced Infrastructure and Transportation (CAIT) at Rutgers, the State University of New Jersey, has built a strong relationship with New Jersey DOT. For example, CAIT's Transportation Safety Resource Center (TSRC) offers statewide resources, including road safety audits, crash analyses, outreach and marketing materials, and training for traffic safety workers (2). By providing a range of engineering and technical services to state decision makers, TSRC has proved itself an asset in the design and implementation of safety programs.

TSRC has developed a web-based software application, Plan4Safety, to assist safety and law enforcement professionals in analyzing traffic crashes. The software incorporates crash records and related data since 2003 and serves as a tool for identifying dangerous intersections and other elements of the road environment that contribute to vehicle crashes.

Developed and maintained in concert with engineers from CAIT and New Jersey DOT, the partnership has produced data that can improve traffic and roadway safety efforts in other states as well.

Plan4Safety received the FHWA National Road Safety Award in 2009 and was cited in FHWA's High-Risk Rural Road Project as an effective tool for transportation planning.

Highway Planning for Tribal Agencies

Located at North Dakota State University, the Mountain–Plains Consortium (MPC) includes five universities in North Dakota, Utah, South Dakota, Colorado, and Wyoming, and is working with regional, state, and local governments to address the unique challenges facing transportation planners in the U.S. Mountain West.

Strengthening the highway planning capabilities of tribal agencies is one of the challenges. The geographic region covered by MPC encompasses a significant proportion of the lands owned by the 564 federally recognized Native American tribes in the United States. These holdings include more than 94,000 miles of Indian Reservation Roads (IRR), jointly managed by FHWA's Federal Lands Highway program and the U.S. Department of the Interior's Bureau of Indian Affairs. Extensive modernization, operational improvements, and maintenance are needed to transform these roads into systems that support the safety, livability, and economic needs of Native American communities.

Although the IRR program funds the design, construction, and maintenance of the roadways, the tribes need to be equipped with the planning, expertise, and analytic tools applied by state transportation agencies. A lack of effective tribal outreach and of innovative technology transfer exacerbates the issues. The MPC member universities—Colorado State University, North Dakota State University, South Dakota State University, the University of Utah, and the University of Wyoming—are collaborating with federal, state, and tribal agencies to address barriers to the modernization of the IRR systems and infrastructure across the region (3).

The initial objective is to familiarize tribal planners with the types of highway data and models used by state and federal governments, to improve understanding of the analyses conducted and the data collected. The Highway Economic Requirements System and the Highway Performance Monitoring System were used in analyzing state highways that pass through reservations, and the initial results were presented. As a result, tribal planners can communicate more effectively with state planners and can understand how states analyze the needs of highways.

Connecting Colonias

Approximately 2,400 colonias—Spanish for neighborhoods—along the Texas–Mexico border are home to more than 500,000 people. The sprawling rural settlements often lack the basic needs most people take for granted, including running water, sewage systems, and electricity. Most of the residents are economically disadvantaged Mexican-Americans who often do not have ready access to education and medical care. Their isolation is exacerbated by the lack of transportation options.

In 1991, the Texas A&M University Center for Housing and Urban Development (CHUD) began a project to improve the lives of impoverished people in colonias along the Texas border. The Colonias Program sought to promote "community self-development"—that is, involving the residents in activities to improve the social infrastructure. A core need was for transportation to the community centers in the colonias, as well as to other towns.

The Southwest Region University Transportation Center (SWUTC), housed at Texas A&M in conjunction with the University of Texas at Austin and Texas Southern University, joined with CHUD in 1997 and funded a project to explore transportation issues and solutions. After evaluating the needs of the colonias, SWUTC researchers developed a demonstration project, supplying a 15-passenger van for transportation service to and from a community center in El Cenizo, a colonia in Webb County.

Photo: Carissa Sestito, CAIT

Team leader Roden Lightbody calls attention to the retroreflectivity, clutter, and driver visibility of road signs during a road safety audit conducted for New Jersey DOT by the Center for Advanced Infrastructure and Transportation at Rutgers, the State University of New Jersey.

Photo: SWUTC

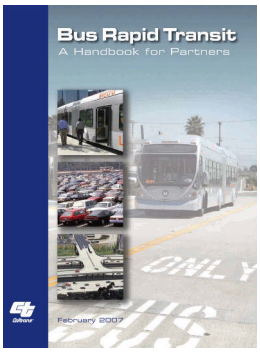
A 15-passenger van that provides transportation for colonia residents in Willacy County, Texas, through a project supported by the State Energy Conservation Office and Texas A&M University.

Photo: Institute for Transportation, Iowa State University

Iowa State University graduate assistant Stewart McCoy describes *Go!* and its mission to then-Governor Chet Culver at the Iowa Science and Mathematics Teacher Educators Summit at Grinnell College.

The success of the pilot program prompted SWUTC and CHUD to approach the State Energy Conservation Office (SECO) to buy additional passenger vans for established centers in the colonias. Through a multiyear SECO contract administered by SWUTC, the pilot project has been replicated many times, and the program has purchased 31 vans (*4*). The vehicles have provided more than 2 million passenger miles of travel annually for medical and dental care, adult education, infant and geriatric services, recreation, employment, and economic development initiatives for colonia residents.

"Many of these residents who don't have a vehicle now have the opportunity to become part of the community by being able to make use of some of the community services at the resource centers," says Robert Otto, a former program administrator with SECO. "The resource centers are a gathering place for the people in each community." As a result of the program, thousands living in South Texas colonias have greater access to critical services and economic opportunities.



The Mineta Transportation Institute at San José State University helped California DOT develop a guidebook on bus rapid transit for its employees.

Facilitating Bus Rapid Transit

Many consider bus rapid transit (BRT) a key ingredient in future transit system management. BRT applies intelligent transportation systems technology, operational strategies, and innovative transit planning to improve mobility and livability in metropolitan areas. As urban communities seek to develop and deploy BRT systems, research into best practices and lessons learned becomes critical for design, implementation, and operation. The Mineta Transportation Institute (MTI) at San José State University has worked with California DOT (Caltrans) to create a guide for the deployment of BRT systems statewide (*5*).

In April 2005, the Caltrans Division of Research and Innovation asked MTI to assist with the research and publication of a guidebook for Caltrans employees who work with local transit agencies and jurisdictions in planning, designing, and operating BRT systems that involve state facilities. The guidebook, *Bus Rapid Transit: A Handbook for Partners*, assists transit operators, local governments, community residents, and other stakeholders in the development of BRT systems (*6*). The guidebook draws on active BRT projects in San Diego, Los Angeles, San Francisco, and Alameda County, explores their efforts, identifies changes that are needed in statutes and policies, and outlines other state concerns.

In addition to the case studies of major BRT projects in California, the MTI team examined several other programs in development around the state. The effort clarified issues to be addressed in the guidebook and compiled information that assisted in identifying needs and emerging issues for legislative or regulatory action and for Caltrans to address through district directives or internal measures.

Workforce Development

The transportation research at every UTC involves a dedicated group of students and faculty who work on projects across the spectrum of disciplines. UTC students typically are dedicated to finding solutions to transportation issues—they represent the next generation of transportation professionals and decision makers. Reflecting the diversity that characterizes the U.S population, the students have taken many different paths to arrive at their career choice. Nonetheless, the number of Americans who are choosing careers in transportation or in related fields such as engineering, science, and mathematics is not keeping pace with the nation's needs.

The U.S. transportation workforce is undergoing fundamental changes. Up to 50 percent of the workforce is expected to retire in the next 10 years; their successors, moreover, need to develop new skills in response to new and emerging areas of expertise.

High-speed rail exemplifies the gap between the nation's needs and capabilities. In the past four decades, Europe, Japan, and China have invested heavily in high-speed rail; as a result, jobs in designing, building, and operating high-speed rail networks have grown overseas, while similar careers have faded in the United States.

Expanding Skills and Disciplines

The initial $10 billion federal investment in a nationwide high-speed rail network has provided an opportunity to establish a foundational education program to develop the expertise needed for high-speed rail

and other critical elements of the 21st century transportation system. Bringing the transportation infrastructure into a state of good repair and deploying systems crucial to modernization—such as NextGen air traffic control and intelligent transportation systems—is an ambitious undertaking that will demand all of the nation's knowledge and ingenuity.

"The U.S. transportation system will depend on a highly skilled and multidisciplinary workforce to meet the challenges of the 21st century," states RITA Deputy Administrator Robert Bertini. "The UTC program has been and will continue to be a key part of our national strategy."

UTCs are establishing programs and partnerships to spark interest in transportation careers and to support those who choose to enter the field. Since 2008, through a joint initiative of the Council of University Transportation Centers (CUTC) and RITA, individual UTCs have sponsored regional workforce development summits to engage local, regional, and national partners in addressing the transportation workforce challenge (*7*).

The future transportation workforce will depend not only on efforts to increase interest among students but also on the expansion of outreach to women, people of color, and other groups traditionally underrepresented in the transportation community.

Magazine for Teens

Encouraging teenagers and young adults to consider a career in transportation requires creative outreaches to raise their awareness, particularly about the importance of transportation to communities; these outreaches are an essential part of the national workforce development strategy. The Institute for Transportation at Iowa State University, for example, publishes a free, online magazine dedicated to making transportation—and transportation careers—relevant to teenagers.

Go! magazine features articles on every element of transportation, from profiles and personal experiences of people who design transportation systems to stories about cities developing green transit (*8*). Published monthly, *Go!* holds contests to encourage young readers to participate and think critically about transportation challenges—such as a "Design your own maglev" contest. In August 2010, *Go!* staff presented the magazine's mission at the Iowa Science and Mathematics Teacher Educators Summit, hosted by the Iowa Math and Science Partnership at Grinnell College, Grinnell, Iowa (*9*).

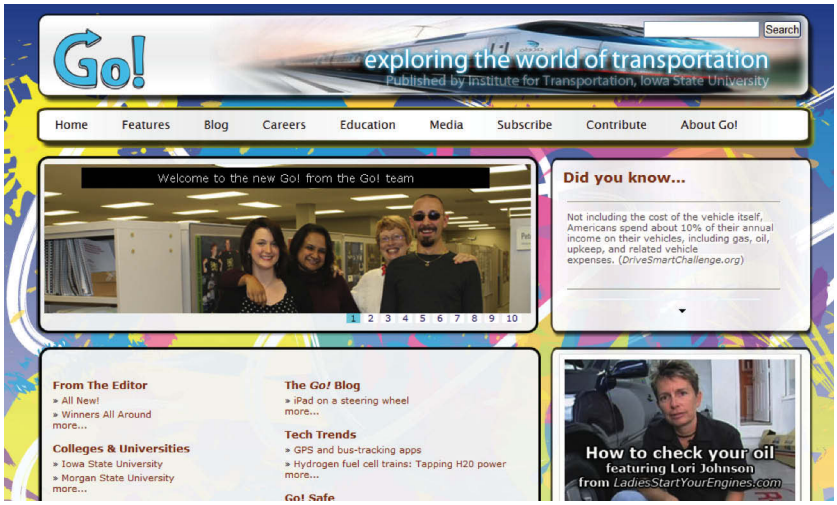
Assisting Teachers

The University of Nebraska, lead member of the Mid-America Transportation Center (MATC),[3] created the annual Professional Development Science and Math Summer Technology Institute in 2006 to help teachers foster interest in transportation careers among secondary school students. The Nebraska Department of Education organizes and hosts the summer program.

Teachers are on campus for three days in June and in August for intensive training in engineering concepts and their implementation. At both sessions, faculty from the university's departments of education and engineering lead workshops on building student awareness of the positive impacts of engineering (*10*).

The workshop in June introduces teachers to the field of transportation engineering through a variety of presentations, tours, and other activities. In one workshop, teachers develop lesson plans for introducing transportation engineering concepts to students.

[3] Other members are Missouri University of Science and Technology, Kansas State University, University of Kansas, University of Iowa, Lincoln University, and Prairie View A&M University.



The monthly online magazine *Go!*, published by the Institute for Transportation at Iowa State University, introduces teenagers to transportation issues and careers.

Nadia Gkritza discusses the recruitment of female students to the fields of science, technology, engineering, and mathematics at the Midwest Transportation Consortium Workforce Summit.

Photo: Wikimedia Commons

A sign on westbound I-696 in Michigan uses both the Clearview typeface (for the text) and Highway Gothic typeface (for the shields). Clearview was developed from research performed at Pennsylvania State University's Pennsylvania Transportation Institute.

Before heading back to school, teachers test their lesson plans on junior high and high school students at the August session. In addition to technical assistance and support in creating lesson plans, the institute provides funds for purchasing curriculum-related classroom materials.

Mary Herrington, a science teacher at Culler Middle School in Lincoln, Nebraska, has witnessed how the institute's approach has sparked student interest in transportation. "All the lessons have a real-world connection," Herrington notes. "The curriculum builds interest and excitement about engineering and technology."

Sponsors for the Summer Technology Institute include MATC, Nebraska's Coordinating Commission for Postsecondary Education, U.S. DOT, and the Garrett A. Morgan Technology and Transportation Futures Program.

Multidisciplinary Research

Robust, multidisciplinary transportation research is a hallmark of the UTC program. Investing in forward-thinking research not only will lead to innovative solutions to critical transportation problems but also will provide crucial experience for the transportation professionals who will grapple with emerging issues in the coming decades.

Readable Signs

Sometimes the simplest solution is the most practical. An example is the Clearview Typeface System, developed through a decade of research by a multidisciplinary team of psychologists, traffic engineers, type designers, graphic designers, vision experts, and optics engineers at the Pennsylvania Transportation Institute, Pennsylvania State University.

The Clearview font increases the legibility of traffic control signage and devices by 20 percent, compared with the FHWA's standard Highway Gothic font. Clearview employs a special spacing of letters and mitigates the adverse nighttime effects caused by headlights. The font improves driver recognition of the messages and minimizes distraction—definite safety benefits.

After two studies conducted by the Texas Transportation Institute, FHWA granted interim approval of the Clearview typeface for all public streets, highways, and byways in 2004 (*11*). Clearview currently is featured on new highway signs throughout Texas and Canada and along Routes 32 and 80 in Pennsylvania.

Assisting Disabled Riders

Persons with disabilities and the elderly often depend on public transportation and transit. The National Center for Transit Research (NCTR) at the University of South Florida (USF) has developed a travel assistance device (TAD), tested by Hillsborough Area Regional Transit Authority (HART).[4] The TAD applies Geographic Positioning System technology in cell phones to assist cognitively disabled riders and new transit riders with recognizing their stops and exiting the bus at the appropriate time and place (*12*).

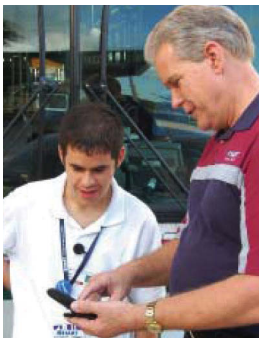
The TAD software is installed on a personal cell phone. The transit rider or travel trainer visits the TAD website, which features a Google Maps–style interface for trip planning, and selects the route, location, stop, and travel times. The trip plan downloads automatically into the user's cell phone.

The software application on the cell phone gives the transit rider two alerts after boarding the bus. The first is a verbal announcement saying, "Get ready," issued a few stops before the destination. The phone also vibrates and displays a text message, to accommodate seeing- and hearing-impaired users. The second alert tells the rider to pull the stop-request cord, issuing the cell phone prompt, "Pull the cord now."

The NCTR team conducted tests with six developmentally disabled 18- to 22-year-old special education transitional students in April and May 2008. The 12 test trips included two different bus routes for each student. The students disembarked at the planned destinations successfully each time.

"Having a travel trainer accompany on the buses creates a sense of security and comfort for a developmentally disabled patron," observes Mark Sheppard, a travel trainer with HART. "A TAD in their pocket is the next best thing to having the travel trainer beside them."

USF has licensed the TAD to a Florida company, Dajuta, LLC, which will handle the daily operation and support of the system and will train travel



Developed by the National Center for Transit Research at the University of South Florida, Travel Assistance Device software can be installed on a user's cell phone and provides safe transit riding assistance for persons with disabilities and the elderly.

[4] Editor's Note: Seed funding and advice for the early TAD research were provided through TRB's Transit Innovations Deserving Exploratory Analysis (IDEA) Program (Project 52).

instructors in the use of the TAD. Dajuta officials have stated that the cost savings, increased bus ridership, and ability to empower people to travel independently make TAD a "win–win."

Sheppard agrees: "The biggest challenge we face in training disabled riders on the fixed-bus routes is their ability to remember when to pull the cord to get off the bus. The TAD solves this challenge by giving riders voice, text, and vibration alerts that remind them when to take action."

Bike Sharing

As urban communities across the United States grapple with traffic congestion, air quality issues, and eroding livability, many transportation agencies are exploring bike-sharing programs. For example, the Southeastern Transportation Center (STC), working with Tennessee DOT, the University of Tennessee, and Currie Technologies, is seeking to develop and evaluate the nation's first automated sharing system for e-bikes, or electric bicycles, on the campus of the University of Tennessee, Knoxville (*13*). E-bikes are powered with a rechargeable battery and electric motor in tandem with the rider's pedaling and can achieve top speeds of 15 to 20 miles per hour, offering an efficient and environmentally sustainable alternative to automobiles and transit vehicles.

The pilot test in spring 2011 will feature two stations with 20 shared bicycles—a mix of e-bikes and traditional models. The research team consists of faculty and students from the STC and corporate researchers from Biosystems Engineering. The research team is also working with Currie Technologies, makers of IZIP e-bikes, to develop an integrated system.

UTC Spotlight Conference

RITA partners with TRB to sponsor an annual UTC Spotlight Conference, which brings together the UTC community, industry, and federal, state, and local government agencies to focus on a salient transportation issue and identify needed research. The results can inform policy decision making, and the program is intended to facilitate communication and coordination among the academic community, government, and industry.

The 2010 conference focused on Transportation Systems for Livable Communities. Research into the impact of transportation on community livability is under way in many areas and among a diverse array of stakeholders. The diversity of facts and opinions on the topic pose a challenge for all.

Linking transportation to livable communities has become a key national priority for transportation policy. The outcome of the 2010 spotlight conference will guide related research by universities, U.S. DOT, and industry and through TRB.

Photo: University of Tennessee, Knoxville

Chris Cherry, University of Tennessee, Knoxville, shows students from Transportation Academy 2010 how to ride an electric bicycle, or e-bike. The university is piloting an automated sharing system for the battery-powered bicycles.

UTC Program's Future

RITA is working to increase the cross-modal focus of the U.S. DOT's research agenda and to create institutional mechanisms that promote coordination and communication among the modes of transportation, while developing tools to bolster coordination and communication among RITA partners.

These efforts have implications for the UTC program and how research partners inside U.S. DOT and in the transportation community collaborate, share information, and produce tangible solutions to current, emerging, and anticipated challenges that affect national transportation goals.

RITA's Office of Research, Development, and Technology is developing a web-based platform to facilitate collaborative research among U.S. DOT researchers and partners and to optimize the results of research studies across disciplines. The Web 2.0 platform will support 14 research clusters that will share information and identify areas for collaboration.

RITA has embraced workforce development as a

Rebecca Sanders, University of California, Berkeley, discusses her research on pedestrian and bicyclist safety at the Transportation Systems for Livable Communities Conference at the National Academies' Keck Center in October.

Beth Osborne, Deputy Assistant Secretary for Transportation Policy, U.S. DOT, spoke about the department's vision for the future of livable communities at the October UTC Spotlight conference.

priority for the transportation system. Working with U.S. DOT modal partners, RITA is developing a focused and data-informed workforce strategy, responding to the needs of current and future employees and of the entire transportation workforce.

