

TR NEWS

NUMBER 260

JANUARY-FEBRUARY 2009

3 Making Certain Progress in Uncertain Times: The Transportation Research Board's 2008 Field Visit Program

The 2008 field visits by TRB Technical Activities staff found that transportation agencies are addressing uncertainties about the economy, energy, climate change, funding, and national policies with new ideas, programs, and techniques to improve customer services. The commitment, hard work, and dedication of transportation personnel promise positive developments in the coming year.

17 The Collaborative Decision-Making Framework: Evolving Product of SHRP 2 Capacity Research

Stephen J. Andrle and Janet D'Ignazio

The Capacity focus area of the Second Strategic Highway Research Program is developing approaches and tools for integrating environmental, economic, and community requirements into the analysis, planning, and design of new highway capacity. The Collaborative Decision-Making Framework provides an adaptable approach, with principles, guidelines, and procedures for a variety of projects and contexts.

24 NEW TRB SPECIAL REPORT Safety Research on Highway Infrastructure and Operations: Improving Priorities, Coordination, and Quality

Jill Wilson

The field of road safety improvement is developing a foundation in science, with knowledge based on high-caliber research studies instead of on conventional wisdom and observation of practice. A study committee appointed by the National Research Council has developed recommendations on the processes for establishing research priorities, coordinating research activities, and improving research quality.

28 NEW TRB SPECIAL REPORT The Federal Investment in Highway Research 2006–2009: Strengths and Weaknesses

Stephen R. Godwin

The TRB Research and Technology Coordinating Committee, appointed by the National Research Council, has published an assessment of the highway research programs funded under the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users. Recommendations and findings address such issues as competitive awards of funding, advanced research, funding cuts, stakeholder-supported programs, dissemination of results, and setting research priorities.



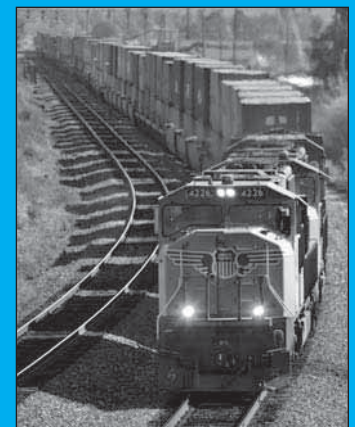
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COVER: A cargo train passes near Riverside, California. During the past year's economic downturn, state transportation agencies and institutions have worked with determination and resolve to keep transportation and research on track, delivering innovations and cost efficiencies. (Photo: Caltrans)

TR NEWS

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

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Publications Office**

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

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COMING NEXT ISSUE

The March–April *TR News* features photo highlights and brief reports from TRB's 88th Annual Meeting, January 11–15, in Washington, D.C., including the spotlight sessions on Transportation, Energy, and Climate Change; an array of speakers, sessions, and poster displays; exhibits and special events; major awards and new officers; and more. Feature articles focus on transportation libraries in the digital age; the history of Transportation Research Information Services, which recently celebrated its 40th anniversary; and a point of view on the vital role of libraries at state departments of transportation. The next issue also includes an examination of the equity implications of financing the nation's surface transportation system and a summary of progress in the Strategic Highway Research Program 2.



The TRB 2009 Annual Meeting program offered more than 600 sessions with approximately 3,500 papers and presentations, plus meetings and special events, earning the focused attention of more than 10,000 registrants, who shared information about research and best practices, networked with colleagues, and pursued professional and educational goals, as exemplified by this group of first-time attendees, briefed by V. Thera Black (*left*), Chair of the Metropolitan Policy, Planning, and Processes Committee.

Making Certain Progress in Uncertain Times

Specialists in the Transportation Research Board's (TRB'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 field visit program. Senior program officers in TRB's Technical Activities Division 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 members are involved in planning and delivering conferences, workshops, and meetings. This report presents a summary of what the TRB staff learned from these visits and activities during the past year.



Photo: CAUTRAMS



Photo: FHWA AND TRANSTEC GROUP



Photo: CAUTRAMS

Uncertainty was the prevailing concern among transportation organizations in 2008. The uncertainties mentioned most often included the following:

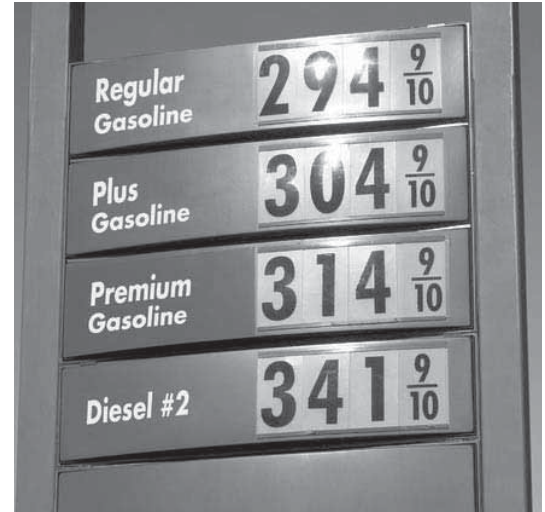
- ◆ The deepening economic recession, its length, and its impacts;
- ◆ The massive fluctuations in the cost of fuel, and the short- and long-term effects on transportation;
- ◆ The long-term viability of the gas tax, and what might replace it;
- ◆ The future of federal and state highway trust funds;
- ◆ The roles of transportation agencies in adapting to—and helping to mitigate—climate change and the generation of greenhouse gases;
- ◆ The transportation philosophies and policies of a new administration and Congress;
- ◆ The provisions and scope of new federal authorizations for surface transportation and aviation; and
- ◆ The content of the economic stimulus bill and the potential enactment of a national carbon cap-and-trade law to curb greenhouse gas emissions.

These and other uncertainties are affecting all transportation modes and disciplines. What is certain, however, is that the transportation community is forging ahead—despite these obstacles—with new ideas, programs, and policies to improve customer services. The 2008 TRB field visits witnessed this determination firsthand.

Institutional Issues

Policy, Management, and Leadership

Chronic funding shortages, combined with the economic downturn, presented state DOTs and other transportation organizations with some of the biggest budget challenges in decades. High gas prices in the first half of the year, along with a deepening recession, drove down gasoline consumption and gas tax



Massive fluctuations in fuel prices were a major source of uncertainty for decision makers, planners, and the general public.

revenue. Congress passed an \$8 billion relief measure to infuse the Highway Trust Fund with additional money to support current programs.

As receipts from property and sales taxes dropped, along with housing prices and consumer spending, many states scaled back their budgets for transportation capital and maintenance programs. Many states are experimenting with innovative funding mechanisms, including public-private partnerships, tolling, and high-occupancy toll lanes.

Personnel is another limited resource. With the first wave of baby boomers retiring, many state DOTs must focus on training to develop and enhance the skills and knowledge of the retirees' successors.

Harvard University selected Virginia DOT's knowledge management program as one of the Top 15 Innovators of 2008, from 1,000 candidates. The Virginia Transportation Research Council administers the program, which has created 40 communities of practice—subject-matter experts who assemble from throughout the department to discuss key

Members of the National Surface Transportation Policy and Revenue Study Commission brief the TRB Executive Committee in January 2008 on the report, *Transportation for Tomorrow*, identifying alternative funding sources; (left to right:) Tom Skanke, Steve Heminger, Jack Schenendorf, Frank Busalacchi, Rick Geddes, and the late Paul Weyrich.



transportation issues. This multidisciplinary approach draws from a spectrum of engineers, planners, and administrators to consider topics selected by staff—such as techniques for managing megaprojects or ways to enhance safety measures. The special program has involved hundreds of staff members and has served to break down stovepipes—or isolated working groups—and to increase collaboration within the organization.

The Alaska Department of Transportation and Public Facilities and the Tribal Technical Assistance Program are establishing a Roads Scholar Program, modeled after a program created and developed by Kansas DOT in 2000. The Alaska program provides training to build tribal technical, supervisory, and executive capacity, skills, and knowledge for road inventories, construction management, and project management.

To attract young engineers, planners, maintenance workers, and skilled laborers to the field of transportation, the University of Connecticut's Transportation Institute coordinates an annual transportation design challenge. Aimed at students in minority groups that are underrepresented in the field of transportation, the program integrates math, science, and social studies in trade-oriented activities, such as welding and making toolboxes. The Connecticut Construction Career Days attracted the participation of approximately 1,200 high school students in 16 state districts.

The University Transportation Center for Alabama, in conjunction with the University of Alabama and the Alabama DOT Personnel Bureau, cosponsored an Advanced Transportation Institute to introduce junior and senior high school students—particularly those from groups traditionally underrepresented in the engineering disciplines—to transportation careers. The agenda for the week-long program included presentations on topics such as transportation careers, selecting and gaining admission to a university, and obtaining scholarships.

Planning

At the January 2008 TRB Annual Meeting, the National Surface Transportation Policy and Revenue Study Commission released its report, *Transportation for Tomorrow*, outlining a dire financial outlook and the looming failure of the Highway Trust Fund. The commissioners and the experts who commented on the report identified alternative funding sources and methods to close the gap—but some of the sources, such as public-private partnerships, may require revisions to the planning process. With unknown levels of funding, unknown sources of funds, and the potential for revisions in the planning



PHOTO: CONNECTICUT CONSTRUCTION INDUSTRIES ASSOCIATION/SWENEY ADVERTISING, LLC

process, transportation planning must proceed in an atmosphere of uncertainty.

The fuel price roller coaster of 2008 created hardships and difficult trade-offs for many—those with low incomes, those who had chosen farther locations when fuel prices were low, and businesses that rely on reasonable transportation costs. For the planning community, the uncertainty created by the fuel price fluctuations indicated the importance of alternatives to the single-occupant vehicle, as well as the lack of alternatives in most communities. Also made evident was the difficulty of planning if even the most fundamental assumptions—such as fuel prices—are suspect. The planning community will continue to develop methods to prepare for alternative futures and to optimize transportation investments for the range of alternatives.

Legal Issues

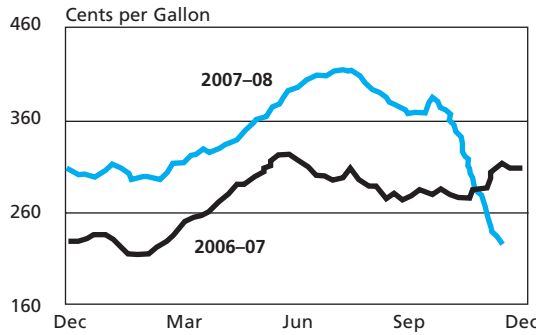
The environment, contracting, and funding—including compliance with federal funding regulations—have dominated the legal issues for transportation organizations.