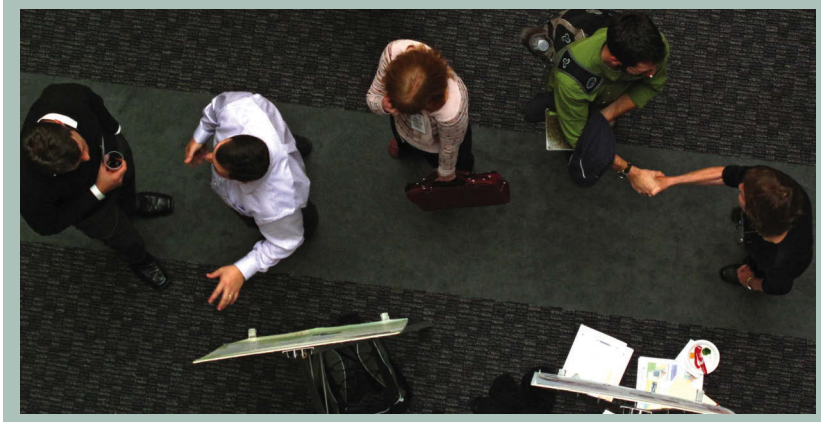
The workforce initiative recognizes the uniqueness of specific occupations in each mode and embraces both the short- and long-term workforce challenges, as well as cross-modal, multidisciplinary, and career life-cycle dimensions. The transportation workforce initiative now has representatives from seven operating administrations of U.S. DOT—rail, highways, transit, aviation, maritime, motor carriers, and pipelines—creating a comprehensive effort.

UTCs capture the spirit of enterprise and innovation that has characterized American progress—bright-minded people of all ages working together. The UTC program invests in the ideal that the nation's colleges, universities, and institutes have the capability to create groundbreaking, innovative solutions that inspire and ultimately change the world for the better. In the process, students gain the expertise and experience to effect change as they forge careers as multidisciplinary transportation professionals. UTC programs across the country are an investment that will pay dividends for decades.

The projects and the research cited in this article are a small sample of the work undertaken in the academic community through the UTC program. More information about institutions supported by the UTC program, including links to projects around the country, can be found at http://utc.dot.gov/.

UTC Spotlight Conferences at a Glance

2010	Transportation Systems for Livable Communities
2009	Infrastructure Preservation and Renewal
2008	The Impact of Changing Demographics on the Transportation System
2007	Research Issues in Freight Transportation: Congestion and System Performance
2006	Research Opportunities in Radio Frequency Identification (RFID) Transportation Applications



The UTC spotlight conferences offer opportunities to gain and exchange information and to network.

Acknowledgments

The Research and Innovative Technology Administration (RITA) thanks Jason Melvin, technical writer in RITA's Office of Governmental, International, and Public Affairs, and the competitively selected University Transportation Centers that were invited to submit information for this article. In particular, RITA acknowledges the contributions of Shashi Nambisan, Iowa State University; Denver Tolliver and John MacGowan, North Dakota State University; Martin Pietrucha and Philip Garvey, Pennsylvania State University; Allison Thomas, Rutgers University; Karen Philbrick, San José State University; Dock Burke and Oscar Munoz, Texas A&M University; Sean Barbeau, Nevine Georggi, and Ralph Winter, University of South Florida; Lindsay Mayo Fincher and Larry Rilett, University of Nebraska; and Chris Cherry and Lissa Gay, University of Tennessee.

References

1. Illinois Center for Transportation. http://ict.illinois.edu/.
2. Rutgers Center for Advanced Infrastructure and Transportation, Transportation Safety Research Center. http://cait.rutgers.edu/tsrc.
3. National Local Technical Assistance Program and Tribal Technical Assistance Program. http://www.ltap.org/.
4. *Transit Services for Sprawling Areas with Relatively Low Demand Density: A Pilot Study in the Texas Border's Colonias*. Texas Transportation Institute. http://tti.tamu.edu/projects/project_details.htm?id=3325.
5. Mineta Transportation Institute. http://transweb.sjsu.edu/.
6. Gray, G., N. Kelley, and T. Larwin. *Bus Rapid Transit: A Handbook for Partners*. Mineta Transportation Institute, College of Business, San José State University, San José, California, June 2006. http://transweb.sjsu.edu/MTIportal/research/publications/summary/0602.html.
7. *Workforce Development*. Council of University Transportation Centers. http://cutc.tamu.edu/workforce.html.
8. *Go! Exploring the World of Transportation*. Institute of Transportation, Iowa State University, Ames. www.go-explore-trans.org/.
9. Midwest Transportation Consortium. http://www.intrans.iastate.edu/mtc/index.htm.
10. Mid-America Transportation Center Summer Institute. http://matc.unl.edu/summer_institute/.
11. *MUTCD: Interim Approval for Use of Clearview Font for Positive Contrast Legends on Guide Signs*. Federal Highway Administration, September 2, 2004. http://mutcd.fhwa.dot.gov/res-ia_clearview_font.htm.
12. Travel Assistant Device (TAD) Aids Transit Riders with Special Needs. *UTC Spotlight*, November 2008. http://utc.dot.gov/publications/spotlight/2008_11/html/spotlight_0811.html.
13. Southeastern Transportation Center. http://stc.utk.edu/.

FINDINGS FROM THE TRANSPORTATION RESEARCH BOARD'S
2010 STATE PARTNERSHIP VISITS PROGRAM

Enhancing Customer Service Despite Cutbacks

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

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

Although the nation's economic outlook improved slowly during 2010, state revenues and budgets lagged behind. The Fiscal Survey of States, released in late November 2010 by the National Governors Association (NGA) and the National Association of State Budget Officers, noted that states have reduced spending dramatically from $687 billion in Fiscal Year (FY) 2008 to $613 billion in FY 2010. According to NGA, 40 states made a total of $22 billion in midyear budget cuts in FY 2010.

Many state departments of transportation (DOTs) and other transportation agencies were forced to reduce staffing levels, institute hiring freezes, furlough employees, curtail travel, and freeze or reduce salaries. The state partnership visits by TRB staff in 2010, however, witnessed a transportation workforce that is more determined than ever to provide value and service to their customers. Individually and collectively, transportation agency staffers are combining hard work, dedication, and innovation to enhance customer service. A sampling of their extraordinary efforts follows.

Institutional Issues

Policy, Management, and Leadership

Transportation agency staff are relying on strategic management to maximize system performance, efficiency, and customer service with available resources. In states such as California, Florida, Minnesota, Missouri, New Mexico, Virginia, and Washington, transportation professionals are instituting and monitoring performance measurement systems that include quantitative and qualitative tracking of maintenance and operation costs, safety and system performance, and customer satisfaction.

Florida DOT's performance measurement system features a central repository for data collection and storage. To reduce the potential for input errors, the data are not entered manually and are loaded into secure folders, preventing changes or manipulation. Caltrans and Texas DOT also are using the software.

Photo: Chris Rossmiller, FHWA

Other planning initiatives under implementation in Montana include the rehabilitation of Glacier National Park's popular Going-to-the-Sun Road, scheduled to reopen in June 2011.

The system originally was designed for the Florida DOT Executive Board—unlike Virginia DOT's Dashboard performance reporting system, Florida's is not geared for public viewing. At first, five categories were monitored: safety, organization, system performance, production, and customer and market focus. This has expanded to 16, including transit, maintenance costs, right-of-way, and acquisition.

The measures are color-coded on the screen—green indicates a performance target reached, yellow indicates that the state is within 5 percent of meeting the target, and red indicates that the DOT is less than 95 percent of the way to meeting the target. Data can be viewed on a statewide or district basis.

The performance measurement effort at the Louisiana Department of Transportation and Development (DOTD) is called the Quality and Continuous Improvement Program. Now in operation for five years, the program generates reports to the governor monthly about each division's progress in meeting established performance measures. Strategic objectives are set every five years and adjusted every three years. Louisiana DOTD has developed a scorecard for departmental measures. Each executive's performance review examines the degree of success in meeting established performance goals.

Planning

Several transportation reauthorization proposals have emphasized the connections between transportation and livability. After the November 2010 elections, however, the future of this focus is in question. Nonetheless, discussions about livability have been informative for transportation agencies—in some cases, changing the understanding of agency staff about what customers want from the transportation system.

Planners for a state route improvement project in Montana accommodated a community's heavy use of snowmobiles.

Photo: Vicki Andersen

The discussions revealed that livability means different things to different residents and communities. Tribal governments and transportation officials, for example, have heard an emphasis on protecting environmental and cultural resources. In Montana, plans to improve a state route that serves as a main street for a northern community included sidewalks, curbs, and gutters. The planners quickly learned, however, that sidewalks were not a livability feature in a community with heavy snowmobile use—the community's definition of livability valued business access for snowmobiles.

Although livability may not be a focus in the upcoming legislation, the information gained in preparation for this initiative will assist in guiding the development of transportation systems that are more responsive to residents' needs.

Legal Issues

Funding limitations have raised challenges for new and ongoing contracts. Transportation agency lawyers are exploring innovative contracting methods to expedite construction, such as construction-manager-at-risk and design–build arrangements.

Other issues addressed by agency legal personnel in 2010 include the following:

- Employment law issues raised by staff cutbacks;
- The impact of furloughs, voluntary vacations, and retirements on state transportation workforces, projects, and infrastructure;
- Compliance with the recent amendments to the Americans with Disabilities Act;
- Challenges to outdoor advertising in the area around a right-of-way, questioning the constitutionality of outdoor advertising statutes and regulations—attorneys are researching the issue and informing government officials about how to avoid problems; and
- Concerns about the use of conservation easements to protect mitigation property—standard nonprofit conservation easements, designed primarily for private parties and federal tax compliance, generally do not fully meet the federal standards.

In addition, the Federal Highway Administration's (FHWA's) 2009 *Manual on Uniform Traffic Control Devices* introduced many changes from the previous edition. To many state DOT engineers and attorneys, some of the revisions allow less flexibility in applying engineering judgment to address unique or unusual circumstances in highway systems. Others note that compliance with some of the new measures may require substantial expenditures by states and municipalities—for example, for upgrading street signs. Some in the legal community and at state DOTs are seeking to have FHWA revisit these issues.

Photo: BP

Environmental damage caused by the *Deepwater Horizon* oil spill, which lasted nearly 4 months and released approximately 185 million gallons of oil, highlighted the need for safe ways to obtain oil and replacement energy sources.

Energy and Climate Change

Congress failed to pass a comprehensive carbon cap-and-trade bill in 2010 and is not expected to take up any far-reaching climate change legislation in 2011. The *Deepwater Horizon* oil spill in the Gulf of Mexico started on April 20 and eventually was capped on July 15, after the release of approximately 185 million gallons of oil. Safely obtaining oil, using oil in an environmentally safe manner, and developing new energy sources to replace petroleum appear to be intractable but critical problems.

Staff at transportation agencies across the country have taken actions to reduce government use of petroleum. Transportation agency operations are switching to alternative-fuel vehicles and to high-fuel-efficiency vehicles for construction, transit, and fleets. For example, Massachusetts DOT has procured efficient hybrid-electric and compressed natural gas vehicles for its fleet, has used funds from the American Recovery and Reinvestment Act (ARRA) to retrofit its on-road diesel light truck fleet with emission controls, and is pursuing a retrofit to make its hybrid-electric vehicles plug-in capable.

Photo: Massachusetts DOT

As part of a department-wide sustainability initiative, Massachusetts DOT has retrofitted four automobiles with plug-in capability.

A team from New York State DOT rehabilitated a culvert (*left*) near Labrador Hollow in Cortland County to protect salamanders crossing underneath the road. Using an old guide rail, the team built walls around the culvert to steer the salamanders safely through the passage (*right*).

PHOTOS: NEW YORK STATE DOT

In Connecticut, the Electric Vehicles Infrastructure Council has prepared recommendations for the state to accommodate the integration of electric vehicles. Operations personnel at agencies continue to improve the operation of transportation facilities to reduce energy consumption—measures include improved signal timing, managing travel lanes, reductions in idling, and providing commuters with alternatives to single-occupancy vehicle trips. Individually, these actions make a small difference, but combined across a region, a state, and the nation, they can have a major impact.

Environment

All state DOTs are dealing with staff reductions and with attrition through retirement. Maintaining the institutional knowledge related to state and federal environmental documentation, in particular, has proved problematic. Workers in several states are now trying to document their processes to assist the next generation of state environmental planners, as well as staff who have inherited environmental responsibilities because of reductions.

Water quality remains a dominant issue, particularly the application of Municipal Separate Storm Sewer System permit requirements. Culvert management and passages for protected aquatic species—particularly in areas designated as critical habitats—also are a water-related focus for states.

State environmental and construction personnel are working together to identify effective solutions for the recycling of construction and demolition materials. Potential changes in regulations may affect available options, such as using industrial fly ash in pavement construction.

Other environmental issues gaining attention include the management of aging bridges designated as historic properties; wildlife passages; tracking the spread and mitigation of invasive plant species along roadway corridors; and developing roadway management programs to accommodate changes in climate, particularly in coastal zones.

Data and Information Technologies

As the issues facing agencies increase in complexity, broader and more timely data are needed to support decision making. State information specialists are working to improve the quality and availability of data sources to support multiple customers and issues. In Minnesota and other states, for example, experts are developing formal business plans to assess the capability of available data sources to meet needs across the department and to ensure that data resource investments match the benefits.

Improving access to the data that serve multiple users within an organization and with partners is a continuing theme. Inventory data collection technologies are becoming more sophisticated. Collection activities can include extracting location features for referencing, including feature types, attributes, and condition.

Some systems integrate an array of business needs—such as transportation asset management, intelligent transportation systems, pavement management, bridge management, and system performance. Colorado has established a statewide traffic data committee to enhance sharing between the state and localities and to reduce duplication of collection activities.

Geographic information systems have been important tools for data sharing. Data professionals

Built in 1948, Bridge 5718 over the Kettle River in Minnesota is designated a historic bridge.

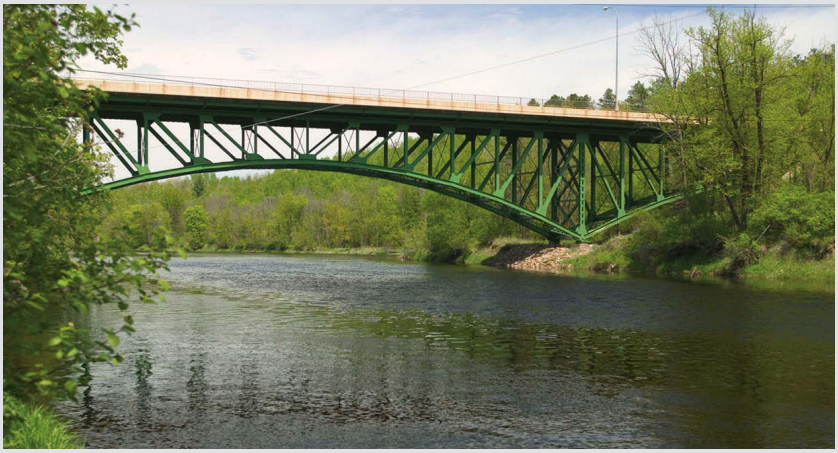


PHOTO: MINNESOTA DOT

in Kansas have developed the KGATE portal for the geographic analysis and display of key data throughout the department. Utah DOT has a similar application. The diversification of uses for spatial data is challenging the capabilities of the linear referencing systems developed a decade ago; some are working to reengineer these critical integration tools.

Aviation

Personnel in the Federal Aviation Administration (FAA) worked on a record 16th budget extension without a formal reauthorization of funding or a clear indication of when the new Congress may approve a longer-term FAA budget. Many state DOTs are cutting back or eliminating their funding for airport improvements and staff management, increasing pressures on state aviation budgets and workforces.

Nevertheless, the rollout of continuous improvements and upgrades under the Next Generation air transportation system initiative is proceeding, along with related safety and environmental programs. These include safety improvements for runway areas; local air quality and climate change mitigation; and investigations of alternative aviation fuels for jets and general aviation.

The implementation of new aviation security measures has stirred debate, revealing a need for better communication among all parties, including the Department of Homeland Security, FAA, airports, and aircraft operators. Improved communication is needed to enhance security measures and to coordinate response in emergencies, such as the disruption of the aviation system after the Eyjafjallajökull volcano eruptions in Iceland earlier in the year.

Freight Systems

Dramatically lower growth rates, tight credit markets, international trade and currency imbalances, and uncertainty continued to affect manufacturers, homebuilders, financial institutions, the public sector, consumers, and other drivers of freight service demand. Most freight transportation sectors showed some improvement during 2010, but none has regained the levels achieved in 2007.

Enterprises that anticipated and made adjustments before the recession and those that had the flexibility to adjust during the recession may have fared better than others. Most are responding to the economic strains through efforts to cut costs and improve efficiency.

The focus has turned from capital investment to research, development, and implementation of new approaches to improve operations—particularly through technological enhancements—and to expand capacity. The goal is to make capital assets more productive instead of investing in new assets.

Nonetheless, the nation's freight infrastructure continues to be inadequate for demands, according to many analysts, who point to the need to improve capacity in anticipation of the economic recovery. Several initiatives are under way to address capacity issues. The Heartland Corridor commenced operations in fall 2010, and other major freight projects—such as the National Gateway Project and the Crescent Corridor—are making progress. In addition, U.S. DOT announced approximately $1 billion in Transportation Investment Generating Economic Recovery (TIGER) and TIGER II grants in 2010 to fund freight and freight-related projects across the country.

Highways

Design

Design personnel in states are strategically meeting the challenges of designing new and improved transportation infrastructure by applying sustainable engineering practices to meet multiple design objectives—

Photo: Norfolk Southern

Construction workers lay track in a newly completed tunnel in the Heartland Corridor, which provides a new, shorter route between Norfolk, Virginia, and Columbus, Ohio. The project, a public–private partnership between Norfolk Southern Corporation and the states of Ohio, West Virginia, and Virginia, opened in September 2010.

Photo: Jef Nickerson, gcpvd.org

Some state initiatives have emphasized multimodal connections. Since October 2010, the Interlink facility at T. F. Green International Airport in Providence, Rhode Island, has linked the airport with a rental car facility, intercity bus services, and a commuter train platform.

Small planes parked on the Merrill Field General Aviation Apron. When it opened in 1930, Merrill Field was the first official airport in Anchorage.

Photo: Harvey Douthit, Alaska DOT & PF

such as environmental stewardship, durable and long-life infrastructure, and shorter durations for construction and rehabilitation projects. In most states, however, reduced budgets have meant fewer staff to deliver the programs.

In Indiana, staff have reported significant cost savings through the implementation of the *Mechanistic–Empirical Pavement Design Guide* (MEPDG) on several Interstates and U.S. highways. In some cases, pavement thicknesses were reduced by 10 to 15 percent but met standards; state DOT professionals project a savings of $20 million per construction season on pavement rehabilitation projects. The MEPDG efficiency is promising, although the savings for state routes are less.

At Washington State DOT, experts have made progress in developing seismic connection specifications for accelerated bridge construction, which can reduce project costs and achieve environmental objectives. Oregon DOT staff have applied practical design principles to leverage asset management funds for the redesign of highway corridor projects—the flexible parameters allow the design teams to implement a solution that is sufficient. In Illinois, researchers in the Bureau of Materials and Physical Research have optimized the use of engineered materials in highway designs, increasing system sustainability.

Construction and Materials

Many states will lose experienced construction personnel in the next few years because of retirements yet are hesitant to hire replacements because of the uncertainty of funding. Foreseeing this attrition of construction staff, many state DOTs are evaluating alternatives to design–bid–build agreements for delivering projects.

PHOTO: PENNSYLVANIA DOT

Equipment operators prepare recycled asphalt pavement millings to be fed into a crusher. Recycled asphalt—the most-used recycled pavement material—was used in the resurfacing of Raccoon Creek Road in Beaver County, Pennsylvania.

Warranties and design–build agreements already are routine in a few states. Guidelines under development through a National Cooperative Highway Research Program (NCHRP) project may enhance the application of warranties.[1] A few states are piloting the construction-manager-at-risk contracting approach, and an NCHRP project is developing a guidebook.[2]

Automated machine guidance systems and intelligent compaction are subjects for research and pilot tests in several states. With the evolution of different methods to deliver projects, state construction professionals seek ways to evaluate alternative quality management systems that may be better suited to these new approaches than the traditional design–bid–build quality management system. NCHRP has launched a project to provide assistance.[3]

Materials and environmental personnel are working together at the state level for environmental stewardship with materials, particularly for the use of recycled materials and industrial byproducts in transportation applications. An NCHRP synthesis project is exploring the viability of many of these materials and byproducts for construction.[4]

Recycled asphalt pavement is still the most widely

PHOTO: CHRISTINE GERENCHER

The Penobscot Narrows Bridge Observatory (*right*) in Maine is the only bridge observatory in the United States. The bridge was planned and built in 42 months.

[1] NCHRP Project 10-68: Guidelines for the Use of Highway Pavement Warranties.
[2] NCHRP Project 10-85: A Guidebook for Construction Manager-at-Risk Contracting for Highway Projects.
[3] NCHRP Project 10-83: Alternative Quality Management Systems for Highway Construction.
[4] NCHRP Synthesis 20-05, Topic 40-01: Recycled Materials and Byproducts in Highway Applications.

used recycled material. Experts in some state DOTs have tried warm-mix asphalt and are waiting for a recommended warm-mix design method in development through NCHRP.[5] In a few states, researchers are looking into applying photocatalytic compounds—such as titanium dioxide nanoparticles—to pavement surfaces to remove harmful air pollutants such as nitrogen oxides and volatile organic compounds.

Geotechnical Engineering

In 2010, geotechnical engineers focused on the implementation of load and resistance factor design for foundations; the investigation and mitigation of landslides and rockfalls; the development of less expensive—yet effective—mitigation measures for slope failures; the characterization of aggregates to predict performance in pavements; pavement subsurface drainage; the use of recycled and waste materials in transportation infrastructure; and the study of soil stabilization.

Geotechnical asset management (GAM) is an emerging trend, raising awareness of the geotechnical engineering assets that a state DOT owns. Some states have initiated asset management approaches related to specific geotechnical assets.

To provide a forum for identifying needs and for disseminating information about GAM, TRB created a subcommittee of the Engineering Geology Committee. The subcommittee organized a program at the 61st Highway Geology Symposium in Oklahoma City in August 2010 to showcase GAM efforts. Presentations included management systems to address rockfalls and landslides; inventorying sources of aggregates; inventorying and assessing the condition of retaining walls; and evaluating buried structural components.

Continued dissemination of this information to practitioners should enhance awareness of a GAM system encompassing all geotechnical assets. The system could be assimilated into the transportation asset management efforts under way in most states.

Highway Operations

With the ever-increasing focus on climate change, the imposition of emission targets, the reductions in revenue, and the need to improve system performance, operations professionals in DOTs point to a growing need to manage and make better use of the highway system. In addition, the ability of agencies to construct new capacity in congested urban corridors is increasingly restricted by funding, construction costs, environmental constraints, and growth in travel.

Actively managing the design and operation of a freeway has become commonplace in many states. Agency personnel are deploying innovative design and operations treatments to optimize the use of the entire roadway cross section to improve the performance of specific lanes or of the entire freeway or highway.

Active traffic management (ATM) offers a toolbox of countermeasures that can be used in various combinations to manage congestion dynamically in response to prevailing traffic conditions by maximizing use of the road space. Operations experts in many states are pursuing ATM to mitigate congestion within highway corridors and to optimize the investment in the roadway infrastructure.

Under an ATM scenario, as traffic congestion increases, various countermeasures are put into effect—although not necessarily at the same time—to manage the congestion. These countermeasures could include improved detection, dynamic speed limits, motorist information through electronic variable message and lane control signs, temporary shoulder use, ramp metering, priced and managed lanes, and dynamic rerouting.

[5] NCHRP Project 09-43, Mix Design Practices for Warm-Mix Asphalt; findings are scheduled for publication as NCHRP Report 691 in 2011.

Photo: George Hornal, Tennessee DOT

A landslide caused by major floods in May 2010 destroyed SR-7 in Maury County, Tennessee. In 2010, landslides and rockfalls were a much-studied topic for geotechnical engineers.

New federal requirements for sign reflectivity, established in 2008, require that signs must either be illuminated or made with retroreflective sheeting materials.

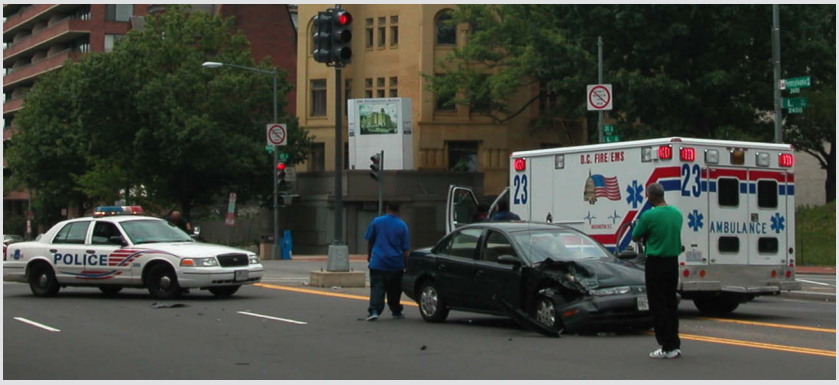


PHOTO: AAA FOUNDATION FOR TRAFFIC SAFETY

Fatalities from highway crashes dropped to a 61-year low of 33,808 in 2009, according to National Highway Traffic Safety Administration data.

Infrastructure Preservation

Safety for the traveling public and for roadway workers in work zones remains a paramount concern for transportation agencies. Many DOT staffs are addressing work zone safety and mobility requirements and are exploring new technologies to provide real-time information to drivers approaching and moving through work zones. Agencies are struggling to find funds to implement the new national requirement to manage and maintain minimum levels of sign reflectivity.

State DOTs have noted that succession planning for maintenance employees at all levels is critical. Several state DOTs have started summer employment programs to attract graduate engineers. Other agencies are supplementing their workforces through outsourcing, citing limited in-house resources, the need for specialized expertise or equipment, statutory requirements, seasonal work, and contractor availability.

The procurement models for outsourcing include short-term input models with payments for labor, equipment, and materials; one- to five-year area or roadway corridor output models with payments for accomplishments such as acres mowed; and longer-term, lump-sum corridor or network outcome models measuring a level of service such as pavement smoothness and friction.

DOTs are integrating their legacy management systems—designed for traditional engineering concerns such as pavements, bridges, and maintenance—into agencywide asset management approaches, with performance measures to monitor progress toward established goals. This approach supports infrastructure preservation by maintaining a functional condition through cost-effective preventive actions that safeguard structural integrity and extend performance life. Personnel in several agencies expressed a need for a preservation terminology that is consistent for all infrastructure assets and for extensive workforce training to promote understanding of the preservation approach.

Highway Safety

Highway crash fatalities declined again in 2009. The nationwide total in 2007 was 41,259 deaths; in 2008, 37,423; and in 2009, 33,808.[6]

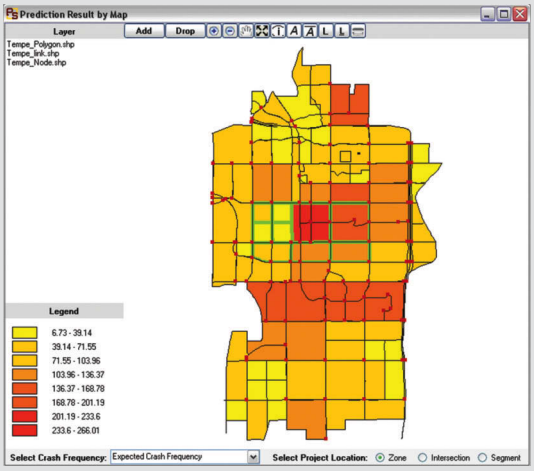
The American Association of State Highway and Transportation Officials published the TRB-developed *Highway Safety Manual* (HSM) in 2010, and states are applying the approaches. A lead state program funded through FHWA and NCHRP began in 13 states in 2010. NCHRP and FHWA have developed training for implementation of the manual.

The safety professionals at state DOTs and partner agencies who are developing and updating Strategic Highway Safety Plans are relying on analyses of systems instead of unsafe hot spots. NCHRP published a CD-ROM tool, *PLANSAFE: Forecasting the Safety Impacts of Socio-Demographic Changes and Safety Countermeasures* (CRP-CD-78), to assist planners at state DOTs and metropolitan planning organizations (MPOs) to include safety in the long-range planning process.[7] Additional pilot testing of PLANSAFE continues at Florida DOT and several MPOs.

Louisiana was one of three pilot test sites for NCHRP's Model Curriculum for Highway Safety Core Competencies, published as NCHRP Report 667.[8] The course attracted interest and attendance from the traffic law enforcement community; Louisiana DODT has scheduled additional course presentations to accommodate the interest.

Several nations have made significant advances in highway safety and are reducing annual traffic fatali-

[6] www-nrd.nhtsa.dot.gov/Pubs/811403.pdf, Table 1.
[7] www.trb.org/Main/Blurbs/PLANSAFE_Forecasting_the_Safety_Impacts_of_ SocioDe_163790.aspx.
[8] http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_667.pdf.



Users of the CD-ROM tool PLANSAFE can select one of three types of crash frequency and can view prediction results in map form. Evaluation results then can be printed into a report document.

ties and fatality rates faster than is the United States. To learn from these successes, TRB has produced a study, Special Report 300, *Achieving Traffic Safety Goals in the United States: Lessons from Other Nations*.[9]

Ports and Waterways

The nation's ports and waterways continue to face environmental and funding challenges, but several examples show the progress made in the past year. The At-Berth Clean Fuels program in the Port of Seattle, Washington, encourages shipping and cruise lines to burn cleaner fuels while at berth and has eliminated more than 340 metric tons of sulfur dioxide emissions. The program is a partnership that includes ocean carriers and the Puget Sound Clean Air Agency.

In November, officials from the Port of Long Beach, California, and from other ports and state and federal agencies launched a five-year, $950 million project to replace the Gerald Desmond Bridge. This joint project of the California DOT and the Port of Long Beach received additional funding from U.S. DOT and the Los Angeles County Metropolitan Transportation Authority.

Earlier in 2010, Florida Governor Charles Crist led the groundbreaking for the Interstate 4–Selmon Expressway Connector project that will include an elevated truck bypass linking the Port of Tampa's main access directly with the Interstate Highway System. The bypass will shift a significant amount of truck traffic away from the city's historic Ybor City district. The project is a coordinated effort of Florida DOT, Florida's Turnpike Enterprise, and the Tampa–Hillsborough Expressway Authority.

Several waterways were designated part of America's Marine Highway program; one, the M-40 Connector, includes the McClellan-Kerr Arkansas River Navigation System and will stretch from Oklahoma's Tulsa Port of Catoosa to the Mississippi River.

Rail

Passenger Rail

The Passenger Rail Investment and Improvement Act of 2008 and the ARRA renewed interest in passenger rail in 2010. The ARRA provided $8 billion in federal assistance to jump-start intercity and high-speed passenger rail service; an annual appropriation made an additional $2.5 billion available during 2010.

Utilization of the federal funds, however, has been slower than expected. Administration of the program has challenged the capacity of the Federal Railroad Administration (FRA) and has presented new issues, such as compliance with the National Environmental Protection Act (NEPA). Historically, rail projects have been financed without federal funds and therefore have been exempt from NEPA; FRA is developing a process for categorical exclusions and an inventory of projects that would qualify.

In addition, many of the passenger rail projects entail development on rights-of-way owned and operated by freight railroads. Freight rail representatives have expressed concerns about the capacity of these rights-of-way to accommodate increases in freight and in passenger service, including high-speed rail, and about the safety of commingled operations. To conclude an FRA grant agreement, the host freight railroad must agree to the project. Negotiation of these agreements has proved time-consuming.

After the elections in November, changes of administration in some states have altered the prospects for enhanced passenger rail. The states must cover project cost overruns, and the ARRA

[9] http://onlinepubs.trb.org/onlinepubs/sr/sr300.pdf.
See article in this issue, page 30.

Photo: Port of Long Beach

Replacement of the 42-year-old Gerald Desmond Bridge—a joint project of the California Department of Transportation and the Port of Long Beach—currently is under way. The nearly $1 billion project is expected to be completed in 5 or 6 years.

Photo: Carl Johnson, Rensselaer, New York

Last year, funds from the American Recovery and Reinvestment Act of 2009 were secured for the eventual replacement of the Livingston Avenue Bridge in New York between Rensselaer and Albany. The rail bridge is nearly 150 years old.

Photo: Amtrak

With new proposals for intercity passenger rail, shared rail corridor use by freight and passenger operations presents a challenge.

funds do not cover expenses for operation and maintenance; as a result, some of the new administrations question whether the public benefit justifies the expense, citing historically low ridership.

Freight Rail

On the freight rail side, the following issues loom:

◆ The proposed shared use of rail corridors by high-speed passenger rail and freight rail operations raises challenges to capacity, safety, and maintenance and remains under discussion.

◆ Some in the freight rail industry maintain that the costs of implementing positive train control by 2015 may exceed the benefits. Financial assistance or tax credits to defray some of the cost have been proposed.

◆ The Staggers Act substantially reduced regulation of freight railroads 30 years ago; reinstituting some level of regulation is now under consideration. In a report, the Senate Committee on Commerce, Science, and Transportation notes that freight railroads have become profitable; yet the committee expresses concern that regulations have allowed the railroads to overcharge so-called captive shippers. Many freight railroads deny this and assert that freedom from additional regulation is necessary to retain and attract private investment.

Public Transportation

Public transportation agencies have implemented innovations in financing and customer service and have formed partnerships in urban and rural envi-

Did You Know?

◆ Arizona State University (ASU) operates a Decision Support Theater, a seven-screen immersive environment that displays complex data, models, and visualizations for decision makers and others. ASU staff have developed and employed graphics and tools to compare alternatives, develop consensus, or view the built environment in new ways. With the tool, decision makers and researchers have explored a range of topics, including urban development, education, environmental issues, policing and security, and public health.

◆ The fatality rate on rural roads is more than twice that in urban areas. The Western Transportation Institute at Montana Sate University, Bozeman, has a Naturalistic Driving Lab with three driving simulators to explore the driver's role in fatal rural traffic crashes. The most advanced simulator is a virtual reality, motion-based unit with a two-cab installation—sedan or pickup—and is used for human factors experiments and system evaluations. Research programs have tested cell phone use and teenage driver safety.

◆ The planets Mars and Venus are better mapped than the state of Alaska. Aeronautical charts for the state are based on survey data from 1948 to 1952, and the inaccuracies have negative effects on safety. Many coastal marine maps similarly are out of date—some incorporate George Vancouver's charts from the late 18th century. The state DOT has launched the Alaska Aviation Safety Project and the Statewide Digital Mapping Initiative. One main task is to identify opportunities to use cell towers as a backup for automatic dependent surveillance-broadcasts in remote mountain areas with poor coverage. Another project is creating digital maps for at least 10 percent of the state's most heavily traveled areas.

◆ Many airports nationwide are using engineered material arresting systems (EMAS) to meet the FAA runway safety area requirements. Alaska has encountered a unique problem—moose walking across can poke holes in the EMAS.

◆ Rural emergency medical service drivers have a crash fatality rate 13 times higher than that of their urban counterparts.

◆ One in eight vehicles in Montana will be involved in a collision with an animal.

◆ Florida DOT is the only state agency with an archaeologist on staff.

◆ South Dakota DOT staff are responsible for more lane miles per person than staff at any other state DOT.

◆ A 300-year cycle near-shore undersea earthquake has been predicted as imminent along the coast of Oregon. If the event occurs, tsunami damage probably would claim Highway 101 along the coast. The coastal geology and infrastructure of Oregon are similar to those of Chile before the February 2010 earthquake.

◆ Oregon State University has a tsunami wave research center with a 120-foot-long channel that can produce a wave 6 feet tall.

ronments. Staff in transit agencies are using social media and smartphone applications with real-time arrival information to improve customer service effectively and to reduce printing costs. Many are forming partnerships and soliciting corporate sponsors for rail lines and stations, bus routes, retail concessions, and special events. For example, the Chicago Transit Authority recently updated the North–Clybourn stop, near an Apple Store, under the corporate sponsorship of Apple, Inc., which holds future naming rights for the station.

States have used creative financing—for example, private matching funds—to support and maintain rural intercity bus service. The Federal Transit Administration (FTA) approved a pilot program allowing states to include the capital costs of private-sector intercity bus service as an in-kind match for funds awarded under 49 U.S.C. 5311(f) for the operation of connecting rural intercity bus feeder services. For example, Kansas replaced lost service by working with Colorado to connect western Kansas with Pueblo and Denver.

State DOTs and transit authorities also are developing partnerships with other agencies to establish new services. In Aspen, Colorado, the Roaring Fork Transportation Authority implements projects to connect the region's trails with transit. In Montana, the Bureau of Land Management of the U.S. Department of the Interior and the state Fish, Wildlife, and Parks agency are helping to identify transit options, including shuttle buses to the Lower Madison River in the summer and to ski resort areas in the winter.

Dedication and Effort

This sampling portrays some of the many behind-the-scenes efforts by dedicated staff at transportation agencies across the country. A cross section of colleagues in industry, consulting, contracting, universities, and research are supporting their initiatives. Despite diminished resources, their combined efforts are progressing toward key goals, ranging from reducing traffic deaths to improving the environment. TRB salutes their extraordinary dedication and efforts in these difficult times.

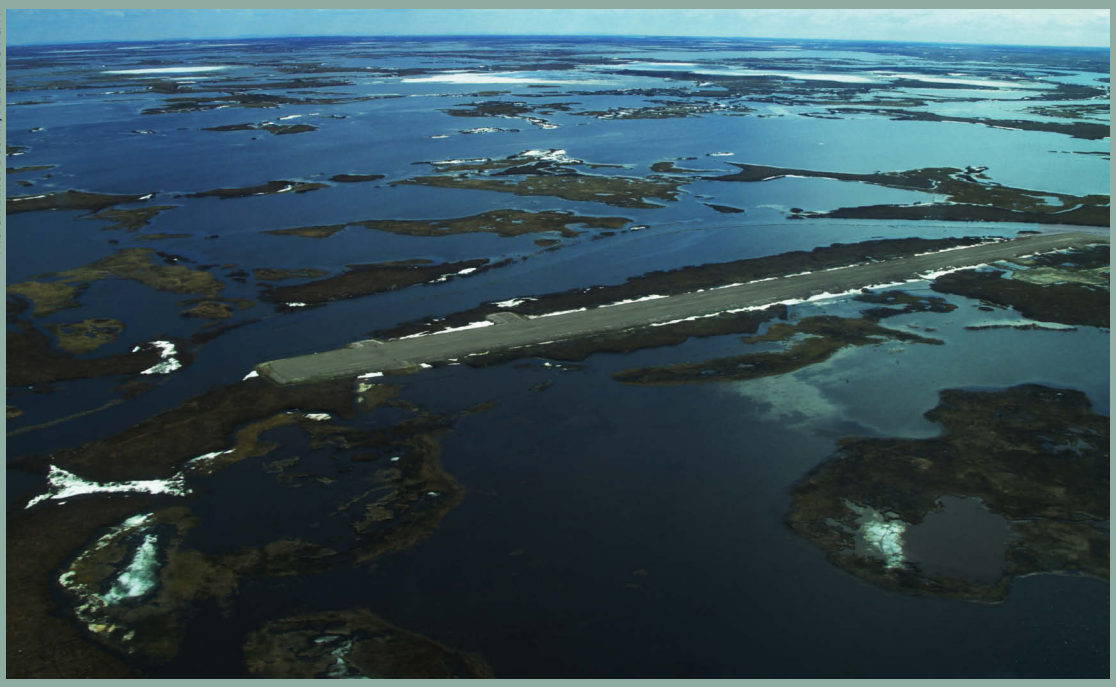


Photo: Harvey Douthit, Alaska DOT & PF

The Nunapitchuk runway in Alaska's Yukon–Kuskokwim Delta. In this region, aviation is the primary form of transportation, and accurate aeronautical data are a necessity.