In environmental law, the pressing issues involve rapid changes in the scientific and public policy standards for energy, climate change, and the siting of facilities. The National Environmental Policy Act requires that new information about environmental conditions be taken into consideration. The challenge is the level of environmental consideration and mitigation that will be required in association with climate change and with changes in the standards for protecting wetlands, wildlife, and forests during the planning and siting of projects.

Other issues include the uncertainty in the Disadvantaged Business Enterprise Program after the court of appeals decision in the case brought by

Students test out one of the many hands-on activities on the program at Connecticut Construction Career Day.

FIGURE 1 U.S. regular gasoline prices, 2006–2007 and 2007–2008. (Source: Energy Information Administration, <http://tonto.eia.doe.gov/oog/info/gdu/gasdiesel.asp>.)



Western States Paving Company, Inc., against Washington State DOT; ethics in governmental contracting and project development; privacy issues related to electronic communications; and innovative financing. For example, to raise needed cash, more than 30 transit agencies entered into tax-advantaged lease transactions with private investors. Because of the downgrade of transactional sureties, equity investors can declare the transit agencies to be in default, a substantial liability in the midst of the economic downturn.

Regulations for transportation agencies that use federal funds for rail, transit, bus rapid transit, and Americans with Disabilities Act paratransit service have been revised significantly, including the regulations for federal third-party contracting, charter buses, and school buses. Transit agencies must change their policies and practices to comply.

Energy

Economists and the travel forecasting community recognize the relationship between fuel prices and travel behavior, including the number of miles driven, the use of transit, and purchasing decisions about vehicles. Historically, increases in fuel costs have been small and gradual, however, and have not greatly affected the traveling public. Most travel forecasts and economic projections therefore include fuel

costs as a minor component. Yet the question, “What would happen if gas prices hit \$4 per gallon?” always was lurking, and in 2008, when the prices reached \$4, the short-term effects became evident.

The dramatic changes in fuel prices experienced by drivers in 2008 are shown in Figure 1 (left). According to Federal Highway Administration data, vehicle miles traveled in the United States were 9.6 billion lower in May 2008 than in May 2007—a 3.7 percent decline. That was the third-largest monthly drop in the 66 years that the data have been recorded (see Figure 2, below). The downward trend predated the increase in fuel costs but was exacerbated by the increase.

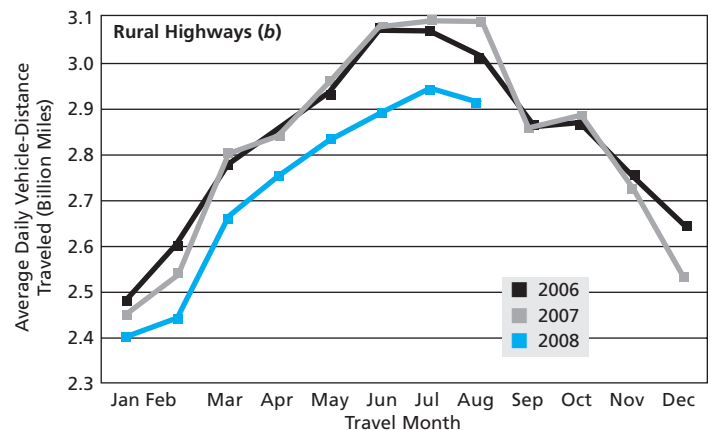
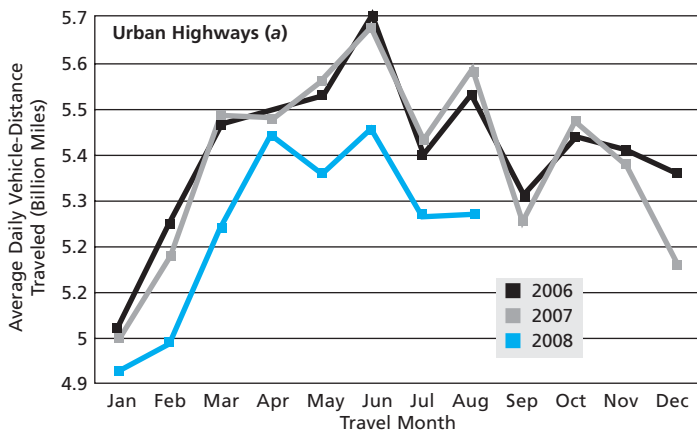
The increases in gas prices contributed to increases in transit ridership. In the second quarter of 2008, public transportation ridership increased by 5.2 percent, with Americans making more than 2.8 billion transit trips. According to a September 2008 survey by the American Public Transportation Association, 85 percent of public transit systems were operating at capacity, with crowded rail cars and buses.

Fuel prices and the general economic downturn also affected vehicle purchasing patterns, with annual sales of large vehicles—trucks, vans, SUVs, and crossover utility vehicles—falling below automobile sales for the first time since 2001 (Figure 3, page 7). Large vehicles comprised 47 percent of the light-duty vehicle sales in April and moved up to 50.48 percent in September.

These were short-term responses to higher fuel prices. How travelers would adjust if the prices remained above \$4 per gallon for a longer period of time remains speculation.

With gasoline prices fluctuating, the exploration of renewable and alternative sources of energy has gained emphasis. Connecticut DOT’s transit agency has been testing a hybrid hydrogen fuel cell bus—one of only six in the United States—and has acquired practical experience and knowledge of fuel

FIGURE 2 Travel on U.S. highways by month, January 2006–August 2008: (a) urban highways; (b) rural highways. (Source: Federal Highway Administration, Office of Highway Policy Information, www.fhwa.dot.gov/ohim/tvtw/08augvt/fig2.cfm.)



cell technology. Because hydrogen buses cost the same as diesel buses to operate, the technology may provide a viable option with low carbon emissions.

Alaska has approved construction of a natural gas pipeline from its North Slope to southern Alberta, Canada. The largest-ever public works project in North America will feature spur lines to Anchorage and Valdez. The Alaska legislature has licensed TransCanada for the project and has committed \$500 million in funding. Construction is slated to begin in 2018; Alaska DOT is upgrading highway infrastructure to support the project.

Intertwined with the energy issues is climate change. State, regional, and local transportation agencies are exploring their roles in mitigating and adapting to climate change in the absence of a national policy. In California, a court ruling for the first time delayed a high-occupancy vehicle lane project, scheduled for U.S. Route 50, until an environmental impact report could determine the project's effect on greenhouse gas emissions. In addition, Congress soon may pass a national carbon cap-and-trade law, which would set limits on the quantity of greenhouse gases that a region can emit each year and would allow companies to swap permits to emit greenhouse gases.

Environment

Water quality issues were a focus for state DOTs in 2008, including total maximum daily load levels for storm water runoff, as well as treatment options to reduce levels of pollution. Federal, state, and public interests have affected progress on state construction projects, as environmental impact statements have required more concerted mitigation efforts. As a result, states are funding research to identify pavements—such as porous asphalt and porous concrete—and roadway erosion controls that can reduce pollution from storm water runoff.

Another challenge for states is the satisfactory mitigation of the environmental impacts of large construction projects that extend for miles—such as highways. For example, highway construction may affect an impaired watershed at one point, but not throughout the whole extent of the project. Because no procedures are available yet for identifying the impact that a road project or a portion of a road project may have on an already impaired watershed, states are encountering difficulties in developing economically viable mitigation plans to satisfy the environmental regulations.

Other environmental issues for states include air quality conformity; the Section 106 process of the National Historic Preservation Act and community involvement—particularly when a listing in the

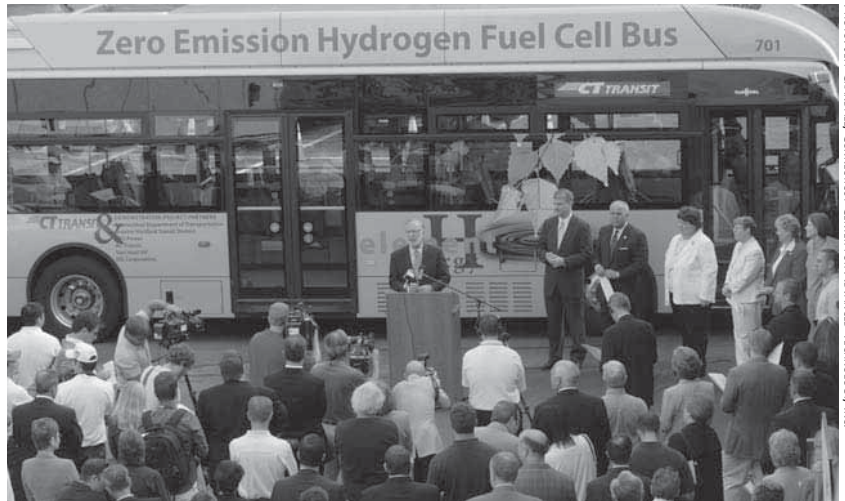


PHOTO: JEFF GRANDALL, CONNECTICUT CENTER FOR ADVANCED TECHNOLOGY, INC.

National Register of Historic Places differs from what a community regards as culturally significant; the protection of endangered species; restrictions to prevent the spread of invasive plant species; the reburial of historical or archeological areas at construction sites; and wildlife crossings and underpasses.

Connecticut officials answer media questions during the August 2008 state tour of CT Transit's hydrogen fuel cell bus.

Infrastructure Preservation

Preservation involves the timing of actions to extend the useful life of pavement infrastructure while minimizing the costs of ownership. This differs from the traditional approach of addressing assets on a worst-first basis. According to one state DOT, the approach results in “project actions that are much lighter than those [previously] selected—more than 70 percent of the individual project actions are preventive maintenance, [and] rehabilitation projects are fewer and lighter.”

State DOT staff have identified the following characteristics of preservation programs:

- ◆ Commitment from top management and the state legislature;
- ◆ Systems to measure the condition of the network features, such as pavement and bridge management systems;

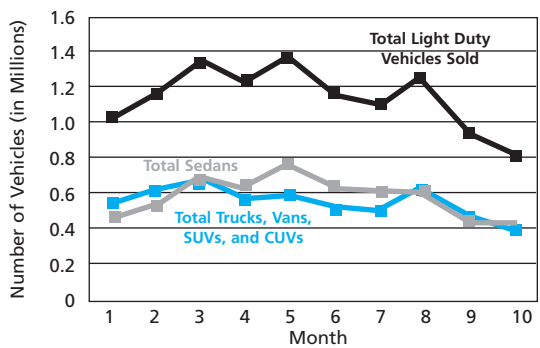


FIGURE 3 Light-duty vehicles purchased in the United States, 2008.

PHOTO: ERIK STUART, UNIVERSITY OF CENTRAL FLORIDA



Pervious pavements under testing at the Stormwater Management Academy Research and Testing (SMART) lab at the University of Central Florida: pervious concrete, Flexipave, and permeable pavers or bricks. Tests include the infiltration rate at which water flows down through the pavements, as well as water quality testing and maintenance of the pavements.

- ◆ Means of setting program goals;
- ◆ Repeatable means of estimating the benefits of actions to the infrastructure features;
- ◆ Dedicated funding and few restrictive rules or requirements, accommodating many different actions, instead of holding to one action for all situations;
- ◆ Champions working throughout the organization; and
- ◆ A basic understanding of the ways in which the benefits of preservation actions change as the features of the infrastructure age.

Preservation efforts are evolving as DOTs implement programs:

- ◆ Integrating network management systems, such as for bridges and pavements, into an enterprise-wide, asset management approach that supports the application of limited funds to a variety of proj-

ects and activities based on benefit or life-cycle cost; and

- ◆ Analyzing assets through their entire life cycle, to identify the reconstruction, rehabilitation, and preservation solutions that have the lowest life-cycle cost.

Data and Information Technologies

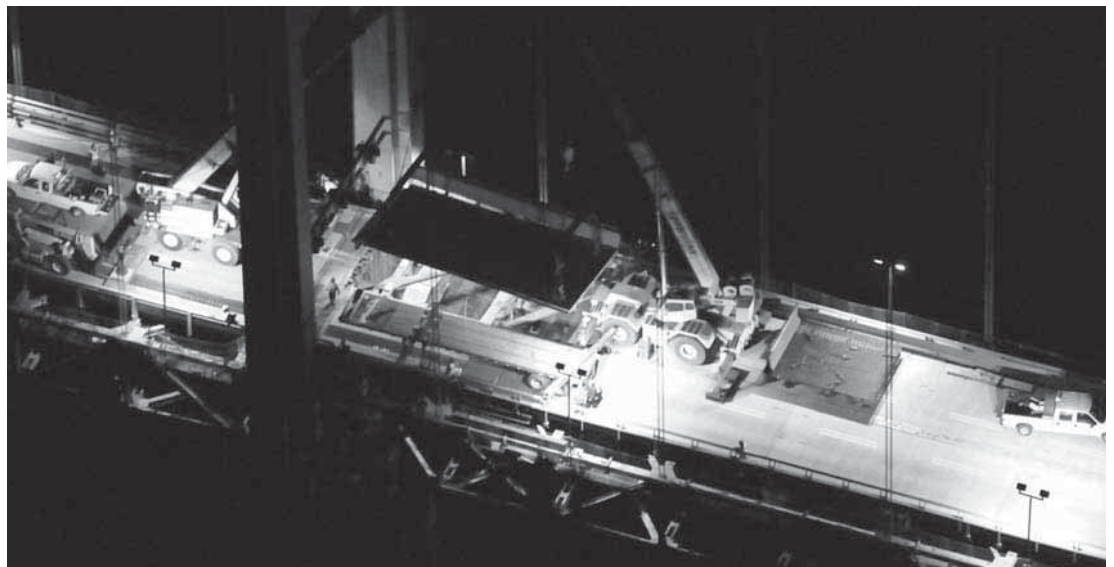
State transportation data programs are coping with increases in the complexity of decisions and with reductions in resources. Considerations about air quality, greenhouse gases, and climate change now have greater influence on decision making. As a result, decision makers are looking for these nontraditional data in forms that can be integrated into traditional transportation decision making.

In California, data programs on goods movement now involve cooperative efforts by the DOT and the Air Resources Board. Traditional systems for collecting vehicle miles traveled now must satisfy more requirements for timeliness and offer more flexible geographic resolution, because these data have become critical input for environmental quality models, as well as for gas tax forecasting.

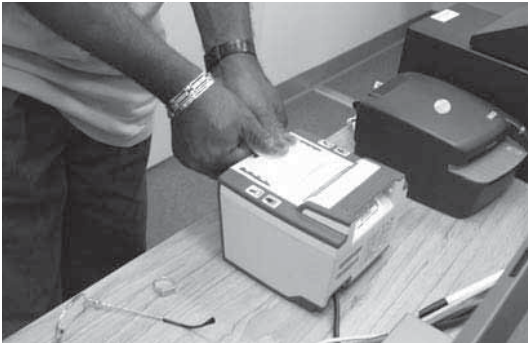
With constraints on resources, states continue to work with metropolitan planning organizations (MPOs) and local governments to share data for common objectives. Displaying information in geographic context with readily available tools such as Google Earth also offers promise.

Freight transportation data are growing in importance for understanding the interaction of the transportation system and the economy. The traditional core federal data set—such as the Commodity Flow Survey and the Freight Analysis Framework—continue to provide the national context for corridor-

PHOTO: MARYLAND TRANSPORTATION AUTHORITY



As part of the preservation project for the Bay Bridge over the Chesapeake Bay in Maryland, large sections of the concrete roadway are replaced with new prefabricated deck panels. The project also includes replacing sections of the span's steel railing, spot structural painting, and other preservation-related work.



A worker in the Port of Miami applies a thumbprint for the Transportation Worker Identity Credential.

state-, and metropolitan-level analyses.

In responding to global influences, economic volatility, and the need for understanding the inter-relationships between freight and climate change, states are exploring methods and approaches that can yield more timely data, provide estimates for smaller geographic areas, and relate vehicle flows with cargo. Building on successful examples, states are exploring general approaches and protocols for agreements with private entities for access to private data essential for public planning.

Critical Infrastructure Protection and Security

The mobile X-ray inspection of trucks entering O'Hare International Airport, Chicago, Illinois, was part of a drill involving federal and city agencies preparing for the 2010 deadline for screening all cargo loaded on passenger planes. The Transportation Security Administration is looking to tighten security of hazardous materials transportation and is soliciting contractors for the Hazardous Materials Endorsement Threat Assessment Program.

Determining the appropriate level of screening for international container cargo—and paying for the measures—continues to be a challenge for states and for the nation's ports. The Transportation Worker Identification Credential program continues to encounter technical problems, objections from unions, and shifts of deadlines, so that many truckers and port workers are without the federal identification required for their jobs.

States along the U.S.–Canadian border are challenged with reconciling the demands for national security with rural economies. Montana, for example, recognizes the need for increased 24-hour cross-border port-of-entry operations but also must reckon with the associated costs. A recent report by the Government Accountability Office highlighted security weaknesses along the northern border, and the U.S. Senate passed a \$3 billion amendment to border secu-

ity funding for hiring new agents and examining technology to improve the patrolling of the border.

Border patrol agents in Vermont, Washington, New York, and other states have increased surprise inspections on domestic trains, buses, and ferries within 100 miles of the borders to intercept illegal immigrants. To protect interior regions of the country, the Department of Homeland Security has launched the Securing the Cities initiative, which includes the testing of fixed and mobile radiation detection systems for commercial trucks on the nation's highways.

Aviation

The volatile economies worldwide and the resulting shifts in fuel prices in 2008 dramatically altered the aviation landscape. Airlines slashed schedules to keep costs in check, affecting revenues and services at airports throughout the United States. Many businesses went into bankruptcy, including several in the emerging markets for very light jets and air taxis.

The federal government is determining how to fund aviation system infrastructure needs in its pending reauthorization plans. Significant concerns remain about the ability to cover future needs with revenues from fuel taxes, user fees, and other charges; moreover, the effect of the volatile economic climate on the federal plans is uncertain.

Many airports are struggling to accommodate the fluctuations in operations and the resulting budget reductions with diminishing staff. Other issues for airports and state DOTs include wildlife collisions with aircraft; climate change mitigation; the fate of the Essential Air Service program; potential closings of publicly available airports; and ongoing research into the Next-Generation Air Transportation System.

Emerging aviation markets, such as air taxis, faced setbacks with the economic downturn.





PHOTO: CALTRANS

Many states are working to bridge the gaps between the public and private sectors and across jurisdictional lines on freight issues and policies.

Freight Systems

Freight transportation demand derives from economic activity. When economic activity is high, large volumes of goods move nationally and internationally. In recent years, large volumes and rapid growth have strained system capacity, and the result was bottlenecks for all modes. Private carriers and public agencies focused on identifying bottlenecks and planning capacity improvements, respectively, but the availability of financing was the overriding concern.

Since the financial and real estate crises, freight volumes have plunged. In the short term, capacity

pressures have been relieved, but declines in revenue are disrupting all modes—trucking companies are going out of business, ocean carriers are laying up ships, the work force faces cutbacks, and infrastructure improvements are being delayed. The length of the recession, the impacts on employment and revenues, the effects of volatile fuel prices, and long-term structural changes in economic activity remain uncertain.

Freight is no longer exclusively in the private domain, but the roles of state DOTs and MPOs are not clear. As one state official has observed, “as a profession, freight is in its infancy, and it is hard for government to keep up with the trends and data.”

Bridging the gaps between the public and private sectors and across jurisdictional lines remains a challenge. Missouri has hired staff with freight backgrounds; Colorado has projected a roadmap of strategic issues for freight; and Wyoming and Washington have developed data and methods to measure the economic impacts of weather-related closures of major highway freight corridors. In sum, freight transportation faces continual changes in short-term and long-term planning and investments.

Highways

Design

As revenues diminish and the infrastructure ages, state DOTs face unprecedented challenges in designing and managing the repair, rehabilitation, and replacement of the nation's highways and bridges. Pavement and bridge management systems, along with asset management principles, are informing the selection of critical projects as states work to meet the challenges.

In 2008, the Rebuild Pennsylvania program dedicated \$350 million to speed the repair of 411 structurally deficient bridges statewide. Many other states—such as Missouri—have identified bridges that need repair, rehabilitation, and replacement and are moving forward with financing and project selection.

To keep pace with the demand and to use limited funds as effectively and efficiently as possible, bridge, bridge deck, and pavement sections are being designed for accelerated construction. Several conferences nationwide have focused on accelerated bridge construction (ABC); demonstration projects and design guides have been completed, and more are in process.