◆ On November 6–7, 2006, a massive debris flow on the east side of Mt. Hood washed out a 2.5-mile section of Oregon Highway 35; the flow contained an estimated 200 million cubic yards—or 20,000 dump truck loads—of mud, trees, and boulders. The highway reopened on December 8, 2006.

◆ The Purdue Road School, held annually at Purdue University since 1914 and cosponsored by the university's School of Civil Engineering and Indiana DOT, brings together approximately 1,500 transportation-related professionals from throughout the state for a three-day program.

DEVELOPING POROUS ASPHALT FOR FREEWAYS IN THE NETHERLANDS

Reducing Noise, Improving Safety, Increasing Service Life

J. T. VAN DER ZWAN

The author is Senior Adviser–Specialist, Rijkswaterstaat Centre for Transport and Navigation, Delft, Netherlands.

Since the 1970s, Rijkswaterstaat—an agency within the Netherlands Ministry of Transport, Public Works, and Water Management—has been working with porous asphalt to improve the quality of the nation's main road network, or freeways. The development project originally aimed at improving road safety, but the noise-reducing properties of porous asphalt soon were recognized as the primary benefit. Porous asphalt has become the standard service course for the main road network in the Netherlands.

The Netherlands is a small but densely populated country in northwest Europe, situated in the delta of three major rivers—the Rhine, the Meuse, and the Scheldt. Large portions of the country are below sea level. With an area of approximately 41,000 square kilometers and a population of 16 million, the settlement density is roughly 12 times greater than that of the United States.

The population density and the nation's strategic position—Rotterdam is one of the world's largest seaports, and Amsterdam's Schiphol is a leading airport—combine to create high levels of road traffic. Average daily traffic approaches 250,000 vehicles. The nation has built a 3,350-kilometer (km) network of freeways during the past decades.

Maintaining the Infrastructure

Rijkswaterstaat manages the Netherlands' main road network. The agency was founded in 1798 to control the distribution of water in the Rhine and its branches. Today Rijkswaterstaat provides services for 40 percent of all traffic on the nation's waterways—a 1,400-km network—and for 45 percent of all road traffic, as well as for the 63,500 square kilometers of the nation's main water system.

The scarcity of land generates competition for land use—for living, recreation, industry, traffic, and agriculture. Mitigating the contributions of the transportation infrastructure to noise, air pollution, climate change, and crash fatalities is high on the nation's political agenda. The Netherlands is implementing policies to discourage the growth of automobile transport in favor of public transport or more

Researchers measure tire–pavement friction on porous asphalt during emergency braking with locked wheels.

environment-friendly means of transportation, such as bicycles.

The Dutch attitude toward government influence and taxation differs from that of most Americans. Because of its struggles to hold back the water from the land, the Netherlands has experienced the need for collaboration and for the combined funding of necessary measures since the Middle Ages. The solutions that are implemented probably could not work in most U.S. states.

The main road network must meet requirements set in accordance with political goals and described in service-level agreements with the ministry. The requirements have changed in recent decades. With daily traffic jams and corresponding economic damage estimated at 2.6 billion Euros to 3.4 billion Euros per year, the pressure to keep the traffic flowing has increased. As the road authority, Rijkswaterstaat must find affordable solutions between sometimes conflicting demands.

Interest in Porous Asphalt

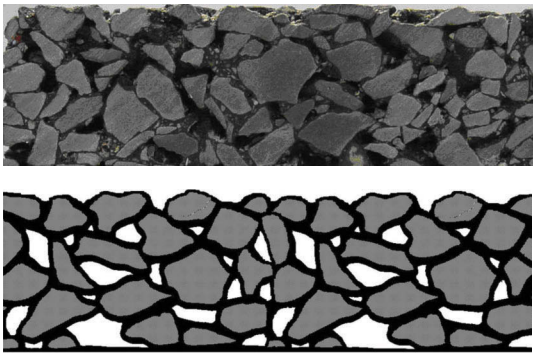
After Malta, the Netherlands has the world's best road safety record. The freeway network is relatively safe, but improvements are needed to reduce the numbers of accidents.

The Netherlands' mild oceanic climate yields an annual precipitation of 800 millimeters, evenly distributed throughout the year. Dutch roads are wet and therefore less safe approximately 12 percent of the time. The risk of traffic accidents on wet roads is three times greater than on dry roads. For that reason, Rijkswaterstaat started an investigation in 1971 to develop new wearing courses. Adapting the formula for antiskid layers used on airfields in the United Kingdom, Rijkswaterstaat introduced the first test section of porous asphalt in 1972.

Porous asphalt is a gap-graded asphalt mix with 20 percent air voids—this facilitates the capture and the drainage of water through the pavement layer. The reduction of splash-and-spray and hydroplaning are beneficial for comfort and safety.

Implementation Begins

The introduction of new asphalt mixes, however, raises questions about durability, structural properties, life-cycle costs, winter maintenance, skid resistance, quality control, and more. Predicting the service life of new mixes from laboratory testing is impossible. Test sections were laid and monitored for many years. Compared with dense asphalt concrete—the standard wearing course at that time—porous asphalt was more expensive because of its shorter life span—approximately 11 years, compared with 15 years for dense asphalt concrete. Life-cycle costs also were considerably higher.



(*Top:*) Porous asphalt, 0/16 mm stone size grading. [Note: 0/16 mm signifies the distribution of grain size up to 16 mm.] (*Bottom:*) Porous asphalt structure.

The implementation of porous asphalt took many years. Costs could be calculated, but the benefits—such as fewer accidents and fewer traffic jams—could not be verified, because the safety level already was high, and the test sections were relatively short.

The breakthrough came with the discovery of an environmental advantage—porous asphalt reduces noise. In the late 1980s, an increase in the speed limit on the network from 100 to 120 km/h increased noise levels by 3 decibels (dB); these noise levels, however, could be counterbalanced on a pavement of porous asphalt.

At that time, the assumption was that accidents on wet surfaces would decrease by 50 percent, which would make porous asphalt cost-neutral. Since then, with normal maintenance, dense asphalt concrete wearing courses have been replaced with porous asphalt. Today more than 80 percent of the freeways are paved with porous asphalt.

Porous Asphalt Composition

The composition of porous asphalt must meet the requirements shown in Table 1 (below).

In recent decades, straight-run penetration bitumen has been used (4.2 percent in the mix). The service life was approximately 11 years for the driving lane and 16 years for passing lanes. In comparison, dense wearing courses have a service life of 15 and 20 years for the driving and passing lanes, respec-

TABLE 1 Composition Requirements for Porous Asphalt, 2009

	Porous Asphalt, 0/16 mm	
Through Sieve	Minimum	Maximum
C16	93	100
C11.2	70–85	30.0
2 mm	15	25
0.5 mm	DV*	DV*
63 μm	2	10
Bitumen content in mix	5.2%	—

** DV = producer-declared value.*

tively. The main failure criterion of porous asphalt is raveling—the progressive separation of aggregate particles from the pavement surface downward.

The composition is based on the new European standard for porous asphalt, EN-13108-7 (*1*). The void content must be 20 percent at minimum. Recently, because of modifications, the minimum binder content in the mix was raised to 5.2 percent. An extra two to three years of service life are expected for this so-called durable porous asphalt.

The longer service life answers the need for avoiding disruptions to traffic. Traffic jams are a daily occurrence in the Netherlands. Although road maintenance causes only a small percentage of traffic jams, the political pressure to minimize disruptions to road users is high. User costs increasingly are a criterion in asset management decisions. Contracts for porous asphalt require a warranty of seven years.

Properties and Characteristics

Because paving technology is empirical, the introduction of a new mix type is difficult. In the past, simple volumetric properties were determined and—in combination with materials and methods of production, laydown, and compaction—achieved a certain level of performance. Empirical frameworks are the only models available for predicting the performance of a new mix.

The general approach is to develop a new mix, estimate the possible failure mechanisms, measure the characteristics related to the failure mechanism through laboratory tests, and compare the results with those for known mixes. Starting with small and eventually larger test sections—or using accelerated loading facilities—more information is gained about field performance. Because the first concern is the safety of road users, skid resistance and winter maintenance are key considerations.

Before application on a wide scale, longer-term investigations are necessary to calculate the life-cycle costs of the mix. The following characteristics influence the decision to apply porous asphalt: technical durability—including skid resistance, rutting, and raveling; comfort; safety; winter maintenance; the quality of water run-off; user costs; and noise properties.

Durability

Rijkswaterstaat's pavement management system specifies minimum levels for the structural and functional quality of the road network. Design and maintenance are based on life-cycle costs, combined with user costs and environmental conditions. The functional condition of the network is monitored in a two-year cycle, gauging skid resistance, longitudinal and transverse evenness, and raveling. The structural quality of the road is not measured routinely, in keeping with the design philosophy of constructing roads with a "perpetual" service life—that is, roads that require only surface maintenance.

Comfort and noise are not measured during the service life of the road and are not maintenance criteria. Raveling is the main failure mechanism of porous asphalt. Skid resistance is not problem, as long as a good aggregate is used with a minimum polished stone value of 58. Rutting rarely occurs, because porous asphalt's stone skeleton resists rutting. In addition, the air voids give porous asphalt an insulating effect, producing lower temperatures in the binder and base compared with those in dense asphalt wearing courses.

Comfort

The public appreciates porous asphalt for its comfort. The near absence of splash-and-spray provides for good driving in wet conditions; the visibility of traffic and of road markings is comparable to that in dry road conditions.

During the road's service life, these advantages are maintained by cleaning the emergency lane twice a year. Because it bears no regular traffic, the emergency lane is susceptible to the effects of pollution, while the movement of traffic cleans the porous asphalt in the driving lanes.

Safety

Porous asphalt originally was developed to improve safety. Nevertheless, the safety advantages were difficult to measure—the test sections were not large enough to yield statistically reliable data on road accidents. After the decision to apply porous asphalt to large parts of the network, different studies surprisingly revealed that porous asphalt was not safer. Apparently, drivers take advantage of the safety benefits of porous asphalt and drive faster at shorter following distances during rainfall than they would on dense asphalt concrete (*2*).

Skid resistance is a safety issue in the first months after construction. Small chipping aggregates are added during the final compaction to bring traditional dense asphalt pavement to acceptable levels of initial skid resistance. For porous asphalt, this step was omitted because of the possible negative effect of filling the voids. Newly laid porous asphalt, therefore, has a lower initial skid resistance but still meets the Dutch standard.

Analysis of fatal accidents, however, revealed a new phenomenon—bituplaning, which occurs when the wheels of a car not equipped with antilock brakes lock up during a sudden, emergency stop. Friction

Exceptional snow conditions in the Netherlands.

in the contact area between the tires and the bitumen generates high temperatures, causing the bitumen to melt. A liquid film with low friction forms between the wheel and the pavement, causing slippage.

For this reason, braking deceleration measurements with locked wheels are mandatory on new wearing courses (see photograph, page 22). Normally, porous asphalt meets the minimum deceleration requirement of 6.5 m/s^2.

The recent decision to increase the amount of bitumen in the mix has increased the risk of bituplaning. Rijkswaterstaat therefore sought to stimulate the market to develop new technologies to improve the initial friction. Technologies for mechanically removing the bitumen layer have been investigated, as well as techniques for chipping. Removal techniques—such as brushing and sand and ice jetting—were not effective.

Safety concerns led to a reexamination of chipping techniques. The timing of the chip spreading and the choice of chip material were found to be critical. A chip spreading unit integrated into the paver yielded the best and longest-lasting results, with no negative effects on the durability of the mix, the drainage, and noise reduction. Milling and hydrojetting, or waterblasting, also produced good results.

Winter Maintenance

Because of its open structure, porous asphalt requires special winter maintenance treatment. The Netherlands rarely has significant snowfalls and experiences 30 days per year with some snow, usually in amounts insufficient to cause serious traffic problems. In a heavy snowfall, therefore, the whole road network is jammed, regardless of the pavement type—Dutch drivers do not cope well in these winter conditions. The traffic congestion makes snow plowing difficult (see photo, above).

In the Netherlands, alternating thaws and freezes are frequent, often producing black ice and icy rain. To lower the risks of snow and ice, preventive winter maintenance with salt starts up a few hours before the onset of freezing conditions.

Rijkswaterstaat employs a road weather information system on the network. Sensors in the roadway measure temperature, humidity, dew point, and the presence of salt; the system combines these data with the weather forecast to determine when salting is needed.

On porous asphalt, the salt and salty water drain away. The pumping effect of tires is necessary to bring the salt back to the surface. Sometimes, for maximum effect, all traffic is directed into a single lane. In general, winter maintenance on porous asphalt is as manageable as it is on dense wearing courses.

Water Run-Off

Traffic is a source of water and soil pollution through water run-off and splash-and-spray. Splash-and-spray spreads pollution over an area up to several hundred

meters from the road. Porous asphalt minimizes splash-and-spray.

Porous asphalt traps a portion of the pollution from water run-off, providing a cleansing effect. The rest of the polluted runoff is captured in the top layer of the soil in the green verge close to the road. Regular maintenance can remove the polluted verge material. As a result, the runoff water can be discharged into surface water without additional treatment, except in watershed areas that supply drinking water.

User Costs

User costs are an important consideration. Because of the frequency of maintenance and the road capacity during rainfall, fewer hours are lost to traffic jams on porous asphalt than on dense asphalt.

The shorter service life of porous asphalt requires an increase in maintenance, creating more hindrances for road users. In the past, this was not a major issue—the higher costs and increased maintenance were acceptable because of the benefits. Rijkswaterstaat's contracts now include incentives to minimize traffic disruptions and delays. This motivated the decision to increase the binder content.

Porous asphalt yields significantly less splash-and-spray than dense asphalt. As a result, the traffic capacity of a porous asphalt road is less constrained by rainfall, causing fewer traffic jams. In contrast, the road capacity of dense asphalt diminishes during rainfall.

Noise Reduction

Noise reduction is the main reason for applying porous asphalt. The Dutch traffic noise model indicates a reduction of 4 dB from the noise levels on dense asphalt concrete. Since the decision in the 1980s to apply porous asphalt on the freeways, noise control has gained importance.

The legal requirements for protecting citizens from traffic noise only apply to new roads or to a reconstruction that changes a road's function or traffic capacity. In those instances, noise studies must determine the projected noise levels near dwellings. If the projected levels exceed the legal requirements, noise-reducing measures—such as noise barriers or noise-reducing pavements—are required. A classification system, known as C_{road}, was developed to gauge the mitigating effects of noise-reducing pavements (3).

The noise reduction value in the C_{road} system is based on the initial noise reduction after construction, determined with the Statistical Pass-By method (ISO 11819-1). At least five different test sections are measured, and the noise-reducing properties are compared with a reference, based on a statistical calculation. The traffic noise model uses the C_{road} noise reduction values to verify compliance with the regulations.

Acoustic Durability

The regulations do not address acoustic durability, although the noise reduction properties of a pavement will decline during its service life. A decline of approximately 2 dB, however, is acceptable, based on the decline in noise reduction on the reference wearing course.

In 2007, Rijkswaterstaat investigated the acoustic properties of a large part of the network. Measured with the close proximity method (ISO-CD 11819-2), the results gave an indication of what was happening, but more information was needed for conclusions at the managerial level. Recent research has confirmed that the noise-reducing properties decrease with time (see Figure 1, below).

The noise-reducing properties may diminish by approximately 3 dB—approximately 1 dB in the first three-quarters of service life and approximately 2 dB in the remaining service life. Raveling in the final

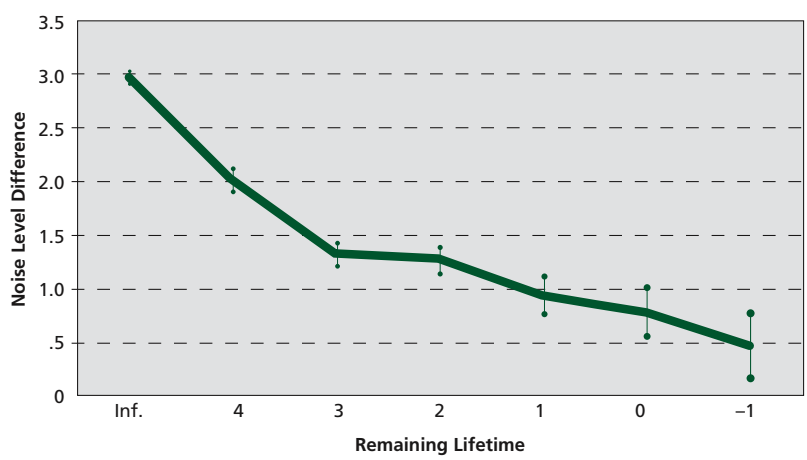


FIGURE 1 Decrease in noise reduction as a function of the remaining service life of a porous asphalt pavement. (Note: –1 indicates that maintenance should have been performed in the previous year.)

quarter of technical service life is the main source of the decline.

Pollution clogging the pores or voids also affects noise reduction negatively. Rijkswaterstaat cleans the hard shoulder regularly to maintain the lateral flow of water. The assumption is that this will create a positive effect on the porosity of the driving lanes and therefore on the acoustic properties. This practice, however, still is under investigation. Introducing regular maintenance practices for noise control will have implications for other policy goals, such as reducing traffic disruptions and costs.

Two-Layer Porous Asphalt

Two-layer porous asphalt, developed to improve the noise-reducing properties, has a bottom layer of coarse porous asphalt and a top layer of fine porous asphalt, with a maximum chipping size of 6 to 8 millimeters (see photo, above right). Two-layer porous asphalt achieves a noise reduction of 6 dB compared with the reference—a 2-dB improvement over porous asphalt.

The technical service life, however, is shorter than that of durable porous asphalt—an expected 8 years versus 13 years. The life-cycle costs also are higher; therefore this material is used only when its benefits compare favorably with those of other noise mitigation measures, such as noise barriers. In time, the noise reduction diminishes by approximately 2 dB. Approximately 4 percent of freeways in the Netherlands have a two-layer porous asphalt wearing course.

Improving Noise Reduction

Under new regulations for quiet pavements, road authorities must not exceed a set maximum noise level during the service life of a road—any increase in traffic density above the level projected in the environmental impact studies must be offset with additional noise measures. This policy creates a continuous need for improved knowledge about new pavement types and construction techniques.

The Netherlands established an Innovation Program for Noise Mitigation to conduct investigations into better-performing mixes that have longer acoustic service life and longer technical service life (*4, 5*). This research effort has attracted international partners.

Reducing Raveling

More than 90 percent of the maintenance needs of porous asphalt wearing courses stem from raveling. Raveling affects safety, noise reduction, and driver comfort. Two-layer porous asphalt has better noise-reducing properties than porous asphalt, but a shorter service life. Extensive research has aimed to increase the durability of two-layer porous asphalt and to understand the raveling mechanism.

Two-layer porous asphalt: top layer, 25 mm thick, fine graded, 2/6 or 4/8 mm stone size; bottom layer, 45 mm thick, coarse graded, 11/16 mm stone size.

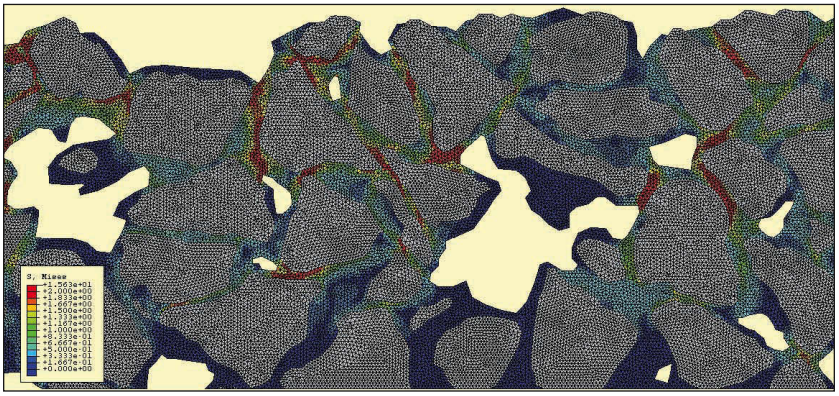
Raveling is a complex phenomenon with many influences: climate, traffic, traffic composition, pollution, oil, and more. These lead to cohesive failure in the mortar bridge between individual stones or to adhesive failure at the interface between the mortar and the individual stones. These processes take place at a mesolevel—the scale smaller than millimeters—or even at a microlevel. In cooperation with the Danish Road Institute, X-ray computed tomography (CT) scans and optical microscopy have been applied to visualize the processes (*4*).