The advantages of ABC include a reduction in total construction costs through time savings in fabrication, as well as congestion mitigation and site safety. Precast concrete elements and sometimes entire bridges can be produced offsite or adjacent to

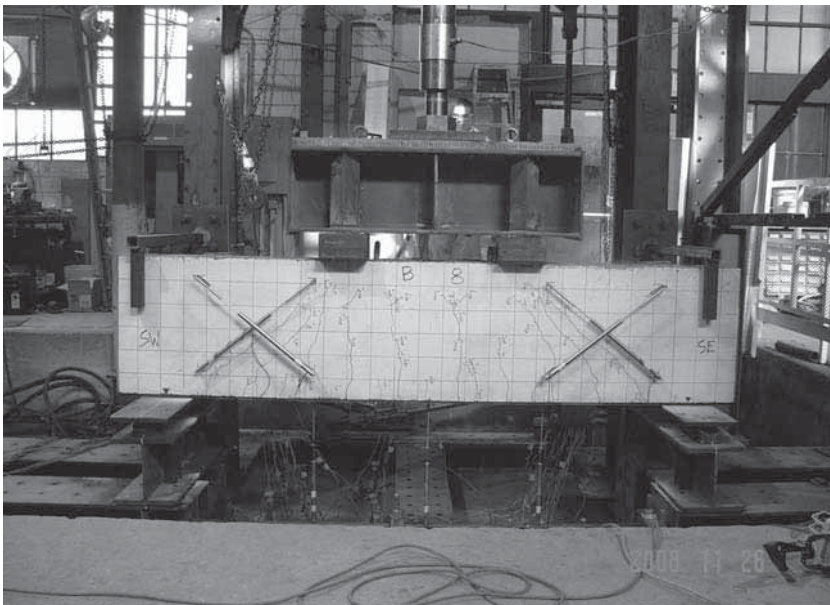


PHOTO: CHRIS B. PANTILLAS, UNIVERSITY OF UTAH

The University of Utah Structures Laboratory is conducting research for the Utah Department of Transportation on reinforced concrete and prestressed concrete girders, simulating corrosion-related deterioration and damage from collision with passing vehicles. The findings will be used to develop design guidelines for a fiber-reinforced polymer composite repair and retrofit of damaged prestressed concrete girders.

the site and then quickly placed. Several states—including California, Washington, and South Carolina—are studying and implementing best practices for seismic ABC connections. Similar efforts are under way for durable precast bridge decks.

Highway Construction and Materials

Because of funding problems, the construction of capital improvement projects is a challenge for most state DOTs. Most projects that are put up for contract bids focus on infrastructure renewal, congestion relief, and safety improvements.

Because much of this work is being done on existing facilities, nighttime construction has become the norm in urban areas, as well as in some of the more rural states, raising concerns about noise, as well as safety, quality, and productivity. Some states are concerned about a decrease in construction quality because of a diminishing trained work force. A few states are looking into high-technology solutions, such as intelligent compaction for hot-mix asphalt, which allows real-time quality control of asphalt density testing; or automated machine guidance, which links design software with construction equipment.

Concerned about the environment and sustainability, many state DOTs are accepting more recycled and nontraditional materials for projects if the materials meet performance standards and are cost-competitive. Crushed portland cement concrete is being used as base material, and the percentage of recycled asphalt pavement (RAP) is being increased in hot-mix asphalt. Research conducted under a National Cooperative Highway Research Program (NCHRP) project soon will provide states with a mix design and analysis procedure for increasing RAP in hot-mix asphalts. A few states allow hot or cold in-place recycling of

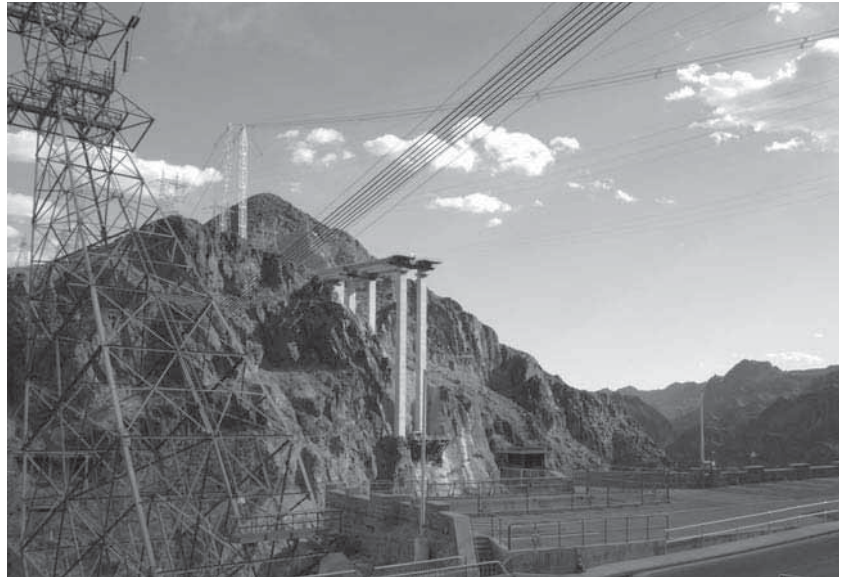


PHOTO: STEPHEN MAHER

asphalt pavements, the subject of an ongoing NCHRP synthesis. This past year, more states have tried warm-mix asphalt to reduce odors and emissions from asphalt operations. At many agencies, construction noise mitigation remains a concern.

Geotechnical Engineering

In 2008, geotechnical engineering professionals were busy with issues such as landslides, rock falls, subsurface drainage, characterization of aggregates, investigation of structural foundations, and soil stabilization. The most noteworthy topics in geotechnical engineering, however, were intelligent compaction, the load and resistance factor design (LRFD) of structural foundations, and the geotechnical aspects of design-build contracting.

Advances in intelligent compaction have allowed

Progress on the construction of the Colorado River Bridge, the central portion of the Hoover Dam Bypass Project, as of March 2008, showing the start of the 1,060-foot twin-rib concrete arch. Completion of the entire project is expected in June 2010.



PHOTO: FHWA AND TRANSTEC GROUP

Field demonstration of intelligent compaction of asphalt, conducted by Minnesota DOT for the FHWA pooled-fund study.

the continuous collection of soil properties with vibratory rollers during earthwork construction; this has enhanced interest in performance-based quality assurance. At the national and state levels, NCHRP Project 21-09, Intelligent Soil Compaction Systems, is under way; FHWA is conducting a pooled-fund study with 13 states on Accelerated Implementation of Intelligent Compaction Technology for Embankment Subgrade Soils, Aggregate Base, and Asphalt Pavement Material; Minnesota DOT introduced a pilot specification in 2008; and a workshop on intelligent compaction was held in April 2008 in Iowa.

October 1, 2007, was the date set by FHWA and AASHTO for the transition to LRFD for the foundations of all substructures of federally funded bridges. The status of LRFD implementation for geotechnical purposes varies from state to state. At a 2008 TRB Annual Meeting workshop, several states presented their experiences in implementing LRFD for geotechnical and substructure design.

Increased use of the design-build approach has raised concerns about incorporating geotechnical procedures. Several states are documenting their experiences, as well as developing standard procedures.

Highway Operations

Highway congestion is a daily occurrence in all large metropolitan areas of the United States. Congestion is a constant source of frustration for drivers and of productivity losses that affect the nation's economy.

State DOTs are increasing efforts to operate and maintain the transportation network more efficiently.

Managing demand and optimizing the operation of the system are cost-effective solutions to reduce delays and improve travel-time reliability.

To manage travel demand, many state DOTs have turned to solutions that involve pricing and motorist information. Pricing solutions include high-occupancy toll lanes, variable pricing, and other managed-lane measures. Motorist information services include pretrip traveler information via the Internet, text messages, and 511 telephone connections.

Transportation agencies are working to improve and optimize the management and operations of the road system. Much of the focus has been on technology-based intelligent transportation systems, including closed circuit TV, electronic toll collection, collision warning systems, the Global Positioning System, dynamic message signs, and vehicle-infrastructure cooperation. Other management and operations solutions include incident response, mitigating the impacts of severe weather incidents, improved work zone traffic control and management, more efficient traffic signal control, and improved freeway traffic management, such as ramp metering, variable speed limits, and lane-use management.

In sum, state DOTs are working to improve systems management and operations to reduce delays, improve travel-time reliability, and improve safety.

Highway Safety

Highway fatalities declined in 2007, with the exception of motorcycle fatalities, which rose for the 10th year in a row, by 12 percent.

All states have completed and are implementing

TRIMARC is an intelligent transportation system designed to improve the performance of the freeway system in the metropolitan Louisville and Southern Indiana area. It includes an integrated system of sensors, cameras, dynamic message signs, highway advisory radio, and computers monitoring more than 60 miles of highway traffic.





A follow-on study shows that the Missouri Smooth Roads Initiative has benefited highway safety. Completed ahead of schedule in December 2006—an occasion marked by Missouri DOT Director Pete Rahn (left)—the program implemented smoother pavement, brighter striping, rumble strips, and other safety improvements on heavily traveled highways.

Strategic Highway Safety Plans (SHSPs). Two states, Missouri and Michigan, have completed updates of their SHSPs, setting new priorities after meeting some of the goals in their initial plans.

Because traffic crashes declined in 2008 as traffic volumes decreased significantly, questions arose about the respective contributions of safety programs and traffic volume changes. Evaluations completed before the large declines in traffic volume indicate that some safety programs were effective.

For example, Missouri performed a cost-benefit evaluation of the striping and delineation programs that were part of its Smooth Roads Initiative. The goal of the initiative was to improve the rideability and the visibility of more than 2,300 miles of major roadways in the state, including the Interstate system, freeways, expressways, and some multilane and two-lane undivided roads. Reductions in fatalities and injuries from crashes ranged from 11 percent to 86 percent, and each \$1 invested in improving the striping and delineation produced benefits averaging \$9.70—a range of \$5 to \$129.

This systemic approach to roadway safety differs greatly from remediation at specific high-crash locations. The systemic approach may be useful for states that have addressed most of their high-crash locations but strive for continued reductions in roadway deaths and injuries.

Ports and Waterways

Despite the current economic challenges, major projects are under way or planned for ports and waterways around the country. On the Great Lakes, the Port of Toledo, Ohio, has received a \$5 million grant from the Ohio Department of Development to dredge for port expansion along the Maumee River and to pay for

landside infrastructure improvements, which will make the Port of Toledo the largest on the Great Lakes. A proposal to build a new \$3 million facility has positioned the Port of Oswego, New York, to become one of the first major container shipping ports on the Great Lakes. Containers offloaded at Oswego would move by rail or truck to their destinations.

On the East Coast, Virginia International Terminals in Newport News has entered into a 10-year, \$500 million agreement to provide terminal space to a consortium of five shipping lines; the port is expected to grow substantially in the next few years. The Georgia Ports Authority operates the Port of Savannah, one of the fastest-growing container ports in the country, and is planning more expansion, with four new super post-Panamax cranes installed in 2008 and four more scheduled for delivery in 2009. Other plans include deepening the harbor and expanding the rail yards. South Carolina is developing distribution centers and industrial space to connect the Port of Charleston with the I-26 corridor.

On the West Coast, Pacific Northwest ports have experienced significant increases in grain traffic—particularly wheat, corn, and soybeans—in response to overseas demand for U.S. grains after drought and poor weather conditions in other areas of the world. The growth in export markets has caused inland congestion on railroads, highways, and rivers.

California ports are upgrading landside access—roads, rail, and bridges—and are working to reduce emissions from port operations. The PierPass Off-Peak program, in operation at the Ports of Los Angeles and Long Beach since 2005, has diverted more than 9 million truck trips from peak daytime traffic, reducing congestion and pollution.

Although ports along the Gulf Coast are recover-

PHOTO: JOEY CAMBRIDGE



The Port of Mobile, Alabama, opened a new container terminal, equipped with cranes capable of handling the larger container ships that will be transiting the expanded Panama Canal.

ing from the hurricane disasters of this and previous years, the region is gearing up for increases in traffic volumes from the expansion of the Panama Canal, which will enable more and larger vessels to travel all-water routes from Asia to the eastern United States. Gulfport, Mississippi, has approved a \$1 billion project to rebuild its hurricane-damaged port and expand it with a seaward extension from the cargo-handling facilities. The Port of Mobile, Alabama, recently opened a new container terminal, equipped with cranes capable of handling the larger containerships that will be transiting the expanded Panama Canal. The Port of New Orleans continues to recover and rebuild facilities and trade.

Because Texas coastal ports are not deep enough

to accommodate the largest oil tankers, and the refineries are expanding, a Texas partnership has submitted plans to build and operate a \$2 billion off-shore terminal east of Freeport. The project will include two floating connections for supertankers to unload crude oil and 160 miles of pipeline to deliver the oil to land and along the coast to refineries in the Houston area.

On the inland waterways, ports along the Mississippi River, the McClellan-Kerr Arkansas River Navigation System, and the Tennessee-Tombigbee Waterway also anticipate opportunities from the expansion of the Panama Canal. Officials in Arkansas are considering creation of an authority to develop a container barge terminal.

Rail

Rail transportation made headlines as high fuel prices spurred increased use of public transportation, pushing commuter and intercity passenger rail ridership to record levels. With fuel costs volatile, it is unclear how much of the shift in ridership is permanent. Concerns about greenhouse gas emissions have directed attention to the fuel-efficiency advantages of freight rail. Toward the end of the year, however, freight volumes trended downward as the economic situation worsened. Issues that dominated the rail scene earlier in the year—such as capacity and the sharing of facilities by freight and passenger operations—became less urgent. In the longer term, however, these issues will demand attention.

Fourteen states support rail passenger services contracted with Amtrak. In addition, many states



PHOTO: TULSA PORT OF CATOOSA

A barge moves containers at the Tulsa (Oklahoma) Port of Catoosa, on the McClellan-Kerr Arkansas River Navigation System. The port's river flow levels are controlled by the U.S. Army Corps of Engineers. Inland waterways are expecting opportunities with the expansion of the Panama Canal.

invest to improve the quality of passenger service. For example, the Missouri legislature approved \$5 million for capital improvements to the St. Louis–Kansas City freight route to increase the reliability of state-supported Amtrak trains.

Many states assist rail freight operations that contribute to economic development and to the creation and retention of jobs. For example, Wisconsin provided almost \$17 million in loans and grants for freight rail projects in 2008.

Landmark federal legislation enacted late in the year authorizes appropriations for U.S. DOT's railroad safety and passenger rail activities and for Amtrak through fiscal year 2013; creates many new rail programs; and revises statutory provisions related to railroad safety and passenger rail activities, including a requirement for the installation of positive train control by 2015 on mainline track used by passenger railroads.

Public Transportation

By normal standards, 2008 was an impressive year for public transportation. Ridership continued to grow, new equipment and services were added, bus and rail systems expanded, and environmentally friendly and energy-efficient technologies advanced. Then petroleum and gasoline costs doubled and dropped, and the transit world changed, with peak-hour service at full capacity and with limited access to credit markets and liquidity.

Transit operators are asking the U.S. Treasury for assistance under the Guarantee Program for Troubled Assets, part of the Emergency Economic Secu-



PHOTO: CALTRANS

The fuel-efficiency advantages of freight rail and capacity issues related to sharing facilities with passenger operations are topics that were eclipsed in the past year but will reemerge.

rity Act of 2008. In many capital equipment lease-back transactions made before 2004, creditors can attempt to collect immediately because of a technicality in the contract—if the insurance company's credit rating is downgraded, long-term notes can be called in. Under the provisions of the sale-in, lease-



PHOTO: LORIE A. BEARIS

Segments of the Euclid Corridor Bus Rapid Transit facility in Cleveland opened in October.

A vehicle prepares to break through the inaugural banner at the grand opening of the Metro Light Rail in Phoenix, Arizona, December 2008.



PHOTO: TOM CALLOW, CITY OF PHOENIX

out and lease-in, lease-out transactions, 25 agencies in 18 states would have to pay \$4 billion, forcing deep cuts in service.

Nonetheless, transit fared well in the November 4 elections, gaining \$75 billion in new state and local funds—31 of 32 measures passed, including large financial support in Los Angeles County and the Puget Sound region of Washington State, as well as for high-speed rail in California and for commuter rail in Honolulu and Rhode Island. New York City, Chicago, and Washington, D.C., however, are considering fare increases.

New service openings included the Euclid Corridor bus rapid transit in Cleveland and commuter rail in Utah, New Mexico, and North San Diego County. Environmental and energy experiments involving green facilities, biodiesel, hydrogen, and natural gas started up.

Two large-scale projects are making progress: the New Jersey Transit Corporation is studying construction of a third tunnel under the Hudson River, including two single-track tunnels, expansion of Pennsylvania Station, and direct links to three New York City subways and the Port Authority Trans-Hudson lines; and in California, approvals were given for high-speed rail connecting urban areas.

Commitment and Hard Work

Uncertainties in the economy, energy, funding, and national policies made 2008 particularly challenging for transportation agencies. The progress amid rapidly changing conditions testifies to the commitment and hard work of transportation personnel. This dedication can be expected to lead the way through 2009.

Did You Know?

- ◆ Juneau, the state capital of Alaska, is not accessible by road—it can only be reached by air or by sea.
- ◆ Alaska DOT operates 258 airports throughout the state—the most of any state DOT.
- ◆ 82 percent of Alaska's communities depend on air service for medical and food supplies.
- ◆ Alaska is more than twice the size of Texas but has fewer road miles than the state of Rhode Island.
- ◆ Alaska has more coastline than all of the continental states combined.
- ◆ Alaska has the lowest gasoline tax of any state—8 cents per gallon.
- ◆ Connecticut DOT is the only DOT with a hybrid hydrogen fuel cell bus. AC Transit in the Bay Area has the five other fuel cell buses in the United States.
- ◆ Georgia DOT owns and operates three asphalt plants.
- ◆ Pennsylvania DOT supports the transportation needs of 67 counties, 48 of which are rural, with a total of 2,563 municipalities.
- ◆ At the Alabama Advanced Transportation Institute for high school students, the most popular event follows a presentation on road safety—the students build safety containers to protect raw eggs dropped from one of Alabama DOT's bucket trucks. Some student designs have successfully protected the eggs on a drop from the full height of the bucket truck—50 feet.



Air travel allows Alaskans to overcome scenic but difficult terrain.

- ◆ Many transportation agency maintenance staff have devised inventions to improve productivity and safety, but these innovations often remain untapped resources. Colorado DOT has funded a research project to document and develop compensation for inventions and to obtain patents for individuals or the agency, depending on when and where the inventions were developed.

Key decisions for transportation projects require a consensus among diverse decision makers to advance and effectively link planning and project development. On a site tour of the Interstate 10 improvement project in August 2008, Arizona Department of Transportation officials brief (left to right) Buckeye Councilman Brian McAchran, Avondale Mayor Marie Lopez Rogers, and (fourth from left) State Representative John Nelson.



PHOTO: ARIZONA DOT

The Collaborative Decision-Making Framework

Evolving Product of SHRP 2 Capacity Research

STEPHEN J. ANDRLE AND JANET D'IGNAZIO

Andrle is Chief Program Officer, Strategic Highway Research Program 2, Transportation Research Board of the National Academies, Washington, D.C.; and D'Ignazio is Principal Investigator, ICF International, Fairfax, Virginia.

The U.S. transportation system will need to expand and adapt to meet the travel and freight demands of the American public. The geographic patterns of population are changing, and concerns about climate change and imported oil are altering habits.

The Capacity focus area of the Strategic Highway Research Program 2 (SHRP 2) is developing approaches and tools for systematically integrating environmental, economic, and community requirements into the analysis, planning, and design of new highway capacity. The National Surface Transportation Policy and Revenue Study Commission has stated that the average of 13 years to deliver a new highway project is too long:

[T]he project delivery process must be reformed by retaining all current environmental safeguards, but significantly shortening the

time it takes to complete reviews and obtain permits. Projects must be designed, approved, and built as quickly as possible ... to meet the transportation challenges.... (1)

The SHRP 2 Technical Coordinating Committee for Capacity has considered that the answer to delivering the necessary capacity with increased environmental and community awareness may lie in systematically institutionalizing collaborative decision making. Having the right people at the table at the right time with the right information to make good choices that will stand up to financial and environmental scrutiny is essential. Transportation and environmental agencies must change their way of doing business by collaborating early to solve problems. The stakes are high—the nation's economic health depends on success.

Trends and Contexts

Megaregions

The U.S. population is forecast to grow by 40 percent to 420 million by 2050 (1). The population will cluster in megaregions (see map, below), with 60 percent of the growth in six Southern and Western states (1).

Each megaregion will comprise many states, increasing the need for multistate planning for transportation, economic development, and environmental protection. More collaborative decision making will occur among agencies and multistate entities for planning, economic development, and the environment.

Planners will need to forecast the freight growth and logistics needs in the megaregions to determine which corridors should expand and how. Shippers, receivers, and carriers must be included in the transportation planning and decision making. Strong market and political forces are emerging, and transportation planners and engineers will have to answer to the public about the climate change implications of transportation solutions.

Capacity Shortage

Between 1985 and 2005, vehicle miles traveled grew by 80 percent, but new lane miles increased by only 4 percent (2). The nation has used up much of the highway capacity built during the Interstate construction period. Only 844 new Interstate lane-miles were added each year between 1993 and 2002 (3); as a result, congested conditions on the nation's highways have increased.

A 2007 project under the National Cooperative Highway Research Program estimated that an additional 173,000 Interstate lane-miles would be needed in the next 30 years (2). This amounts to an 80 percent expansion to keep up with projected demand

for car and freight travel—an average of 5,760 additional lane-miles per year until 2037.

Environmental Concerns

With the public's high level of environmental awareness and concern for quality of life, expanding capacity is bound to be controversial. Highway agencies, resource agencies, and the concerned public must work together to improve the environment instead of only mitigating the impacts.

Environmental solutions therefore will need to be investigated earlier in the planning process than ever before, and the standards will be higher. The law requires compensatory mitigation, but the public demands environmental stewardship—that is, more than the law requires. Stewardship may take the form of an ecological approach to environmental protection, as FHWA has recommended (4). SHRP 2 research will take that approach closer to implementation.