The results were fed into a finite element model to predict both adhesive and cohesive failure. Models have been developed to simulate the raveling process in relation to material properties and in-service conditions. To improve the quality of the laydown material, the market has been challenged to develop ideas and methods to increase the homogeneity of the product.

Degradation Process

CT scans of asphalt cores provide three-dimensional (3-D) images of the material. The microscopic study yields 2-D images of slices of asphalt. Both techniques

FIGURE 2 2-D scan showing calculated stresses in adhesive and cohesive bounds.



provide information on the distribution of voids, the adhesion between mortar and aggregate, and the cohesion within mortar and stones. Deterioration also has been observed in the deeper stone layers.

Sand particles, released from the mortar during aging, also play a role in the degradation process. These particles may initiate erosion at the interface between bitumen and stone, so that the individual stones no longer adhere to the porous asphalt skeleton. In combination with water intrusion and traffic loading, this may be one of the most important factors in the raveling process. The results indicate that raveling is a combination of both adhesive and cohesive failure; which failure is more critical has yet to be determined.

Aging of Bitumen

Another research project provided more information about changes in bitumen properties over time (*6*). The molecular composition of bitumen changes with the effects of weather and interaction with aggregates and fillers.

Asphalt mixes generally are designed to use fresh bitumen. The prediction of service life therefore should incorporate changes in bitumen properties into the mix design. This requires a method to simulate the weathering processes so that samples can be aged.

The study made clear that traditional aging methods are inadequate to simulate the field aging of materials in the road. A new aging method was tested—the Weather-Ometer, developed to test the aging of exterior paint coatings. The method can simulate accurately the first three years of field aging. Further research is needed to simulate field aging of up to 13 years, the average service life of durable porous asphalt on freeways.

Predicting Service Life

The Lifetime Optimization Tool (LOT) combines a finite element material model and a Bayesian statistical model to describe the influences on asphalt quality. The Technical University of Delft developed the material model (*7*).

The model examines the mesolevel, including the interfaces of mortar, stone, and mortar with stone. Researchers first determined the relevant material component properties—such as mortar response and mortar and adhesive zone damage. These were then combined with data from a geometrical structural model of the surface stresses under a tire, to produce a model that can predict damage over time. New test methods were developed for this model, which can incorporate the effects of aging and water sensitivity.

Results from a recent study of the effects of water on durability (*8*) are being incorporated into the LOT. The tool's finite element models translate the surface load of the porous asphalt, the mixture geometry, and the response behavior of the mortar into signals of stress and strain at various locations in the mixture. The life expectancy of the modeled porous asphalt is estimated by interpreting the computed stress and strain signals. Although the model does not yet include all influences, verification of the model results with tested asphalt mixes in accelerated loading facilities is promising.

The second part of the model, developed by TNO Built Environment and Geosciences of Delft, is a statistical data mining tool that uses 42 parameters representing influences on raveling (*9*). These parameters were selected based on expert opinion and include material, weather, production, laydown, and compaction. The output is a projected service life, qualified with a level of uncertainty. As more field data are processed through the model, the accuracy of the predictions of service life will increase. Rijkswaterstaat is continuing to develop the LOT.

Increasing Homogeneity

Requests for proposals sought to address the homogeneity of the asphalt mix, particularly for ways to prevent temperature variation during laydown—for example, at the stopping and starting of the paving machine. Two techniques have undergone testing—the use of aggregates that have a higher heat capacity, such as steel slag, and the use of a shuttle buggy.

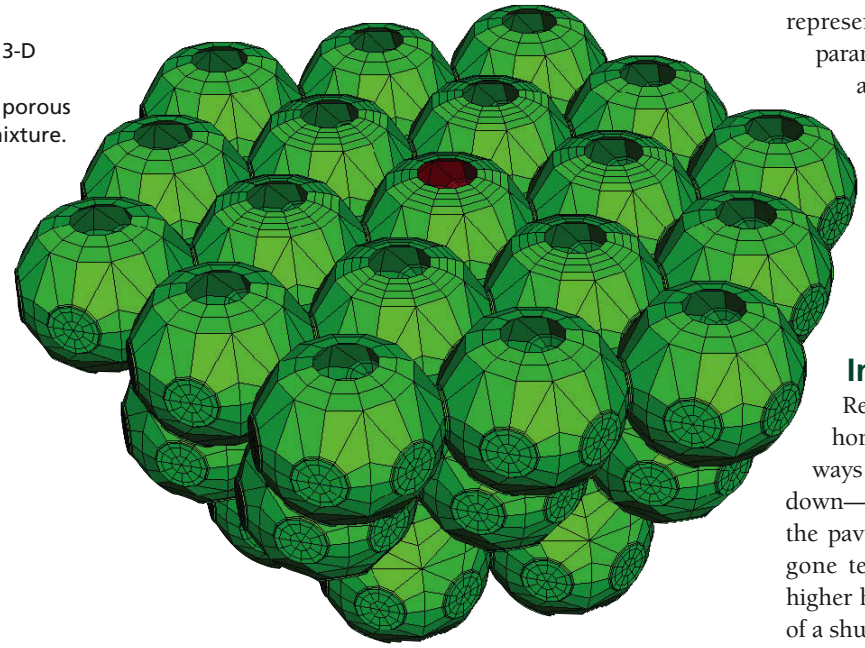
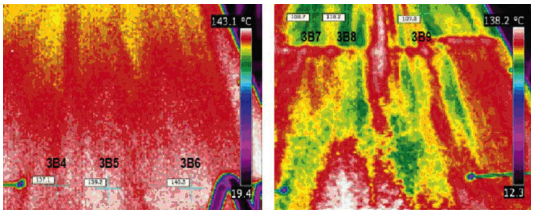


FIGURE 3 3-D model of idealized porous asphalt mixture.



Infrared images showing differences in the temperature homogeneity of porous asphalt sections placed (*left*) with a shuttle buggy and (*right*) without a shuttle buggy.

A mix with steel slag cools more slowly, extending the time for compaction. Long in use in North America, the shuttle buggy acts as a link between the haul trucks and the paving machine. The buggy remixes the asphalt, homogenizing the temperature and acting as a buffer, so that the process runs more smoothly, avoiding stoppages of the paving machine. The photographs above show infrared images of the temperature variation achieved with and without a shuttle buggy.

Although the results remain to be validated, the shuttle buggy offers improvement in the quality of the asphalt and its service life. Contractors are starting to adopt this equipment.

Acoustic Optimization

Rijkswaterstaat has encouraged the industry to develop an acoustic optimization tool (AOT) to improve the acoustic properties of materials and to develop supersilent pavements as rapidly as possible. The Dutch consulting firm M+P developed the first version of the AOT in 2008—a hybrid physical model that describes noise generation and propagation and predicts the noise levels that will be perceived by the public (*10*).

The noise generation is modeled with road surface properties such as the texture profile, the noise absorption coefficient, airflow resistance, and the mechanical impedance or elasticity. The model is based on field measurements of more than 30 sections of different pavement types. The model predicts acoustic properties as a function of those parameters. Two studies on optimizing pavement noise reduction have used the AOT—one for single-layer porous asphalt and the other for poroelastic road surfaces that contain rubber.

Supersilent Pavements

Rijkswaterstaat has launched a program to develop supersilent pavements that would reduce noise by 10 dB from the levels on the reference wearing course. The investigations draw on research findings from Japan and from Dutch studies of rubberized pavements. The project will examine all aspects, including rolling resistance and driver behavior, to determine if supersilent pavements can be implemented. Initial results indicate that a noise reduction of at least 8 dB is achievable for high-speed pavements, such as highways.

Next Steps

Porous asphalt has advanced considerably since the first investigations in the early 1970s. Despite many difficulties in implementation, the mixture today is the standard wearing course on freeways in the Netherlands. With the growing demand for silent roads, additional development is necessary, and more fundamental research is needed to understand and improve performance. The Netherlands has made great strides in gaining and applying knowledge about the performance of porous asphalt.

Acknowledgments

The author thanks colleagues at the Rijkswaterstaat Centre for Transport and Navigation for their input, especially R. Hofman for his contributions and critical remarks.

References

1. *RAW Standard Conditions of Contract Works of Civil Engineering Construction 2005: Addition, May 2008* (in Dutch). Ede, Netherlands, 2008.
2. Van der Zwan, J. T., J. Eikelboom, and T. Bennis. Skidding and Texture. Presented at European Conference on Porous Asphalt, Madrid, Spain, 1997.
3. *The C_{road} Method for Road Traffic Noise* (in Dutch). CROW Publication 200, Ede, Netherlands, April 2004.
4. *Improved Life Span for Two-Layer Porous Asphalt: Synthesis Report* (in Dutch). Rijkswaterstaat Centre for Transport and Navigation, Delft, Netherlands.
5. *Innovation Program for Noise Mitigation* (in Dutch). Scientific Strategy Document, Report DVS-2008-16, Ministry of Transport, Public Works, and Water Management, Rijkswaterstaat Centre for Transport and Navigation, Delft, Netherlands, 2008.
6. Hagos, E. T. *The Effect of Aging on Binder Properties of Porous Asphalt Concrete*. Dissertation. Section of Road and Railway Engineering, Faculty of Civil Engineering and Geosciences, Delft University of Technology, Delft, Netherlands, 2008.
7. Huurman, M. *Lifetime Optimisation Tool (LOT): Main Report*. Report No. 7-07-170-1, Delft University of Technology, Delft, Netherlands, 2008.
8. Scarpas, A., N. Kringos, and A. de Bondt. *Fundamental Experimental and Numerical Research into Raveling of Porous Asphalt Caused by Water Damage* (in Dutch). Final Report, Phase 1, Delft University of Technology, Delft, Netherlands, 2007.
9. Lifetime Optimization Tool (LOT) for Two-Layer Porous Asphalt. Final Report, 2007-D-R1230/B, TNO Built Environment and Geosciences, Delft, Netherlands, 2007.
10. *Acoustic Optimization Tool: Milestone RE2 Models Implemented in the First-Stage AOT Model*. M+P Consulting Engineers, Vught, Netherlands, November 2006.

NEW TRB SPECIAL REPORT

Achieving Traffic Safety Goals in the United States

Lessons from Other Nations

JOSEPH R. MORRIS

The author is Senior Program Officer, TRB Division of Studies and Special Programs, and served as Study Director for this project.

This article summarizes the conclusions and recommendations of the study committee.

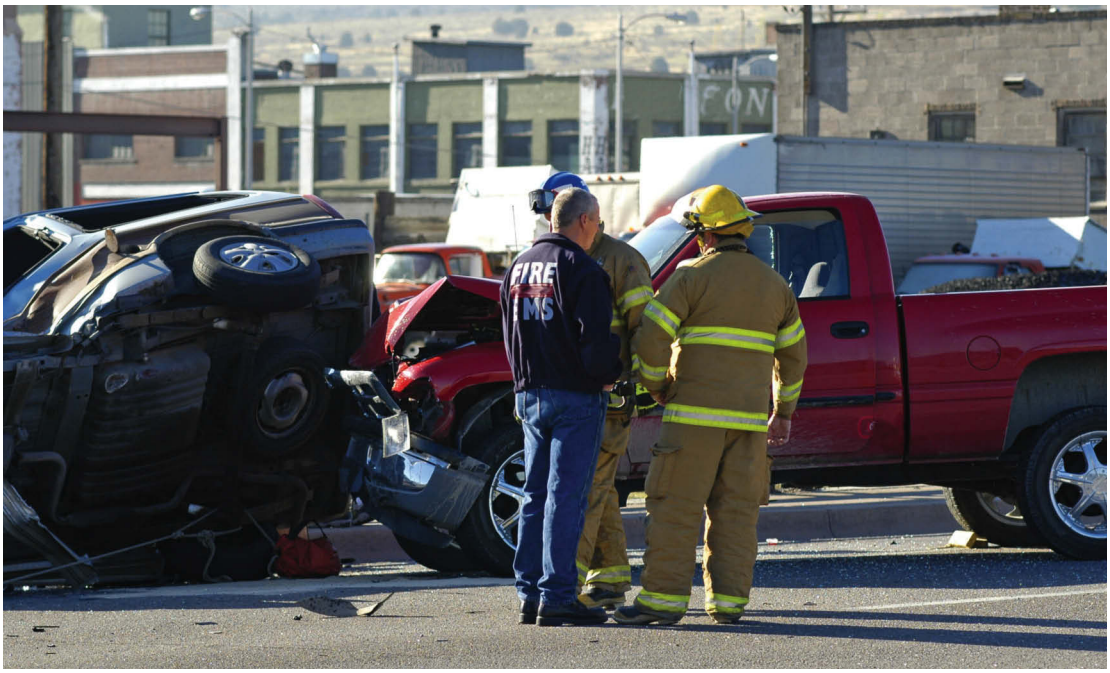
In 2009, some 34,000 people lost their lives on U.S. highways, a 19 percent reduction since 1995. During the same period, however, annual traffic fatalities declined by 52 percent in France, 39 percent in the United Kingdom, 25 percent in Australia, and 50 percent in 15 high-income countries for which long-term fatality and traffic data are available.

Although the decline in the U.S. total is significant, review of other nations' experiences indicates that the United States could achieve greater improvement in highway safety by adopting systematic, results-oriented safety management practices that are flexible enough to take into consideration local and regional legal constraints, community attitudes, resources, and road system and traffic characteristics.

U.S. Highway Safety

By some measures, the safety of road travel has improved greatly over the history of the automobile. Traffic deaths were five times higher in the United States per kilometer of vehicle travel in 1950 than today. Per capita annual deaths of pedestrians and cyclists in road crashes declined by about two-thirds for the same period, although walking and bicycle trips per household increased.

Nevertheless, the cost of automobile travel in terms of human lives remains high, because of the growth in traffic. Motor vehicle crashes caused 28 percent of all deaths among people 1 to 24 years of age in the United States in 2006. The annual number of U.S. traffic deaths changed little from the early 1990s until declining by 9.3 percent to 37,000 from



Nearly every high-income country is reducing annual traffic fatalities faster than is the United States.

2007 to 2008 and by another 9.7 percent to 34,000 in 2009. The U.S. economy entered a recession in 2007, and the decline in traffic deaths since then is consistent with the declines that occurred during past recessions.

Benchmark Comparisons

Nearly every high-income country is reducing annual traffic fatalities and fatality rates faster than is the United States. Several countries that 15 years ago posted fatality rates substantially higher than those in the United States per kilometer of travel now are posting rates that are lower.

The benchmark group of high-income nations with traffic safety practices commonly compared with those of the United States includes Australia, New Zealand, Canada, the Netherlands, Germany, Sweden, Finland, Norway, France, and the United Kingdom. Officials in these countries attribute their progress primarily to government traffic safety programs, including improvements in traffic control and road design; willingness to enact and enforce stringent driver regulations with regard to speed, alcohol and drug use, and seat belt use; and restrictions on younger and older drivers.

Differences among these countries in population characteristics, development patterns, and transportation systems account for part of the difference in their overall safety performance. Nonetheless, the demonstrated successes of specific safety initiatives in the benchmark countries offer important lessons for the United States.

Exploring the Gap

The gap in traffic safety progress between the United States and other high-income countries deserves the attention of U.S. transportation administrators and the public. The gap indicates that the United States may be missing important opportunities to reduce traffic deaths and injuries. The Transportation Research Board (TRB) formed the Committee for the Study of Traffic Safety Lessons from Benchmark Nations (see box, page 33)—appointed by the National Research Council—to review the factors that account for other countries' safety improvements and to recommend actions that would take advantage of the foreign experiences and fit the U.S. context.

The committee's report, published as Special Report 300, *Achieving Traffic Safety Goals in the United States: Lessons from Other Nations*, documents the experience of the benchmark nations in sharply reducing traffic deaths through comprehensive safety programs. The report examines traffic safety program management practices, risk reduction techniques, and the sources of public and political support for safety interventions.

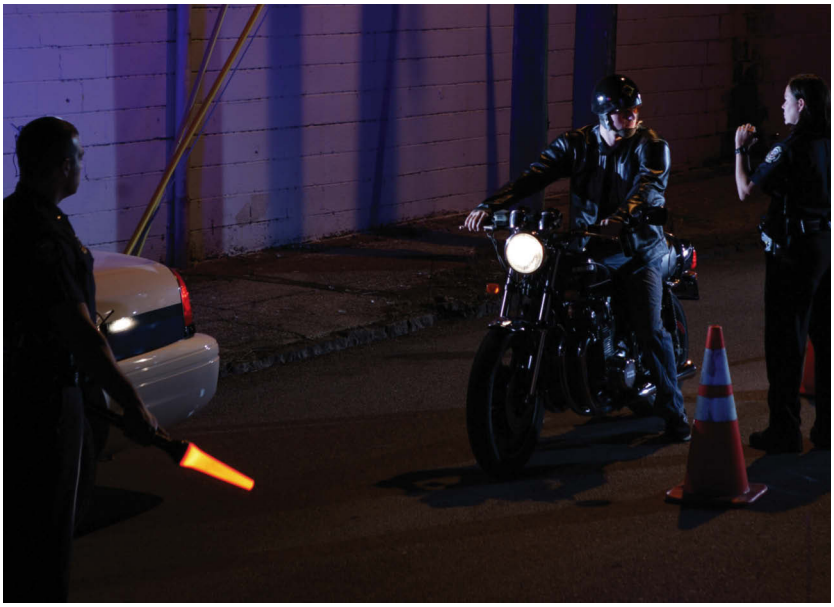


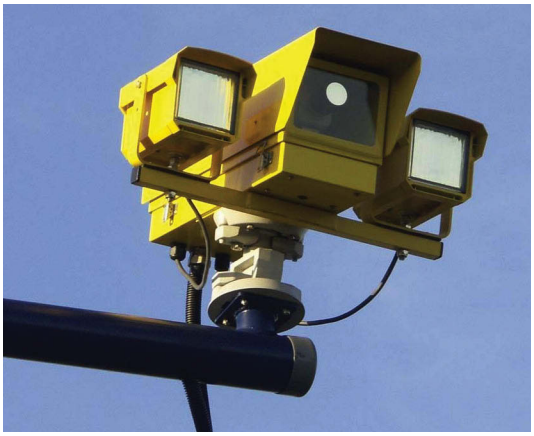
Photo: National Highway Traffic Safety Administration

Police officers conduct a sobriety test on a motorcycle driver. Many nations with exemplary safety records employ roadside sobriety checks as tools against road fatalities and mandate motorcycle helmet use.

Comprehensive Programs

The committee found that the nations most successful in reducing traffic deaths had implemented comprehensive safety programs that include improved road design and traffic management; regulation of vehicle safety; and regulation of driver behaviors with regard to speed, alcohol and drug use, and seat belt and helmet use. In addition, the successful national programs excel in management and planning and benefit from political support and leadership.

The committee noted that the most critical area for improvement in the United States may be in management and planning. Improved management will ensure the best use of available resources and, over time, will help foster political and public support by demonstrating that progress in traffic safety is attainable.



The Speed Check Enforcement System, in use in the United Kingdom, employs a digital safety camera to calculate a vehicle's point-to-point average speed.

Victoria, Australia, uses mobile speed cameras that operate on low-powered radar, detectable only at close range.

Management and Planning

Successful national safety programs are more distinguished by management than by particular interventions. The essential management model includes a systems perspective; a plan that specifies goals, milestones, methods, and resource requirements; regular monitoring to identify problems and measure progress toward goals; and ongoing evaluation to determine the effectiveness of the actions taken.

Comparisons of management methods in other countries with those in the United States, however, must take into account the decentralized structure of U.S. government. Management practices in U.S. traffic safety programs typically are deficient in elements of the ideal management model.