Generating Revenues

Finally, transportation infrastructure will need more revenue from state, local, and private sources; tolls and public-private partnerships are likely to generate some new funds. The National Surface Transportation Policy and Revenue Study Commission has recommended an annual investment of \$225 billion from all sources for the next 50 years—up from the current level of less than \$90 billion from all sources (1). SHRP 2 Capacity research is incorporating public-private partnerships into a framework for collaborative decision-making and is forecasting the effect of tolls on travel demand.

The Big Picture

In sum, the big picture reveals the following trends as contexts for SHRP 2 Capacity research:

- ◆ Growth in population, personal travel, and freight travel has outpaced most of the highway capacity built during the Interstate construction era. The result is increasing congestion.
- ◆ To avoid negative consequences for the U.S. economy, the efficiency of the highway and transportation system must be improved and capacity must be added.
- ◆ The U.S. population will grow by approximately 120 million by 2050 and will cluster in 10 megaregions.
- ◆ The expansion of highways and transit will have significant impacts on the surface environment and air quality. To obtain public support for highway expansion, transportation agencies will need to demonstrate a new level of environmental stewardship and ecological practice.

FIGURE 1 Emerging megaregions in the United States.



- ◆ Transportation decision making must address heightened concerns about climate change.
- ◆ More private funding and toll facilities can be expected, adding another new dimension to planning and decision making.

Decision-Making Phases

The transportation decision-making process consists of many steps. Most are work activities that take place during the technical decision making. Key decisions, however, require review of the general work activities and approval from higher levels of authority or a consensus among diverse decision makers before the project can advance.

Key decisions occur most often at the policy level. Although only a portion of the complete process, key decisions effectively link planning and project development.

Transportation agencies share many common key decision points. Some are defined by law; others follow best practice. The specific work activities that link and contribute to key decisions can differ from state to state.

The SHRP 2 Capacity program has developed a Collaborative Decision-Making Framework (CDMF) to identify key decision points in four phases of transportation decision-making processes:

- ◆ Long-range transportation planning,
- ◆ Corridor planning,
- ◆ Programming, and
- ◆ Environmental review and permitting.



PHOTO: CALTRANS

The Alameda Corridor, serving the ports of Los Angeles and Long Beach, is a series of bridges, underpasses, overpasses, and street improvements that separate freight rail, passenger, and street traffic; the 20-mile project eliminated more than 200 at-grade rail crossings, easing traffic congestion and reducing air and noise pollution. The planning and construction required the collaborative effort of many government agencies and jurisdictions and the private sector.

Complementary Steps

SHRP 2 Capacity research is being implemented in coordination with the Federal Highway Administration's (FHWA's) Surface Transportation Environment and Planning Cooperative Research Program (STEP).^a STEP aims to improve the understanding of the complex relationship between surface transportation, the environment, and planning. Following are examples of STEP research that complement the SHRP 2 Collaborative Decision-Making Framework:

- ◆ A pilot program with the New Mexico Department of Transportation (DOT) is determining how much carbon dioxide can be captured in plants and soils along highway rights-of-way.^b This will enable state DOTs to sequester carbon and sell the credits, generating revenue and improving the environment.

- ◆ *Eco-Logical: An Ecosystem Approach to Developing Infrastructure Projects* was developed to identify approaches to avoid, minimize, and mitigate the impact of transportation projects on the environment and to promote ecosystem sustainability.^c

- ◆ The *Planning and Environment Linkages Implementation Resource Guide* assists practitioners from multiple disciplines in incorporating planning and environmental linkages (PELs) into transportation decision making.^d

- ◆ The Transportation Planning Capacity Building (TPCB) Program supports collaborative decision making for transportation planning in state, metropolitan, rural, and tribal settings.^e

- ◆ Travel model research supports technology deployment, training, and technical capacity building for planning agencies. Dynamic network modeling technologies and activity-based demand methods are being developed and moved into practice.^f

^a www.fhwa.dot.gov/hep/step.

^b www.environment.fhwa.dot.gov/strmlng/newsletters/sep08nl.asp.

^c www.environment.fhwa.dot.gov/ecological/eco_index.asp.

^d http://environment.fhwa.dot.gov/integ/resources_training_marc.asp.

^e <http://planning.dot.gov/>.

^f <http://tmip.fhwa.dot.gov/>.

The SHRP 2 Collaborative Decision-Making Framework will be adaptable to projects of different sizes, budgets, schedules, and organizational structures.



Design Goals

The key decision points in the CDMF incorporate principles of context-sensitive solutions, consultation, project management, and risk management and are built on design goals established by the SHRP 2 Technical Coordinating Committee for Capacity. The design goals provide the following guidance:

1. Establish a collaborative decision-making approach that identifies participants' roles and responsibilities at each key decision point, to

- Ensure the early and ongoing involvement of formal decision makers and individuals who may contribute to the timely and cost-effective delivery of transportation improvements, and
 - Encourage binding decisions as early as possible.
2. Encourage timely and cost-effective project delivery:
 - Ensure the transfer of information and decisions between phases;
 - Encourage early and comprehensive agreement on data sources, level of detail, evaluation criteria, and performance measures; and
 - Establish a comprehensive and proactive risk management strategy.
 3. Encourage a decision-making approach that evaluates transportation needs within broader community and natural contexts; integrates land use planning and development policy, capital improvement planning, and protection and enhancement of the human and natural environment; and addresses sustainability issues to the greatest extent possible, to support the community's vision and goals.
 4. Encourage consideration of a range of options to address capacity problems during the planning phase of decision making, as well as the early and ongoing incorporation of operational elements as a part of the decision-making approach.
 5. Establish a decision-making approach that fulfills the intent of legal and regulatory requirements while providing flexibility and adaptability for implementation consistent with the design goals.

Collaborative Decision Making in Action

In 2003, the New Jersey Department of Transportation (DOT) was preparing a draft environmental impact statement for the most recent design of the long-proposed Flemington Bypass. Several developments led to another reexamination of the corridor. First, the project was not consistent with the state's new smart growth principles. Second, the cost of the bypass exceeded the available state highway funding. Third, the community was expressing concern about the possible negative impacts of the bypass on the local business community and the area's environmental resources.

In response, New Jersey DOT began an effort to integrate land use and transportation planning. The agency engaged local governments and other stakeholders in a collaborative planning process that produced a transportation solution and recommended land use changes. Through the process, the project team overcame the community's initial distrust, as well as skepticism that the smart growth alternative could accommodate the projected increases in area traffic. The plan included a new parkway, improved use of present and future local roads, and the rezoning of more than 1,000 acres of land after a market valuation study.

The major lessons from the planning process included the following:

- ◆ Local decisions about land use and the local road network can reduce the traffic burden on state highways.
- ◆ Local champions should be identified and recruited.
- ◆ The planning process should be adapted to the needs of the participating community.
- ◆ Effective collaboration requires trust, which may take time to develop.

Web Tool

Practitioners who want to adopt a collaborative decision-making approach will be able to apply the CDMF throughout the entire transportation process or only in specific areas. The vision is for the framework to be accessible through a web-based tool, and the architecture is being designed accordingly. The structure of the CDMF web tool consists of a series of portals through which increasingly detailed information can be retrieved for each key decision point, first at the entry level and then at the practitioner level.

The diagram on page 21 represents the CDMF entry level as a series of portals, each a phase of the transportation process that can yield one or more key decision points. The entry level demonstrates the upper-level steps in decision making and how the individual phases relate to one another. The community visioning process ensures that transportation decision making includes the larger economic and environmental goals and visions of the region. The entry level allows the practitioner to select an

area of specific interest within the process that can be approached in greater detail.

Although the entry level provides a concise overview of the CDMF, transportation practitioners will need specific information at each key decision point to implement the collaborative decision-making process. A CDMF practitioner level will provide access to the full extent of information available at each key decision point, including

- ◆ The purpose and outcome of the key decision point;
- ◆ The decisions made at this step;
- ◆ The roles and responsibilities of the formal decision makers;
- ◆ Stakeholder or project-champion roles and relationships;
- ◆ Supporting data, tools, and technology;
- ◆ Related influencing processes and sub-processes;
- ◆ Primary products of this step;
- ◆ Associated best practices; and
- ◆ Links to other SHRP 2 Capacity research, such as the Performance Measurement Framework.¹

The web tool will allow states and MPOs to map their processes in conjunction with key decision

¹ www.trb.org/TRBNet/ProjectDisplay.asp?ProjectID=2184.

points. The guidance developed in SHRP 2 research then can be linked to the way that the state or MPO conducts business.

Links to Influencing Processes

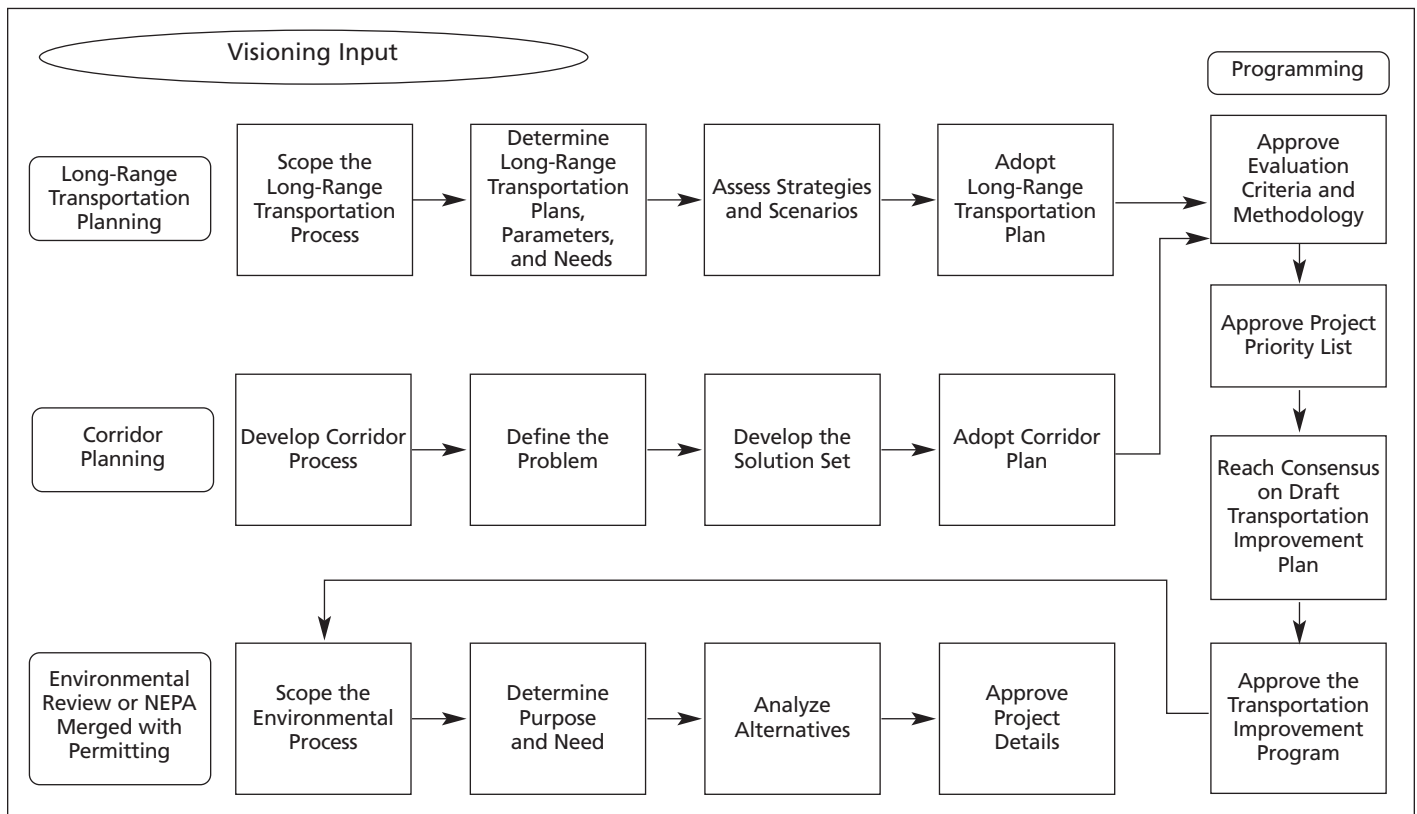
Other community planning processes that are outside the transportation process may have an impact on transportation decision making—for example, the natural and human environment, safety and security planning, and capital improvement planning. The CDMF identifies these as influencing processes. Although these may have a direct effect on the transportation process, other external processes also may influence transportation decision making; in best practice, collaboration would engage these other external processes as well.

The CDMF identifies key decision points that link to the influencing processes, along with detailed information to assist in their integration and in related consultation.

Diagnostic Tool

The roles, responsibilities, and relationships of the decision makers and the stakeholders are critical in collaboration. Although theory has addressed collaborative decision making among partners with different interests and goals, the principles rarely have been applied to a transportation context. Under-

FIGURE 2 Collaborative Decision-Making Framework, entry level. (NOTE: NEPA = National Environmental Policy Act. SOURCE: SHRP 2 Project C01, work in progress.)



standing the characteristics of collaborative decision making can help practitioners understand the environment for collaboration, the motivations and rationales of the decision-making partners, and the role that relationships play in decision making.

Decision makers can use a diagnostic tool that supports the CDMF—the Dynamics of Collaboration Scale (see chart, below)—to evaluate the degree to which the structure, roles, and relationships within a decision-making team support the collaborative decision-making process. The scale has five characteristics, each of which can be evaluated from low to high: decision-making authority, participant stability, role clarity, shared goals, and a sense of ownership.

These five characteristics can affect the speed and the quality of the decision-making process. Reaching a decision quickly implies that issues were not revisited during the process and that the decision did not have to be referred to a higher level of authority. A quality decision is one that all participants accept and agree to support through decisions made during other processes.

The Dynamics of Collaboration Scale can be used at the start of the decision-making process or at any point that collaboration is at risk. Supporting guid-

ance outlines the scale and how to use it and suggests rules and strategies that decision makers can implement to support collaborative decision making and reduce the risk that the collaboration will break down.

Integrating Research Results

The SHRP 2 Capacity research projects are grouped into four areas:

1. CDMF:
 - Systems-based performance measurement,
 - Community visioning,
 - Incorporating greenhouse gas emissions into the CDMF,
 - Effect of public-private partnerships on collaborative decision making,
 - Strategic plan for improved freight demand modeling and data,
 - Integrating freight considerations into collaborative decision making,
 - Effect of smart growth policies on travel demand,
 - Expedited-schedule case studies, and
 - Pilot tests of the CDMF

TABLE 1 Dynamics of Collaboration Scale

Scale Definition	Low	Medium	High	Potential Effect
Decision-Making Authority <i>Level of authority that has been granted to the individual participating in the decision-making team</i>	Individual is present to gather information	Individual can only make a technical commitment	Individual has the authority to make all decisions and make binding commitments on behalf of the agency	Speed and quality
Participant Stability <i>The consistency of participation in the decision-making group</i>	Turnover among team participants is high, with little consistency in individual member participation	Turnover is experienced in approximately half of the positions	A majority of the same individuals are present throughout the decision-making process	Speed
Role Clarity <i>How well individual participant roles are defined and accepted within the decision-making group</i>	No one understands or accepts individual participant roles	Understanding and acceptance of individual roles in half of the participating individuals	Everyone understands and accepts all individual participant roles in the decision-making group	Speed and quality
Shared Goals <i>The degree to which the decision-making group supports common goals</i>	Individuals represent only their agency and share no common ground with others	Individuals meet the expectations for collaboration without true acceptance of the goals	There is universal acceptance of the collective goal(s) in the decision-making group	Speed
Sense of Ownership <i>The degree of individual buy-in to the process, goals, and outcome.</i>	Little or no sense of commitment to the process, goals, and outcome by the individual participants	A commitment to participate without an understanding of the requirements of the process or a willingness to act beyond the process	True commitment to the outcome, as well as a willingness to make independent decisions in support of the outcome	Quality

2. Ecological approach to environmental protection:

- Developing an outcome-based, ecosystem approach—that is, the business case for environmental stewardship;
- Developing an ecological assessment process and credits system; and
- Pilot testing of the ecosystem approach and the ecological assessment process.

3. Economic impacts of transportation investment:

- Interaction between transportation capacity, economic systems, and land use, and
- Improved economic analysis tools.

4. Models and networks partnerships:

- Partnership to develop an integrated, advanced travel demand model and a fine-grained, time-sensitive network;
- How highway pricing and congestion affect travel demand; and
- Contribution of operations, technology, and design to meeting capacity needs.

Results from individual projects will be integrated into a web-based product organized around the CDMF. Each key decision point will be a portal for access to information. Every state has its own practices, but every project in every state must pass through these key decision points.

Vision and Focus

The vision is for the CDMF, as an integrated web-based tool, to allow users to enter the framework at any point and follow a topic of interest through all the available information and scales of analysis. For example, analyzing greenhouse gas emissions is different in the context of a 20-year plan, a corridor study, or an individual project. Similarly, community visioning may be carried out in the long-range planning, corridor planning, or even at the intersection level.

Approaches, techniques, and expectations differ at each stage. One of the benefits will be the ability to track an issue horizontally through the CDMF or to focus on a single key decision point. Case studies, tools, source material, and institutional approaches will be available for users.

Results from individual SHRP 2 Capacity research projects will be synthesized and condensed in the final user-oriented product, with links to full-text source material supported by examples and illustrations. This new collaborative planning document focuses on decisions, not on process.

Although it will not make the decisions any easier, the CDMF will support decision making that

Designing and Applying the Framework

Feedback from practitioners on the concept and design of the Collaborative Decision-Making Framework (CDMF) is essential for success. The design of the CDMF was accomplished through a series of workshops involving transportation professionals. The workshops will be followed by a series of tabletop exercises to test the effectiveness of the design for selected key attributes. Exercises will be conducted in each of the four regions of the American Association of State Highway and Transportation Officials, with a follow-up report on the lessons learned.

The following objectives have been established to guide the exercises:

1. Identify opportunities for information exchange between transportation phases;
2. Identify barriers that may prevent binding decisions during the transportation decision-making process; and
3. Evaluate the new features in the CDMF for enhancing the transportation decision-making process.

delivers the needed transportation system to the megaregions, as well as to places in-between, in the larger community context. With the continued integration of emerging issues, decision makers at all stages of the transportation process will have ongoing support in making the most effective investment as efficiently as possible.

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Safety Research on Highway Infrastructure and Operations

Improving Priorities, Coordination, and Quality

JILL WILSON

The author is Senior Program Officer, TRB Studies and Special Programs, and served as study director for this report.

Fatalities and injuries from road traffic crashes remain a major public health concern in the United States. In 2007, 41,059 people were killed as a result of road traffic crashes (1). This figure represents a 3.9 percent decline from the number of fatalities in 2006, and corresponds to 1.37 fatalities per 100 million vehicle miles traveled, a historic low.

Nonetheless, the 2007 fatality rate is well above the target of 1.0 deaths per 100 million vehicle miles traveled, set by the American Association of State Highway and Transportation Officials (AASHTO) in its 2005 Strategic Highway Safety Plan. In addition, approximately 2.49 million people were injured in road traffic crashes in the United States in 2007 (1).

Benefits, Opportunities, and Challenges

Research on road traffic safety over the past five decades has led to important reductions in death and

injury rates. Properly used seat belts, for example, are one of the most effective measures for reducing death and injury, and the National Highway Traffic Safety Administration (NHTSA) estimates that approximately 147,000 lives were saved through seat belt use between 1975 and 2001 (2).

Other examples of research payoffs include the installation of median cable barriers on selected Interstates in Missouri after research conducted by the Missouri Department of Transportation (DOT) in the 1980s. On Interstate 70, the installation of 179 miles of median cable barrier reduced cross-median roadway fatalities to 2 in 2006, from a peak of 24 in 2002 (3). An assessment indicated that 21 technologies and methods produced by Texas DOT research programs will save 245 lives, reduce the number of crashes by more than 24,000, and save more than \$322 million during the 10 years from 2003 to 2013 (4).

As the field of road safety improvement develops a foundation in science, with knowledge based on



PHOTO: MISSOURI DOT

Research by the Missouri Department of Transportation showed median cable barriers to be more cost-effective safety devices than concrete barriers or guardrails for long-distance installation on rural Interstates. The cable barriers have reduced cross-median roadway fatalities in the state.

high-caliber research studies instead of on conventional wisdom and observation of practice, many research opportunities are arising. The challenge is to determine which of these opportunities is likely to yield the greatest benefit in safety improvements and therefore deserves financial support.

The organizations that fund and conduct road safety research are under pressure to demonstrate the return on investment. Deciding how best to allocate scarce research funds requires not only identifying and prioritizing the best research opportunities, but also ensuring that the research produces reliable and useful results and avoids unnecessary duplication.

To assist the highway safety community in identifying research funding opportunities and priorities, the Federal Highway Administration (FHWA) and the state DOTs, through the National Cooperative Highway Research Program (NCHRP), requested the National Research Council to convene an expert committee under the auspices of the Transportation Research Board (see box, page 27). The committee was asked to provide an independent review and assessment of the processes for establishing research priorities and coordinating research activities in the area of highway infrastructure and operations safety. The committee also was charged with recommending an efficient and effective process for setting research priorities and coordinating research efforts and with commenting on strategies to improve research quality. The committee's findings and recommendations are detailed in TRB Special Report 292, *Safety Research on Highway Infrastructure and Operations: Improving Priorities, Coordination, and Quality*.