Congress therefore should authorize the U.S. Department of Transportation (DOT) to cooperate with the states in organizing a series of large-scale demonstrations of important elements of safety management to document the technical and resource requirements of effective safety programs. In addition, Congress should consider designating and funding an independent traffic safety evaluation and policy research organization to provide technical support and policy advice to government safety agencies and to reinforce accountability through performance evaluations.

Finally, in hiring and promotion decisions, transportation agencies should take into account demonstrated competency and professional qualifications in highway safety. Engineering schools and accreditation associations should set standards for the safety competencies of engineers practicing in areas that affect highway safety. In addition, in-service training programs are needed, especially short courses designed for local government public works engineers.

Countermeasures

Two enforcement techniques aimed at driver behavior have contributed to reductions in fatalities in the benchmark nations: automated enforcement of speed limits and frequent roadside sobriety checks to enforce laws against alcohol-impaired driving. Neither technique is in common use in the United States because of legal restrictions, popular opposition, and cost considerations.

Despite these constraints, the United States can learn important lessons from the benchmark nations' enforcement practices. Sustained and intensive enforcement, rationally organized and managed, can alter driver behavior sufficiently to improve safety systemwide.

The benchmark countries have reduced the frequency of alcohol-involved fatal crashes by lowering the legal limits on the maximum blood alcohol content, while intensifying enforcement, public health measures, efficient judicial procedures, and high-frequency, random sobriety testing. In other countries, successful speed management initiatives receive high visibility and endorsement from elected officials, are sustained for years, target major portions of the road system, use intensive automated enforce-

Speed cameras on Maryland Route 210 in Prince George's County.

ment and traffic calming features, and monitor progress toward publicized objectives for speed and crash reduction.

Laws in every benchmark country require motorcyclists to wear helmets. Seat belt use is higher in most of the benchmark countries than in the United States, although the rates in some U.S. states are comparable with those of the benchmark countries.

In several of the benchmark nations, nongovernmental organizations conduct assessments of road programs. The goal of revealing and publicizing hazards is to increase public demand for safety and to make officials more accountable for the safety performance of highways.

State and local governments can raise their level of highway safety enforcement by using resources more effectively; by increasing funding; and by adopting more cost-effective methods—particularly automated enforcement. In addition, the states and U.S. DOT should give high priority to encouraging regular use of sobriety checkpoints.

State officials and the federal government should act to preserve universal helmet use laws by communicating to legislators the health, safety, and economic costs of repeal. Each state should ensure that local police receive regular and substantial training in enforcement against impaired driving, speeding, and other high-risk driver behaviors. Finally, the states and U.S. DOT should transform the traditional hazard elimination program into a corridor safety improvement program that systematically identifies high-priority corridors and then designs comprehensive safety improvement strategies for each corridor.

Political and Public Support

Successful safety initiatives in the benchmark nations have the active support of elected officials in almost all cases. Public and political support has come about through the long-term efforts of professionals, officials, and nongovernmental advocates.

The creation of new high-level institutional structures has been valuable in the evolution of national programs in the benchmark nations. Sustaining the initiatives has depended on gaining the trust of the public by emphasizing transparency with respect to goals and communications, and by creating channels of communication between all parties.

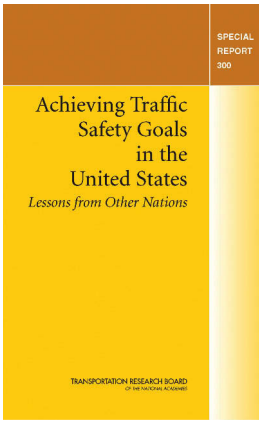
Public administrators and professionals often have been the initial leaders in educating and developing support among elected officials and the public. Most programs have used sustained, large-scale, and sophisticated social marketing to amplify the deterrent effect of enforcement and to influence public attitudes to high-risk behavior.

State legislatures should require regular reporting from the responsible executive agencies about progress in fulfilling the state's safety plan and in meeting the plan's goals. As a preliminary step to strengthening U.S. capabilities for application of social marketing to traffic safety, U.S. DOT should conduct an in-depth review of methods and outcomes in other countries. The national organizations of transportation and public safety officials, state legislators, and safety researchers should organize forums for the exchange of information and views on traffic safety.

Public agencies should cooperate in the development of the U.S. Road Assessment Program, but the program must maintain independence to be effective. All states should enact the minimum framework of traffic safety laws that has been instrumental in achieving the gains of the most successful safety programs in the benchmark countries. The framework should include legislation for automated speed enforcement.

Sustaining the Progress

The United States has opportunities to reduce the costs of road crashes through improvements in all three dimensions of safety programs: through management reforms; through wider application of the highest-payoff interventions; and through long-term efforts by professionals, officials, and nongovernmental organizations to build more consistent political and public support for rigorous safety programs. Sustained progress will require competent application of the full range of available interventions in a balance that is appropriate to the characteristics of jurisdictions.



Special Report 300, *Achieving Traffic Safety Goals in the United States: Lessons from Other Nations*, is available from the TRB Bookstore at www.trb.org/Finance/Public/Bookstore.aspx; to view the book online, go to http://onlinepubs.trb.org/onlinepubs/sr/sr300.pdf.

Committee for the Study of Traffic Safety Lessons from Benchmark Nations

Clinton V. Oster, Jr., School of Public and Environmental Affairs, Indiana University, *Chair*
Tony Bliss, Transport Division, Energy, Transport, and Water Department, World Bank
William A. Bronrott, Federal Motor Carrier Safety Administration, U.S. Department of Transportation
Troy E. Costales, Transportation Safety Division, Oregon Department of Transportation
Kent L. Cravens, New Mexico Senate
John J. Cullerton, Illinois Senate
Joseph A. Farrow, California Highway Patrol
Patrick S. McCarthy, Georgia Institute of Technology
Alison Smiley, Human Factors North, Inc., Toronto, Ontario, Canada
John S. Strong, College of William and Mary, Williamsburg, Virginia
Richard Tay, La Trobe University, Bundoora, Australia
Allan F. Williams, Insurance Institute for Highway Safety (retired)

Research on the Transmission of Disease in Airports and on Aircraft

Summary of a Symposium

CHRISTINE L. GERENCHER

The author is Senior Program Officer, Aviation and Environment, TRB, and served as rapporteur for the symposium.

On September 17–18, 2009, a diverse group from academia, government, industry, and nonprofit organizations convened at the National Academies' Keck Center in Washington, D.C., to share insights into the transmission of disease in airports and on aircraft. The Transportation Research Board (TRB) has published a summary of the symposium, including speaker-written highlights of the presentations, as Conference Proceedings 47, *Research on the Transmission of Disease in Airports and on Aircraft.*

The goals of the symposium were to examine (*a*) the status of research on or related to the transmission of disease on aircraft and in airports, (*b*) the potential application of research results to the development of protocols and standards for managing communicable disease incidents in an aviation setting, and (*c*) areas for additional research. The symposium program was designed to provide an opportunity for the aviation community to share data, models, and methods; discuss findings and preliminary conclusions of ongoing research; and identify gaps to inform future research projects.

Funded by TRB's Airport Cooperative Research Program (ACRP), the symposium was the product of almost eight months of planning and discussion by a committee chaired by Katherine B. Andrus, then with Air Transport Association of America, Inc. Appointed by the National Research Council, the committee consisted of experts from the public sector—federal, state, and local agencies, including public airports; the private sector, including an airline official and consultants with expertise in airport emergency response; and research institutions (see box, page 35).

Ben S. Cooper, U.K. Health Protection Agency, speaks on Human Movement Patterns and the Spread of Infectious Disease during the opening session of the TRB symposium in Washington, D.C., September 2009; his presentation examined the role of travel in the dissemination of pandemics and the impact of air travel restrictions.

Symposium presentations triggered audience questions and discussions, which identified topics for future research, and attracted media attention and coverage.

Timely Program

When planning began on the program, the committee knew the importance of the topic but had no expectation of the timeliness of the symposium. In April 2009, the outbreak and rapid spread of the novel H1N1 influenza virus renewed attention on communicable diseases.

Photo courtesy of Byron Jones, KSU

Aircraft cabin mock-up in the Aircraft Cabin Environment Research Laboratory, Kansas State University (KSU), is equipped with coach seats from a Boeing 767. In this experiment to measure contaminant dispersion, each seat is occupied by a thermal mannequin, and carbon dioxide tracer gas mixed with helium is released through the vertical tube in the center of the aisle.

Although the H1N1 pandemic underscored the role that travel often plays in the spread of disease, affecting the pattern and rate at which the spread occurs, the planning committee decided to focus on the actual transmission of disease during air travel. The committee decided that interest in—and uncertainty about—the spread of disease within an aircraft and airport environment was sufficient to justify this focus.

The introductory session helped participants develop a common understanding of how infectious disease spreads, how aircraft are ventilated, and the role of travel in spreading disease. After that session, three panels of researchers presented the science that underlies current understanding of the transmission of pathogens in the special environment of an aircraft cabin and in airport facilities. Each of the panels presented a distinct approach to research: case study investigations, theoretical modeling, and "bench science" experimental methods.

Photo courtesy of Byron Jones, KSU

In a KSU experiment with bacteria dispersion in the aircraft cabin, a researcher releases aerosolized surrogate bacteria with a handheld mister at the head height of the seated mannequins; bacteria are then collected from plates on top of the seat backs.

On the second day, the program shifted to examine practices and policies that can be informed by science, but too often are not. Several speakers noted that more scientific evidence, subjected to more rigorous analysis, is needed to determine the effectiveness of current practices such as applying pesticides to aircraft to control vector-borne diseases, developing airline and airport sanitation measures, or imposing travel restrictions to stem the spread of a pandemic. In the concluding session, members of the audience joined the session moderators in identifying areas for more research to improve understanding and to mitigate the transmission of disease through air travel.

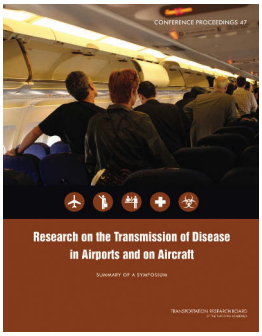
Diverse Perspectives, New Research

The symposium presented many opportunities for the exchange of ideas, and the discussions illustrated the benefits of bringing together researchers from different disciplines, along with the potential users of the research findings. The diverse perspectives and expertise applied to these issues identified many topics for researchers to explore in the transmission of disease.

ACRP subsequently funded two research projects stemming from the dialogue at the symposium:

◆ The Role of Air Travel in the Transmission and Spread of Insect-Borne Diseases (ACRP Project 02-20), which will develop a user-friendly geographic information system–based tool on CD-ROM to define the roles of airports and airlines in the transmission and spread of insect-borne human diseases; and

◆ Evaluating the Risk of Disease at Airports and on Aircraft (ACRP Project 02-20A), which will explore the best available epidemiological data and most current modeling techniques to assess and quantify the exposure risk of air travelers to infectious disease.



Conference Proceedings 47, *Research on the Transmission of Disease in Airports and on Aircraft: Summary of a Symposium*, is available from the TRB Bookstore at www.trb.org/Finance/Public/Bookstore.aspx; to view the book online, go to http://onlinepubs.trb.org/onlinepubs/conf/CP47.pdf.

Committee on Research on the Transmission of Disease in Airports and on Aircraft: A Symposium

Katherine B. Andrus, Air Transport Association, *Chair*

Alan Black, Dallas–Ft. Worth International Airport

Anthony D. B. Evans, International Civil Aviation Organization

Mark Gendreau, Lahey Clinic Medical Center and Tufts University School of Medicine

Marc Lipsitch, Harvard School of Public Health, Department of Epidemiology

John C. Neatherlin, Centers for Disease Control and Prevention

Chris Seher, Department of Homeland Security

John (Jack) Spengler, Harvard School of Public Health

Jennifer Topmiller, National Institute for Occupational Safety and Health

Jeanne C. Yu, Boeing Commercial Airplanes

Jean Watson, Federal Aviation Administration, *Liaison*

Improved Predictions of Pier Scour Save Bridge Resources

Florida Develops and Applies Findings

RICK RENNA AND VICKI MORRISON

The authors are with Florida Department of Transportation, Tallahassee; Renna is State Hydraulics Engineer, Office of Roadway Design, and Morrison is Technology Transfer Coordinator, Research Center.

Travelers in the United States rely on more than one-half million bridges to traverse valleys, bodies of water, roads, railroad tracks, and other physical obstacles. Bridge designs vary with function and with the nature of the terrain. In Florida, more than 8,600 bridges cross bodies of water.

Problem

Pier foundations placed in water disrupt the water's natural flow. The disrupted flow causes sediment erosion around the piers. This type of erosion, called local or pier scour, eventually lowers the channel bottom in the vicinity of the piers, reducing the stability of the bridge.

Standard practice requires that bridge foundations be designed to withstand the effects of scour for 100 years of flow. If the impacts of scour are underestimated, the bridge foundations will not be placed deeply enough in the stream bed, leading to bridge failure. In contrast, designs that overestimate scour depths produce bridge foundations that are deeper than required, significantly increasing the cost of construction. Accurate predictions of scour depths, therefore, are essential for a bridge to withstand conditions throughout its lifetime.

Local sediment scour at a bridge pier in a flood plain after a flow event.

Solution

The worldwide research community has identified the most important parameters related to structure, water flow, and sediment affecting pier scour depths. Applying dimensional analysis, researchers also have identified several dimensionless parameters that affect local scour depths. Determining the parameters that have the greatest impact and their interactions, however, has proved difficult.

Refining Predictive Equations

In the late 1980s, under a contract with the Florida Department of Transportation (DOT), Max Sheppard of the University of Florida tested the physical models of specific bridges. The test results showed that the predictive equations in the Federal Highway Administration's *FHWA Hydraulic Engineering Circular Number 18* (HEC-18) overpredicted scour depths for the cases examined. Applying the physical model results reduced the construction costs for the bridges significantly.

Florida DOT reinvested the savings from the shallower bridge substructure designs in additional research to develop equations for accurately predicting pier scour in noncohesive sediments, such as sand. As part of this research program, initiated in the early 1990s, Sheppard conducted local scour experiments in laboratories at the University of Florida, Colorado State University, the University of Auckland in New Zealand, and in a U.S. Geological Survey (USGS) Laboratory in Massachusetts. The experiments covered a range of structures and of sediment and flow conditions. The results from these tests served as the basis for developing the predictive equations.

The test results showed that local scour depths could be predicted accurately in terms of three parameters: V/V_c, y_1/a, and a/D_{50}, where V is the velocity of the flow approaching the pier, V_c is the flow velocity that initiates the movement of sediment away from the structure, y_1 is the unscoured water depth at the pier, a is the width of the pier, and D_{50} is

the median grain diameter of the sediment at the site. Working independently, other researchers confirmed that these three are the most important parameters. The equations that were developed work well for piers of simple shape.

Adjusting for Complex Piers

Many bridge piers, however, are complex in shape, composed of pile groups, pile caps, and columns. In the late 1990s, Florida DOT and FHWA collaborated to develop predictive scour equations for complex piers. The equations build on the work with scour on simple structures and apply the predictive equations.

The complex pier was divided into its components, and an effective width was computed for each component. Effective width is defined as the width of a component if it were a single circular pile subjected to the same flow and sediment conditions as the complex pier component. The effective width of the complete complex pier is the sum of the effective widths of the components.

After the effective width of the complex pier is determined, the simple pier equations are used to compute the scour depth. Laboratory tests were conducted with pier components and complete piers to provide the information needed to develop equations for computing the effective widths of pier components. The fourth edition of HEC-18, issued in 2001, included a version of this procedure, and the methods and equations have been updated twice since then for the *Florida Scour Manual* as additional data became available.

Implementation

In 2005, Florida DOT adopted the newly developed pier scour equations as part of its design procedures. Florida DOT continues to update both the simple and complex pier scour design equations to reflect findings from ongoing research. Florida DOT applies the scour equations in the design of new bridges and in the scour analysis of existing bridges. Other states also are applying the equations.

Benefits

The findings from this research have improved the accuracy of local scour prediction. By using the new, more accurate equations, Florida DOT has avoided overpredicting scour at piers, especially for designs with fine sediment and large substructure widths. Florida DOT engineers have been able to design bridge foundations with lesser penetration depth and—in some cases—with fewer or smaller pilings.

In the past five years, Florida taxpayers have saved millions of dollars through the application of the new pier scour equations to bridge designs. In addition, Florida DOT has reclassified some bridges that previously had been considered high risk to low risk, because of the more accurate scour predictions.

Washington State applied the new equations in the construction of the new eastbound span of the Tacoma Narrows Bridge on State Route 16, reducing the predicted scour depth by 43 feet from that generated with the equations in HEC-18. This savings in construction cost for the two main piers amounted to approximately $8 million.

For more information, contact Rick Renna, State Hydraulics Engineer, Office of Roadway Design, Florida Department of Transportation, 605 Suwannee Street, Tallahassee, FL 32399-0450; phone 850-414-4351; rick.renna@dot.state.fl.us.

Local scour test in the S. O. Conte Anadromous Fish Research Center Hydraulics Laboratory, USGS, Turners Falls, Massachusetts: (*left*) setup in the 20-ft-wide by 126-ft-long flume with a 3-ft-diameter pier in 2.9-mm-diameter sand; (*right*) clear-water scour at the 3-ft-diameter pier after a testing with 6-ft water depth and flow velocity of 2.2 ft/s.

Resources

Sheppard, D. M. *Large-Scale and Live-Bed Local Pier Scour Experiments, Phases I and II.* Coastal Engineering Technical Report No. 133, Civil and Coastal Engineering Department, University of Florida, Gainesville, 2003. www.dot.state.fl.us/research-center/Completed_Proj/Summary_STR/FDOT_BB473_1_rpt.pdf; www.dot.state.fl.us/research-center/Completed_Proj/Summary_STR/FDOT_BB473_2_rpt.pdf.

Sheppard, D. M. Overlooked Local Sediment Scour Mechanism. In *Transportation Research Record: Journal of the Transportation Research Board, No. 1890*, Transportation Research Board of the National Academies, Washington, D.C., 2004, pp. 107–111.

Sheppard, D. M., and R. Renna. *Florida Scour Manual*. Florida Department of Transportation, Tallahassee, 2006. www.dot.state.fl.us/rddesign/dr/Bridgescour/Florida-Scour-Manual-Training-Course.shtm.

Sheppard, D. M. and T. Glasser. Local Scour at Bridge Piers with Complex Geometries. *Proc., International Foundations Engineering Congress and Equipment Expo 2009*, Orlando, Florida, March 2009.

EDITOR'S NOTE: Appreciation is expressed to Waseem Dekelbab 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).

Michael T. Long

Oregon Department of Transportation

As project delivery manager for the Oregon Department of Transportation (DOT), Michael T. Long oversees more than 150 projects within a 13,000-square-mile region of western Oregon. Long's program is supported by more than 200 employees in the areas of planning, environmental services, engineering design, and construction. He previously managed Oregon DOT's statewide program for geotechnical engineering, hydraulic engineering, engineering geology, hazardous materials management, and environmental services.

Before joining Oregon DOT as a principal executive manager in 1998, Long managed the geotechnical services in several national forests for the U.S. Department of Agriculture. He started his career as a technician and geologist with the U.S. Forest Service after graduating from the State University of New York and the University of Oregon with degrees in geology and geography, respectively.

"The topic of low-volume roads has a wide scope of interest because the roads contain every element of planning, design, construction, safety, operations, and environmental and social issues."

Longtime management experience has given Long perspective on effective leadership. He cites a paraphrased quotation from Theodore Roosevelt as his inspiration: "It is not the critic who counts…The credit belongs to the person who is actually in the arena; whose face is marred by dust and sweat and blood; who strives valiantly; who errs and comes short again and again; who knows the great enthusiasms, the great devotions; and spends themselves for a worthy cause…and who at the worst, if they fail, fails while daring greatly, so that their place shall never be with those cold timid souls who know neither victory or defeat." Long affirms that a manager must "be visible as a representative of his or her employer, be effective as a communicator and consensus builder, and be consistent with expectations, rewards, and consequences." He describes the necessary elements of leadership as vision, sharing the decision process, leading by example, and mentorship.

Constructive and careful leadership has proved a necessity on many projects Long has helmed, such as an analysis of Oregon's Blue River Watershed. As the lead engineering geologist on the project, Long located, mapped, and analyzed the distribution of natural landslides and those associated with road construction. "From this empirical information, I extrapolated a reasoning for the dominant mass wasting process, for the types of soils that were most at risk, and for the slope angles and bedrock types that were the triggering factors," Long explains. Applying Level I stability analysis, he developed a hazard rating on the greatest slope instability of landforms, soil types, and topography related to road construction, timber harvest, and wildfire.

In the aftermath of a major fire in 1994 at Hatchery Creek in Wenatchee, Washington, Long codirected a team of engineers, geologists, and consultants to assess slope stability hazards in Tumwater and Icicle canyons. From the air and the ground, the team collected data on 10 square miles of land and more than 5,000 feet of relief, which Long and others analyzed and synthesized into recommendations for diversion and retention structures. Other projects on which Long has served as consultant or leader include an assessment of failure problems with rock abutments in the excavation of Seven Oaks Dam in San Bernardino, California, for the U.S. Army Corps of Engineers; overseeing the subsurface investigation, field-developed cross sections and subsurface interpretations, and rock slope discontinuity mapping and design of a 3.5-mile highway realignment project in Estacada, Oregon; and the rehabilitation of the Canyon Creek Bluffs Rock Slope in Sweet Home, Oregon.

Since 2000, Long has been a member of TRB's Low-Volume Roads Committee; he has chaired the committee since 2007. Long developed an appreciation for the role of low-volume roads in the nation's economy in childhood, when he spent time at his grandparents' home in rural Kentucky. His expertise in the field of low-volume roads and highways includes administration, economics and finance, environmental laws, project and workforce management, construction, geotechnical engineering, and materials.

"The topic of low-volume roads has a wide scope of interest, because the roads contain every element of planning, design, construction, safety, operations, and environmental and social issues," he explains.

Long also serves as a member of TRB's Design Section and of the Committee for the 10th International Conference on Low-Volume Roads. He is a registered professional geologist and is certified as an engineering geologist in Oregon and Washington; in the 1990s, he consulted for and appeared in two television shows for Oregon Public Broadcasting's "Oregon Field Guide."

Rebecca S. McDaniel

Purdue University

Technical Director of the North Central Superpave® Center at Purdue University, Rebecca McDaniel works to enhance the state of the art and practice in asphalt construction by training paving inspectors and other personnel; developing standards and conducting research; sharing information via technology, including a website, presentations, webinars, and an electronic newsletter; and mentoring graduate, undergraduate, and high school students.

McDaniel is a Purdue alumna with bachelor's, master's, and doctoral degrees in materials. In 1985, she joined the Indiana Department of Transportation's (DOT) Division of Research, working in pavements, materials, and accelerated testing. For several months in 1986 and 1987, she served as loan staff to the first Strategic Highway Research Program (SHRP); she recalls this as a highlight of her career: "Even though it was before full funding was received, serving on the SHRP staff was a fabulous experience. I met some icons of the industry, learned how major research programs work, and got in on the ground floor of the most influential research program of the past half century or so." While with SHRP, McDaniel attended her first TRB Annual Meeting and has missed only two meetings since.

"Making asphalt pavements that last longer, are quieter, are more sustainable, are safer, and can be constructed quicker or more economically is vitally important."

"Now that the North Central region has adopted Superpave as the routine asphalt mix design system, our work has expanded to asphalt in general," McDaniel notes. Current research at the center, which handles asphalt and Superpave issues for approximately 10 Midwestern states, includes increasing the use of locally available aggregate materials instead of importing high-friction aggregates, using reclaimed asphalt pavement (RAP) in surface mixtures, evaluating plant-produced asphalt mixtures that contain up to 40 percent RAP, and developing a decision strategy to determine if a substandard low air void mix should be replaced.

A registered professional engineer in the state of Indiana, McDaniel wears a special ring that reminds her of her obligations as a member of the Order of the Engineer. Seeing the ring on others creates a recognizable bond and brings to mind the engineer's commitment to serve and protect the public, McDaniel observes. She notes that asphalt research is fundamental to transportation infrastructure: "It is vital to our economy and way of life. Making asphalt pavements that last longer, are quieter, are more sustainable, are safer, and can be constructed quicker or more economically is vitally important."

As a woman in the field of engineering, McDaniel admits that her gender has brought her recognition but also has raised challenges. "Being in the minority lets you stand out and be noticed in a sea of men," she comments. "Yet on many occasions I have had to prove myself because of my gender, especially in the field when I was fresh out of college." She completed her Ph.D. over 10 years, while working full time and raising her three children; she still can recall the feeling of accomplishment when she turned in her dissertation. She currently is the second vice president of the Association of Asphalt Paving Technologists (AAPT) and is in line to become the second-ever female president of AAPT in 2012. "I would encourage young women to persevere—the rewards are worth it," she affirms.

McDaniel's first career influence was her father, an engineer and U.S. Army veteran who had worked on the Alaska Highway. "Childhood vacations included a visit to Alaska to 'his' highway, and frequently involved driving along construction projects—dodging dowel bar baskets and sometimes being stopped by bridges that were not finished," she recalls. Other mentors include Leonard E. Wood, her major professor at Purdue, who prompted McDaniel to become involved in TRB, and D. W. Lucas of Indiana DOT. "Mentoring younger people, to show them how rewarding a career in engineering and research can be, is very important," McDaniel comments.

McDaniel is a longtime active member of TRB committees. She chairs the Expert Task Group on Long-Term Pavement Performance Special Activities and the General Issues in Asphalt Technology Committee; she is a current or past member of the Mineral Aggregates Committee, the Characteristics of Asphalt Materials Committee, the Asphalt Materials Section, and of several National Cooperative Highway Research Program project panels. She also serves as vice chair of the American Society for Testing and Materials Committee on Road and Paving Materials and is a member of the Federal Highway Administration's Expert Task Group on Hot-Mix Asphalt Recycling and of the Multiregional Training and Certification Group.

Photo: AAA Foundation for Traffic Safety

Researchers at the University of Minnesota's ITS Institute tested the spatial orientation and way-finding skills of aging drivers.

Study Tests Navigation Skills of Aging Drivers

Researchers at the University of Minnesota's Intelligent Transportation Systems (ITS) Institute recently completed a study on navigation and spatial orientation in elderly drivers. According to the November 2010 report, much of the research on older drivers focuses on vehicle control, but elderly drivers' navigation skills have received scant attention—most of the research has concentrated on the use of navigational aids.

The ITS Institute study investigated how spatial orientation and way finding are maintained as adult drivers age. Two groups were tested—one consisting of drivers between the ages of 25 and 40 and one of drivers between the ages of 65 and 85—driving their own cars along a standardized 3-mile neighborhood route. Participants drove the route until it became familiar; at various points along the route, researchers asked the drivers to point in the direction of out-of-sight landmarks or intersections. The accuracy of participants' spatial identifications was recorded.

According to the report, elderly drivers made almost double the errors of younger drivers, indicating a possible link between aging and a decline in the ability to divide attention between tasks—namely, keeping control of a vehicle and way finding. Researchers note that the situation lacked experimental control; moreover, vehicle control was not examined in this study.

This report can be accessed at www.its.umn.edu/Publications/ResearchReports/reportdetail.html?id=1976.

Photometrics Evaluate Streetlight Technologies

The National Lighting Product Information Program (NLPIP) at Rensselaer Polytechnic Institute's Lighting Research Center has analyzed a variety of streetlight technologies for light output and distribution, energy use, spectral effects on visual performance, discomfort glare, and economy. NLPIP performed photometric evaluations on streetlights that used high-pressure sodium (HPS), pulse-start metal halide (PSMH), induction lamps, or light-emitting diode (LED) modules in installations that met *American National Standard Practice for Roadway Lighting* standards for a simulated 1-mile stretch of roadway.

According to the findings, twice as many LED or induction pole-mounted streetlights as HPS and PSMH lights would be needed to meet the standard lighting criteria because LED and induction streetlights require narrower spacing to achieve sufficient lighting. The average power demand of the LED streetlights was 1 percent to 10 percent less than that of the HPS streetlights and 8 percent to 24 percent less than that of PSMH lights; however, projected cost savings from decreased energy use were negated by the high cost of installing new poles, the report noted.

A November addendum to the report analyzes higher-powered LED streetlights—identified from the websites of the LED streetlight manufacturers included in the main report—using current LED streetlight prices and manufacturer-provided photometric data, with pole spacing held constant. Excluding pole cost, the average relative life cycle cost of LED streetlights with a module life of 25,000 hours was 2.3 times that of 150-watt HPS lights. With a module life of 50,000 hours, LED lights were 1.7 times the cost of HPS lights.

For more information about the report, visit www.lrc.rpi.edu/nlpip/publicationDetails.asp?id=927&type=1.

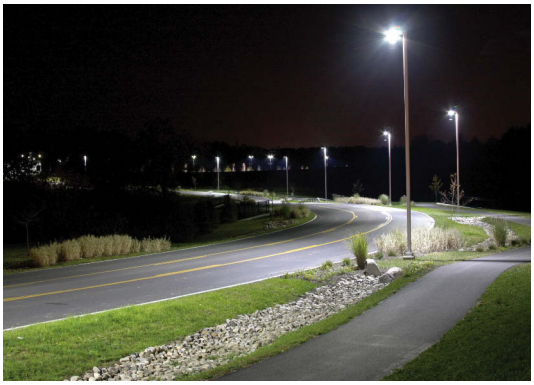


Photo: Lighting Research Center

The life-cycle costs of LED luminaires, shown here, exceed those of high-pressure sodium lights, according to findings by Rensselaer Polytechnic Institute's Lighting Research Center.

Photo: Washington State Department of Transportation

Among the crosswalk marking patterns studied in the report were transverse markings (*left*), bar pairs (*center*), and continental markings (*right*).

Study Rates Crosswalk Patterns for Visibility

In October, the Federal Highway Administration (FHWA) released a study of three crosswalk marking patterns: transverse lines, continental, and bar pairs. Although research on pedestrian treatments has explored the effectiveness of the presence of crosswalk markings, FHWA had noted a lack of research on the marking patterns.

Participants drove on a route through the campus of Texas A&M University, College Station, in a vehicle outfitted with instruments that allowed researchers to measure and record driving performance data. The route featured eight crosswalk markings—six at intersections and two midblock markings—and nine new midblock markings, each in one of the various patterns. The drivers noted when they saw a crosswalk, and the sight distance and response time were recorded. They also were asked to rate the markings on a scale of A to F in terms of visibility. Separate analyses were conducted for daytime and nighttime conditions.

Results showed that the marking pattern was statistically significant: during the daytime, continental markings and bar pair markings were detected most swiftly, at distances of approximately two times farther away than those at which transverse markings were detected. According to the report, this difference translates to approximately 8 seconds of increased awareness at a speed of 30 mph. Participants also gave the highest ratings to continental and bar pairs markings. Traffic had an obscuring effect on crosswalk detection, according to the study. Recommendations included standardizing the use of the highly-rated bar pair markings.

For more information and researchers' recommendations, visit www.fhwa.dot.gov/publications/research/safety/pedbike/10067/index.cfm.

Transit Facing Capacity and Operations Challenges

From 1998 through 2008, public transportation ridership growth surpassed overall population growth as well as the growth of vehicle miles traveled on U.S. highways, according to a Government Accountability Office (GAO) report. Although high unemployment and recession-related factors have caused public transit ridership to decline since 2008, GAO expects growth to resume in the future.

Examining data from the Federal Transit Administration's National Transit Database, the GAO report notes that the increased demand for public transportation led to capacity challenges for transit agencies. These include vehicle limitations, as well as insufficient and aging infrastructure—from a lack of rail cars and buses to difficulty meeting maintenance schedules. The responses of various agencies include service adjustments, new system investments, and system maintenance.

Future increases in public transit demand pose particular challenges for transit agencies in increased costs and fiscal uncertainties, however, and transit fares have not kept pace with increased operating costs—in 2008, fare revenues covered only one-third of operating expenses. In 1998, the federal government provided the largest share of transit funding; by 2008, local agencies had taken on this role, but since then, the recession has constrained funding.

The report recommends keeping rail and bus systems in a state of good repair, streamlining the delivery of federal grant programs and projects, and incorporating performance accountability into federal programs to make the most of the resources available to transit agencies.

To access the GAO report, visit bit.ly/GAO_Transit_Report.

IMPLEMENTING RESEARCH RESULTS—At a second Strategic Highway Research Program (SHRP 2) Oversight Committee meeting, December 1, 2010, at the Keck Center, TRB Executive Director Robert E. Skinner, Jr. (*upper left*), discusses preimplementation of SHRP 2 research results with (*clockwise from lower left*) SHRP 2 Deputy Director Ann Brach; SHRP 2 Director Neil Hawks; Oversight Committee Chair Kirk T. Steudle, Michigan Department of Transportation; Erik Maninga, Missouri Department of Transportation; Jeffrey F. Paniati, Federal Highway Administration; and Alan Clark, Houston–Galveston Area Council.

FUTURE TRANSPORTATION RESEARCH—John C. Horsley, American Association of State Highway and Transportation Officials (AASHTO) Executive Director, speaks at a meeting of the AASHTO Standing Committee on Research (SCOR) at the National Academies' Keck Center in Washington, D.C., December 9, 2010. SCOR solicits and evaluates projects and problem statements for the National Cooperative Highway Research Program. The meeting also featured a workshop examining long-range strategic issues for the transportation industry and the transportation research landscape in the coming decades.

SHRP 2 Showcases Integrated Planning

Three new case studies from SHRP 2 explore planning processes seemingly unrelated to transportation decision making that affect transportation—land use and air quality conformity, environmental, economic, safety, and security planning. The case studies present examples of collaboration to integrate transportation concerns into the planning process.

In Maricopa County, Arizona, a Transportation Policy Committee was established to secure continued funding for a new freeway system before the dedicated half-cent sales tax expired in 2005. Under the direction of the Maricopa Association of Governments, the committee developed a regional transportation plan (RTP)—a comprehensive, long-range, multimodal transportation plan that covers the next 20 years—and the sales tax was secured through 2025.

A second case study details the 10-step process used by the Wasatch Front Regional Council in the Salt Lake City, Ogden, and Layton areas of Utah to develop an RTP for the region. Key innovations include public involvement, a scoring method to facilitate prioritization, and the use of UrbanSim and a large amount of data in the project's early stages.

In a case study from Colorado, the Federal Highway Administration, Region 8 of the U.S. Environmental Protection Agency, the Colorado Department of Transportation, and the North Front Range Metropolitan Planning Organization joined forces in the Strategic Transportation, Environmental, and Planning Process for Urbanizing Places, or STEP UP. Made possible by an environmental streamlining grant, the pilot project advanced the technology needed to support the collaboration and allowed agency representatives to participate in decision making during the long-range planning process.

For more about these and other studies, visit the SHRP 2 web page at www.trb.org/StrategicHighwayResearchProgram2SHRP2/Public/Blank2.aspx.

PHOTO: JEANNIE BECKETT

NEW MARINE BOARD MEMBERS—Marine Board chair Michael Bruno, Stevens Institute of Technology (*center*), and Vice Chair Tom Leschine, University of Washington (*second from right*), welcome new members: (*left to right*) Ed Comstock, Raytheon; John Holmes, Port of Los Angeles; Peter Velez, Shell International Exploration and Production, Inc.; Stephan Grilli, University of Rhode Island; and Ali Mosleh, University of Maryland. The board met November 18–19, 2010, in New Orleans, Louisiana; the agenda included a U.S. Army Corps of Engineers tour of the city's new levees and pumping stations.

TRB Meetings 2011

March

13–16 Geo-Frontiers 2011*
Dallas, Texas

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

30–April 1 5th University Network Summit: Catastrophes and Complex Systems*
Washington, D.C.

May

1–3 International Transportation Economic Development Conference: Economic Impact of Connecting People, Goods, Markets, Employment, Services, and Production*
Charleston, West Virginia

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

10–11 Transportation Planning, Land Use, and Air Quality Conference
San Antonio, Texas

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

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

June

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

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

7–9 Joint Harbor Safety Committees and Area Maritime Security Committees Conference*
Houston, Texas

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

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

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

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

July

10–13 TRB Joint Summer Meeting
Boston, Massachusetts

11–14 Southern African Transport Conference*
Pretoria, South Africa

17–20 50th Annual Workshop on Transportation Law
Seattle, Washington

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

August

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

TBD 19th Biennial Symposium on Visibility and Traffic Control Devices
Minneapolis, Minnesota
Richard Cunard

September

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

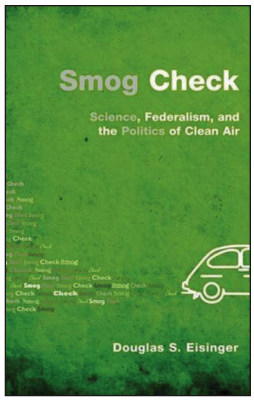
14–16 3rd International Conference on Road Safety and Simulation
Indianapolis, Indiana

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.

Smog Check

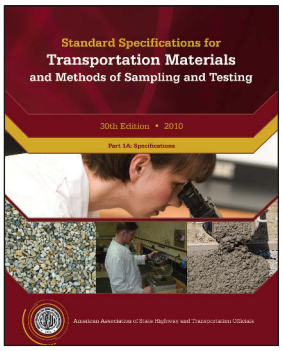
Douglas S. Eisinger. Earthscan–RFF Press, 2010; 256 pp.; $34.95; 978-1-93311-572-6.



After the Clean Air Act Amendments of the 1990s, a controversial U.S. Environmental Protection Agency (EPA) mandate for an overhaul of auto emissions testing led to a conflict between federal regulators and states—for example, the mandate prevented California from continuing its test program, "Smog Check." In the end, EPA granted states greater regulatory flexibility. Former EPA official and TRB Transportation and Air Quality Committee member Douglas S. Eisinger recounts the struggles between the states and federal regulators during this time. Questions about bargaining between agencies, the advantages of regulatory flexibility and performance-based regulations over command and control approaches, and decision making in the face of scientific disagreement are addressed in the book, which also includes commentary from EPA officials who observed or participated in the Smog Check controversy.

Standard Specifications for Transportation Materials and Methods of Sampling and Testing, 30th Edition; AASHTO Provisional Standards, 2010 Edition

American Association of State Highway and Transportation Officials (AASHTO), 2010; 4,484 pp.; AASHTO members, $625; nonmembers, $750; 1-56051-479-4.



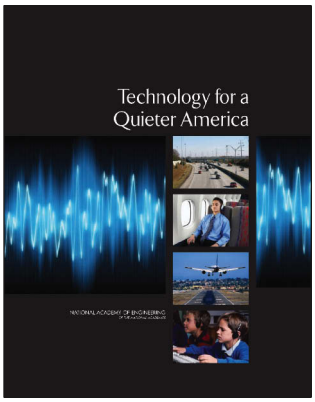
The 30th edition of the *Standard Specifications for Transportation Materials and Methods of Sampling and Testing*—also known as the Materials Book—contains revised and new specifications and test methods to accompany the more than 400 materials specifications and test methods used in the construction of highway facilities. Developed and maintained by AASHTO's Subcommittee on Materials, the text is organized into two volumes—Materials and Testing.

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

The 14th edition of the *AASHTO Provisional Standards*, which includes 7 revised standards and 19 new standards, can be purchased as a set with the Materials Book. Both references also are available as a single-user CD-ROM.

Technology for a Quieter America

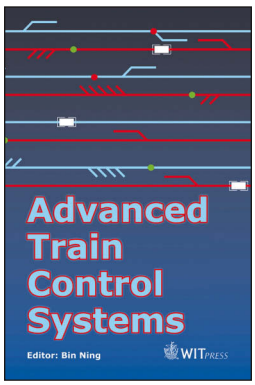
National Academies Press, 2010; 216 pp; $44; 978-0-309-15632-5.



The most commonly identified sources of noise and their characteristics are explored in a National Research Council and the National Academy of Engineering report. The text also describes efforts to reduce noise emissions and reviews the standards, regulations, and agencies that govern noise levels. An issue in industry, communities, and buildings, problematic noise is likely to become more pervasive as developing countries industrialize and as the world population grows. This report reviews efforts to mitigate noise and assembles sources of information that are available to the public.

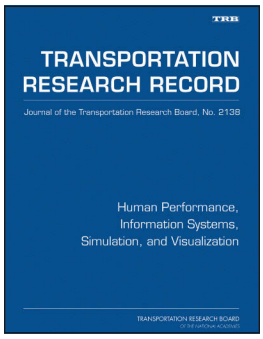
Advanced Train Control Systems

Edited by Bin Ning. WIT Press, 2010; 176 pp.; $134; 978-1-84564-494-9.



As the brains and nerves of trains, advanced train control systems are critical in improving the efficiency and safety of train operation. These complex computer tools ensure reliable and safe systems, which typically consist of four parts: the central control system, station control and wayside systems, onboard control systems, and a communication network. Their life cycle includes design and development, redesign for application, simulation verification and testing, and safety assessments of systems and subsystems. This volume comprises papers on such topics as communication-based moving block systems on metro lines, emergency braking intervention in automatic train protection systems, and the resignaling of Paris Métro's Line 1 for driverless operation.

TRB PUBLICATIONS



Human Performance, Information Systems, Simulation, and Visualization
Transportation Research Record 2138

This volume includes papers on the driving behavior of military personnel during wartime deployment, intrafamilial influences on driving behavior, signs and markings for partial continuous-flow intersections, the effect of headlight swivel angle on driver behavior, using driving simulators in geometric design, driver distractions that lead to crashes, the impact of cognitive workload increase on young adult drivers, the immediate recall of driver warnings in forward collision warning scenarios, and more.

2009; 145 pp.; TRB affiliates, $46.50; nonaffiliates, $62. Subscriber category: safety and human performance.

Energy and Global Climate Change 2009
Transportation Research Record 2139

The 21 papers in this volume explore the effects of shifting to diesel-powered vehicles, road grade impacts on fuel consumption and carbon dioxide emissions, fuel prices and consumer vehicle preferences, plug-in hybrid electric vehicles, hydrogen fueling, addressing climate change in transportation planning, the implications of climate change for future airport weather delays, information technology to improve railway capacity and service quality, a carbon dioxide emissions trading scheme in Germany, and more.

2009; 188 pp.; TRB affiliates, $52.50; nonaffiliates, $70. Subscriber category: planning and administration.

Pedestrians, Bicycles, and Motorcycles
Transportation Research Record 2140

Research is presented on topics including the impact of weather and season on pedestrian traffic volumes; an automated analysis of pedestrian–vehicle conflicts using video data; a Federal Highway Administration project to reduce pedestrian fatalities, injuries, and conflicts; a comparison of latent walk trips in Toronto and Montreal, Canada; pedestrian safety education for elementary and middle school children; risk-taking in moped and motorcycle crashes; impaired operation of motorcycles; and the effectiveness of motorcycle training and licensing.

2009; 223 pp.; TRB affiliates, $56.25; nonaffiliates, $75. Subscriber category: safety and human performance.

Nanotechnology in Cement and Concrete, Vols. 1 and 2
Transportation Research Record 2141 and 2142

The papers in this two-volume set explore the effects of microsilica and nanosilica in concrete, nanoindentation of alkali-activated fly ash, cement paste microstructure evolution, atomic force microscopy examinations of mortar, atomic force microscopy to measure the nanoscale mechanical properties of cement pastes, and many other topics.

2010; 245 pp.; TRB affiliates, $57.75; nonaffiliates, $77. Subscriber category: materials and construction.

Transit 2010, Volume 1
Transportation Research Record 2143

Authors present research on network connectivity; soft costs in major fixed-guideway projects; a data-processing framework for transit performance analysis; subway productivity, profitability, and performance; short-headway transit services; rail transit preferences of commuters, travelers, and shoppers; estimating greenhouse gas emissions from public transit vehicles; mitigating excessive bus idling; the impact of car sharing on vehicle ownership; and the Global Positioning System integrated with real-time transit information.

2010; 176 pp.; TRB affiliates, $54; nonaffiliates, $72. Subscriber categories: public transportation; administration and management; planning and forecasting; vehicles and equipment.

Transit 2010, Volume 2
Transportation Research Record 2144

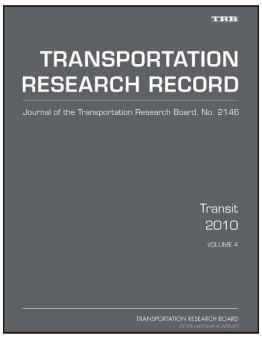
Topics examined include the effect of gasoline prices on transit ridership in the United States, alternative methods to estimate transit accessibility, a social experiment to encourage drivers to try transit, a multimodal overview of art in public transportation, a travel time analysis using smart card data, customer loyalty modeling, and intermodal transfer between bicycles and rail in China.

2010; 196 pp.; TRB affiliates, $56.25; nonaffiliates, $75. Subscriber categories: public transportation; planning and forecasting; terminals and facilities; passenger transportation; operations and traffic management; environment.

Transit 2010, Volume 3
Transportation Research Record 2145

Explored are subjects such as a direct ridership model of bus rapid transit, citywide bus network restructuring, a coordinated and conditional bus

TRB PUBLICATIONS *(continued)*



priority approach, a method for determining bus route passenger origin–destination flows, space requirements for wheeled mobility devices in public transportation, influence of basic rural paratransit characteristics on organizational culture, and an information management system for public and specialized transportation providers.

2010; 114 pp.; TRB affiliates, $44.25; nonaffiliates, $59. Subscriber categories: public transportation; vehicles and equipment; society; passenger transportation; operations and traffic management.

Transit 2010, Volume 4
Transportation Research Record 2146

An innovative transport solution for suburban areas; track geometry for light rail systems; vehicle and pedestrian safety at light rail stops; a solution to rail overcrowding; service control on a high-frequency metro line; rail infrastructure development; personal rapid transit; transit security awareness campaigns; the impact of rail terminal design on transit service reliability; the implementation of a multijurisdictional, public–private partnership commuter rail project; and a commuter rail implementation study are among the topics covered in this volume.

2010; 132 pp.; TRB affiliates, $48; nonaffiliates, $64. Subscriber categories: public transportation; marine transportation; vehicles and equipment; passenger transportation; security and emergencies; terminals and facilities.

Highway Safety Data, Analysis, and Evaluation 2010, Volume 1
Transportation Research Record 2147

The papers in this volume examine publication bias in road safety evaluation, using personal digital assistants to collect data on animal carcass removal from roadways, the U.S. Road Assessment Program star rating protocol, a proposed safety index based on driver risk-taking, the effect of street patterns on road safety, models of severity of traffic crash injuries, predicting single-vehicle fatal crashes for two-lane rural highways, identifying hot spots, and a comparison between models estimated with accident-modification factors and covariate models.

2010; 122 pp.; TRB affiliates, $44.25; nonaffiliates, $59. Subscriber categories: highways; safety and human factors.

Highway Safety Data, Analysis, and Evaluation 2010, Volume 2
Transportation Research Record 2148

Research is presented on a full Bayes approach to before-and-after safety evaluation with matched comparisons, the effect of rumble strips in collision reduction, safety performance dispersion parameters for two-lane rural roads, and model-based applications of the Abbreviated Injury Scale to police-reported crash injuries, along with an electronic crash data collection transmission model, the fatality risk of intersection crashes on rural undivided highways, and implementation of in-vehicle safety systems.

2010; 123 pp.; TRB affiliates, $44.25; nonaffiliates, $59. Subscriber categories: highways; safety and human factors.

Traffic Control Devices, Visibility, and Highway–Rail Grade Crossings 2010
Transportation Research Record 2149

School traffic control devices, speed control at rural intersections, innovation in temporary pedestrian signing, chevrons with full retroreflective signposts on rural horizontal curves, pedestrian countdown signals' influence on vehicle speed, dilemma zone driver behavior, and impacts of highway–rail grade crossings on surface mobility are among the topics examined.

2010; 114 pp.; TRB affiliates, $44.25; nonaffiliates, $59. Subscriber categories: highways; railroads; pedestrians and bicyclists; operations and traffic management; safety and human factors.

Infrastructure Maintenance and Preservation
Transportation Research Record 2150

Papers explore performance-based road maintenance contracts, replacing equipment at state departments of transportation, pavement preservation, thin surface treatments for bituminous pavements, chip seals, hot-poured crack sealants, monitoring the structural health of bridges and tunnels, fiber-reinforced polymer (FRP) systems in concrete, FRP

The TRR Journal Online website provides electronic access to the full text of more than 10,700 peer-reviewed papers that have been published as part of the Transportation Research Record: Journal of the Transportation Research Board *(TRR Journal) series since 1996. The site includes the latest in search technologies and is updated as new TRR Journal papers become available. To explore the TRR Online service, visit www.TRB.org/TRROnline.*

TRB PUBLICATIONS *(continued)*

pile repair that incorporates cathodic protection, and the failure and repair of a deck closure pour on I-81.

2010; 128 pp.; TRB affiliates, $48; nonaffiliates, $64. Subscriber categories: highways; maintenance and preservation; materials; pavements; bridges and other structures.

Construction 2010, Volume 1
Transportation Research Record 2151

Research is presented on topics including a sliding-scale contingency for the project development process, the effects of project cost-reduction methods, roadway construction sustainability impacts, coordination of a design contract with a preconstruction service contract, optimization of equity capital structure in public–private partnership contracts, the duration of the design–build procurement effect on the performance of transportation projects, the optimum sample size for percent-within-limits specifications, and a probabilistic, performance-related specifications methodology that is based on the *Mechanistic–Empirical Pavement Design Guide* (MEPDG).

2010; 102 pp.; TRB affiliates, $42.75; nonaffiliates, $57. Subscriber categories: highways; construction; pavements; bridges and other structures.

Construction 2010, Volume 2
Transportation Research Record 2152

The eight papers in this volume examine determining concrete pavement thickness using probing and coring methods; nonwoven geotextile interlayers in concrete pavements; estimating asphalt density using ground-penetrating radar; an evaluation of asphalt pavement longitudinal joints that uses a combined falling-weight deflectometer and multichannel analysis of surface waves; rapid bridge deck replacement; horizontally curved steel I-girder bridge construction engineering; the effect of a cross-frame on the stability of a double I-girder system under erection; and the fatigue performance of groove-welded tube-to-end-plate connections in support structures for signs, luminaires, and signals.

2010; 70 pp.; TRB affiliates, $40.50; nonaffiliates, $54. Subscriber categories: highways; construction; pavements; bridges and other structures.

Pavement Management 2010, Volume 1
Transportation Research Record 2153

A pavement rehabilitation project ranking approach using probabilistic long-term performance indicators, integrating MEPDG distresses with local performance indices, piecewise approximation in pavement performance modeling, using a specific panel rating method to develop an overall combined condition index for pervious concrete pavements, an evaluation for transverse cracking in freeway asphalt pavements, optical texture-based tools for monitoring pavement surface wear and cracks, a mechanistic–empirical program to analyze and design flexible pavement rehabilitation, runway instrumentation and response measurements, and more are addressed in this volume.

2010; 169 pp.; TRB affiliates, $51; nonaffiliates, $68. Subscriber categories: highways; pavements.

Guidebook on Risk Analysis Tools and Management Practices to Control Transportation Project Costs
NCHRP Report 658

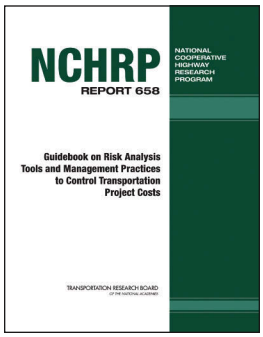
Project cost escalation is a serious problem for state highway agencies—it has a detrimental effect on later programs and causes a loss of the public's faith in the agency. It is vital for engineers, project managers, and cost estimators to recognize uncertainty early in the project development process and to inform stakeholders. A comprehensive risk management approach can help project teams identify, assess, mitigate, and control project risks; specific, practical, and risk-related management practices and analysis tools are explored in this report.

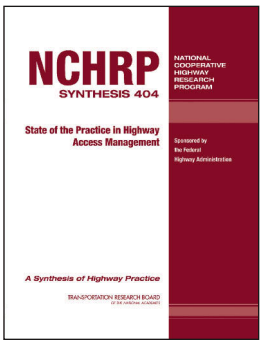
2010; 119 pp.; TRB affiliates, $40.50; nonaffiliates, $54. Subscriber categories: administration and management; construction; design; environment; highways; planning and forecasting.

Guide for the Geometric Design of Driveways
NCHRP Report 659

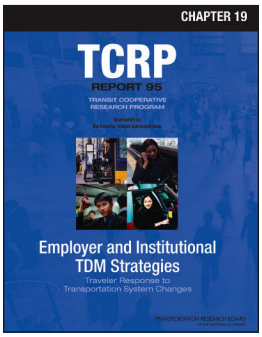
Although roadway design, function, and traffic volumes have continued to change and develop since the mid-20th century, driveway design has received little guidance. Driveways—especially busy commercial drives—can have a significant impact on the adjacent roadway; good driveway design should facilitate vehicle egress and ingress to and from the roadway and should accommodate pedestrians and bicyclists. This report includes driveway-related terms and definitions, an examination of basic geometric controls, a summary of access spacing principles, and discussions of various geometric design elements.

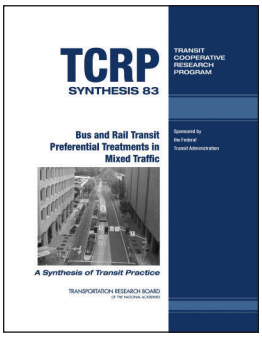
2010; 84 pp.; TRB affiliates, $37.50; nonaffiliates, $50. Subscriber categories: highways; design; operations and traffic management; and pedestrians and bicyclists.

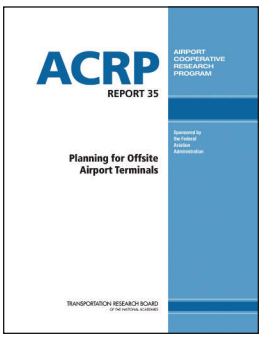


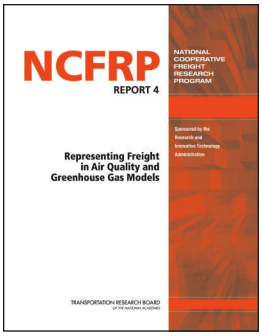


TRB PUBLICATIONS *(continued)*









Transportation Performance Management: Insight from Practitioners
NCHRP Report 660

Departments of transportation collect substantial amounts of data, and many calculate performance measures; however, recent years have seen a shift from performance measurement to performance management and to a careful and strategic selection of measures, targets, and decision making. This report examines how other agencies bring performance management into the decision making process. Decisions on strategy, resource allocation, operations, and human resources are considered.

2010; 48 pp.; TRB affiliates, $30.75; nonaffiliates, $41. Subscriber categories: highways; public transportation; administration and management; planning and forecasting.

State of the Practice in Highway Access Management
NCHRP Synthesis 404

Through a comprehensive review of existing access management-related literature and a survey of state departments of transportation, metropolitan planning organizations, counties, and municipalities, this synthesis explores current practice among highway access management programs. Primary focus areas include legal, legislative, policy, program, implementation, and effectiveness issues related to access management.

2010; 112 pp.; TRB affiliates, $41.25; nonaffiliates, $55. Subscriber categories: design; highways; operations and traffic management.

Employer and Institutional Transportation Demand Management (TDM) Strategies: Traveler Response to Transportation System Changes
TCRP Report 95: Chapter 19

Analyzing a collection of 82 cases, authors evaluate the relative importance of TDM strategies—for example, a transit subsidy versus a high-occupancy vehicle parking discount—through pair-wise comparisons. Employer and institutional TDM actions are classified into four major categories: employer or institutional support actions, provision of transportation services, financial incentives or disincentives, and alternative work arrangements.

2010; 173 pp.; TRB affiliates, $49.50; nonaffiliates, $66. Subscriber categories: public transportation; planning and forecasting.

Bus and Rail Transit Preferential Treatments in Mixed Traffic
TCRP Synthesis 83

This synthesis reviews the application of different transit preferential treatments in mixed traffic and the decision-making process for choosing the treatment most applicable to a particular location. Treatments addressed include median transitways, exclusive lanes outside the median area, limited stop spacing and stop consolidation, transit signal priority, special signal phasing, queue jump and bypass lanes, and curb extensions.

2010; 202 pp.; TRB affiliates, $51; nonaffiliates, $68. Subscriber categories: design; operations and traffic management; public transportation.

Planning for Offsite Airport Terminals
ACRP Report 35

An airport must establish goals and objectives before evaluating the feasibility of offsite terminals. This guide provides practical assistance to airport staff and other decision makers for planning and developing an offsite terminal and airport transportation link. Also investigated are issues related to providing originating passengers with transportation to remote terminal facilities and identifying potential markets for an offsite terminal.

2010; 86 pp.; TRB affiliates, $39.75; nonaffiliates, $53. Subscriber category: aviation.

Representing Freight in Air Quality and Greenhouse Gas Models
NCFRP Report 4

As demand for freight transportation grows, so do concerns about the greenhouse gas emissions that contribute to global warming—freight emissions will account for a greater share of the transportation sector's carbon footprint. This report explores the current methods of generating air emissions information for all freight transportation activities and assesses the suitability of the information for health and climate risk assessments for prioritizing emission reduction activities and for use in public education.

2010; 162 pp.; TRB affiliates, $46.50; nonaffiliates, $62. Subscriber categories: aviation; energy; environment; freight transportation; highways; marine transportation; motor carriers; railroads; vehicles and equipment.

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

INFORMATION FOR CONTRIBUTORS TO

TR NEWS

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

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

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

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

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

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

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

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

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

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

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

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

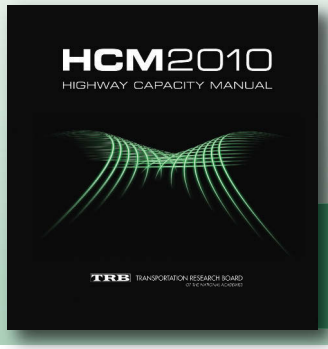
NOTE: Authors are responsible for the authenticity of their articles and for obtaining written permissions from publishers or persons who own the copyright to any previously published or copyrighted material used in the articles.

HIGHWAY CAPACITY MANUAL 2010

A Classic Updated—Order Today!

The long-awaited fifth edition of the essential *Highway Capacity Manual* (HCM 2010) will ship in March. TRB is taking advance orders for the publication. HCM 2010 updates the 2000 edition and significantly enhances the way that engineers and planners assess the traffic and environmental effects of highway projects by

- Providing an integrated, multimodal approach to the analysis and evaluation of urban streets from the points of view of automobile drivers, transit passengers, bicyclists, and pedestrians;
- Addressing the application of microsimulation analysis and the evaluation of the results;
- Examining active traffic management in relation to demand and capacity; and
- Exploring specific tools and generalized service volume tables, to assist planners in sizing future facilities.



HCM 2010 consists of four volumes:

Volume 1: Concepts;

Volume 2: Uninterrupted Flow;

Volume 3: Interrupted Flow; and

Volume 4: Applications Guide (electronic only).

The multivolume format provides information at several levels of detail, helping HCM users apply and understand the concepts, methodologies, and potential applications. Volumes 1, 2, and 3 are a boxed set. Volume 4 is electronic only, accessible via the Internet by registered HCM 2010 users, and includes supplemental chapters on methodological details and emerging issues; interpretations, clarifications, and corrections; comprehensive case studies; and a technical reference library.

Order your HCM 2010 today—
http://books.trbbookstore.org/hcm10.aspx.

THE NATIONAL ACADEMIES™
Advisers to the Nation on Science, Engineering, and Medicine

The nation turns to the National Academies—National Academy of Sciences, National Academy of Engineering, Institute of Medicine, and National Research Council—for independent, objective advice on issues that affect people's lives worldwide.
www.national-academies.org

TRN272