Scientific Advisory Committee

The committee recommends that an independent scientific advisory committee (SAC), consisting primarily of experienced safety program managers and knowledgeable researchers, be charged with (a) developing a transparent process for identifying and prioritizing research needs and opportunities in highway safety, with emphasis on infrastructure and operations; and (b) using the process to recommend a national research agenda that focuses on highway infrastructure and operations safety. To conduct these tasks, the SAC would enlist the help of outside experts as needed.

One of the greatest challenges in developing a national research agenda for highway safety is prioritizing research opportunities. Each of the public and private organizations funding research establishes its own priorities in response to its mission and to the needs of its stakeholders. Because the highway safety research community in the United States is diverse

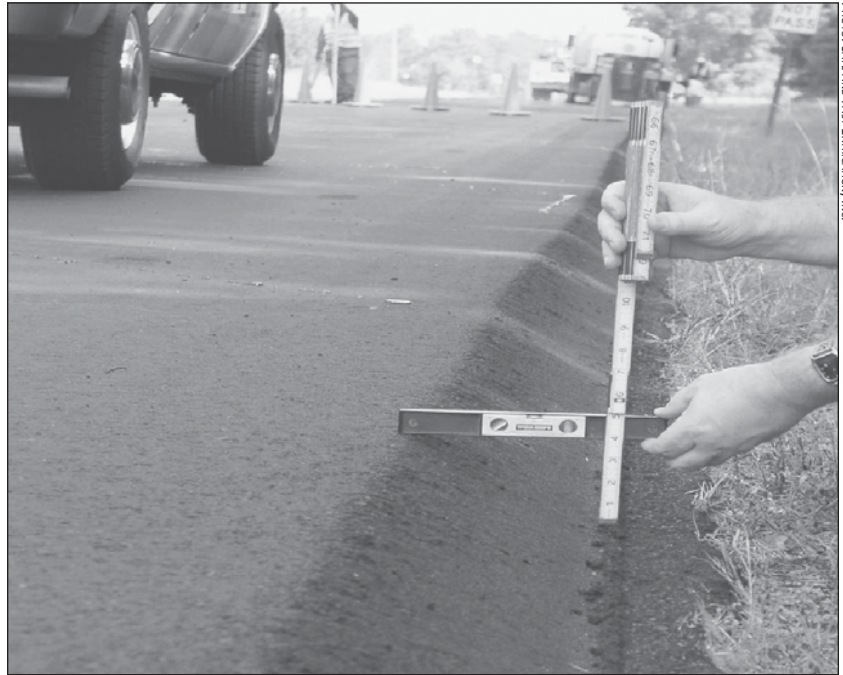


PHOTO: SAFE AND FAST EXTRUSION, INC.

and decentralized (see sidebar, page 26), obtaining consensus on research priorities appears unlikely.

Nonetheless, a national research agenda that lacks priorities would not be helpful for a funding organization that is deciding which topics and projects to support. In contrast, assigning priorities by taking a quantitative analytical approach—examining clearly defined criteria to determine the value of a research project or topic—could provide decisive information to those who allocate research funds, even when the organization's priorities differ from those in the national agenda.

The committee identifies two possible approaches to setting priorities—one that could be considered traditional and one based on the methods of decision analysis. Both approaches merit further consideration by the SAC in developing a national research agenda. The choice of approach should take into account the needs of safety program managers, the state of knowledge, and the potential for research to solve the problem.

The SAC's national research agenda therefore should be based on in-depth knowledge of current research, include a quantifiable measure of the value or benefit of a proposed research effort in terms of improved road safety, assess the ability of research to address the problem, and reflect expert judgment about the implementation of the findings.

Improving Research Quality

The problems confronting road safety researchers are not easy. Motor vehicle crashes are complex events, the result of a combination of effects involv-

Because of the numbers of fatalities and serious injuries associated with run-off-road crashes, an effective process is needed to select research projects that will result in progress toward crash reduction. Above, a safety edge is installed that will allow a departing vehicle to return safely to the roadway.



PHOTO: SAFE AND FAST ERUCTION, INC.

Crash statistics for highway intersections highlight the need for improvements in design and operation. Even at signalized intersections, drivers may be confused about the proper turn path. Delineation of turn paths has proved useful to drivers making opposing left-hand turns.

ing the driver, the vehicle, and the roadway. Researching crashes therefore requires elements of many disciplines, including civil and mechanical engineering, statistics, psychology, and public health. Crash research also relies on data that frequently are limited in quantity and varied in quality. In addition, controlled experiments are seldom possible, complicating efforts to determine how a given countermeasure is likely to affect crash frequency or severity.

This combination of a challenging research area and a need for multidisciplinary research teams, together with a shortage of trained researchers, suggests that measures to ensure high-quality research

could have considerable payoff in more reliable and usable research results. The committee concluded that a well-conceived national agenda would be a primary strategy for improving research quality. The agenda also could help ensure that high-priority research issues are identified and funded on a continuing basis.

One strategy for improving research quality is to award funding competitively through the judgment of scientific peers. This proven strategy is likely to yield increasingly important benefits as highway safety research makes the transition to a science-based approach. In addition, the trained and independent researcher needs to be a more influential partner throughout the entire knowledge development process, working with the experienced safety program manager not only to formulate research programs and projects, shape proposals, and select researchers to perform the work, but also to monitor ongoing research and assess final results before publication. Finally, a portion of available funding could be set aside for investigator-initiated fundamental research to improve research methods and to explore innovative solutions to road safety problems.

Research Coordination

Research coordination helps ensure the effectiveness of research funds by eliminating unnecessary duplication and targeting high-priority research. Experience with safety-related projects under NCHRP shows that when state DOTs coordinate research efforts through a large-scale pooled-fund program—

Diverse Missions and Priorities

U.S. highway research is funded and conducted by a variety of public and private organizations, each with its own mission and related priorities. The Federal Highway Administration (FHWA) has the nation's largest single highway research program, which includes an important safety component. Other federal agencies funding highway safety research include the National Highway Traffic Safety Administration, the Federal Motor Carrier Safety Administration, and the Centers for Disease Control and Prevention.

State departments of transportation fund highway safety research through state planning and research programs, individual state programs, the National Cooperative Highway Research Program, and FHWA's Transportation

Pooled-Fund Program. Nonprofit and private organizations, such as the AAA Foundation for Traffic Safety, the Insurance Institute for Highway Safety, and private insurance companies, also fund highway safety research, and automobile manufacturers conduct highway safety research for their products.

Federal agencies, state and local governments, industry, and nonprofit organizations fund highway safety research by University Transportation Centers. In addition to these varied, continuing sources of highway safety research funding, periodic efforts—such as the Strategic Highway Research Program 2, through its Safety focus area—provide concentrated resources for highway safety research over a short time.



Properly used seatbelts remain one of the most effective measures for reducing death and injury.

instead of pursuing separate research programs with limited funding—higher-quality research can result.

Nonetheless, any new coordination mechanism that requires a cumbersome, costly, and rigid administrative structure is likely to fail, because of limited resources and an inability to accommodate the goals and constraints of research funding organizations. The committee's knowledge of the field and statements by representatives of key research funding agencies at a workshop hosted by the committee supported this observation.

The committee therefore proposes an informal approach to research coordination, with the SAC's national research agenda as a unifying focal point. The SAC would host a one-day meeting each year for research funding organizations and other interested parties, including congressional staff, to discuss the national research agenda. The meeting would provide an opportunity to explore the potential benefits of coordinating research in the priority areas and topics identified by the SAC.

The committee was unable to obtain reliable estimates of the total funds currently applied to research in highway infrastructure and operations safety. An approximation was generated with data from TRB's Research in Progress database. Excluding periodic efforts such as the ongoing Strategic Highway Research Program 2, the total came to \$24 million a year. The cost of developing a national research agenda and hosting the first informal coordination

meeting therefore would be less than 3 percent of total annual research expenditures on highway infrastructure and operations safety. The annual cost of a follow-on, informal research coordination meeting would be approximately one tenth of 1 percent of annual research expenditures.

Champion Needed

Starting up the SAC activity would require not only funding, but also an effective organizational strategy. In the committee's view, having an influential champion with the necessary knowledge and expertise leading the effort could go a long way toward garnering support from the range of constituencies. AASHTO and FHWA would be strong candidates for this role.

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Committee on Research Priorities and Coordination in Highway Infrastructure and Operations Safety

Forrest M. Council, University of North Carolina, Chapel Hill, *Chair*

Ann M. Dellinger, Centers for Disease Control and Prevention, Atlanta, Georgia

Leanna Depue, Missouri Department of Transportation, Jefferson City

Nicholas J. Garber, University of Virginia, Charlottesville

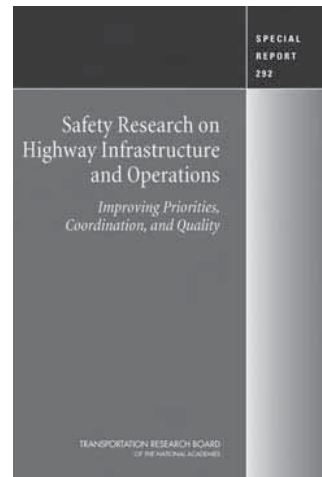
Ezra Hauer, University of Toronto, Ontario (retired)

Thomas Hicks, Maryland State Highway Administration, Hanover

Timothy R. Neuman, CH2M Hill, Inc., Chicago, Illinois

Alison Smiley, Human Factors North, Inc., Toronto, Ontario

Daniel S. Turner, University of Alabama, Tuscaloosa



TRB Special Report 292, *Safety Research on Highway Infrastructure and Operations: Improving Priorities, Coordination, and Quality*, is available from the TRB online bookstore, www.trb.org/bookstore; to view the book online, go to <http://onlinepubs.trb.org/onlinepubs/sr/sr292.pdf>.

The Federal Investment in Highway Research 2006–2009

Strengths and Weaknesses

STEPHEN R. GODWIN

The author is Director, TRB Studies and Special Programs, and served as study director for this project.

The nation has 8.4 million lane miles of roads that connect metropolitan areas, towns, and counties to serve more than 300 million residents and 7 million business establishments. Publicly funded highway research programs have developed innovations that have produced longer-lived assets at lower costs, reduced environmental impacts, saved lives, and improved economic efficiency. Additional innovation will be needed to improve safety, reduce congestion, address environmental and energy concerns, and provide the quality highway system that the nation's citizens expect.

To foster this innovation, research funding should be awarded through a process of competition and merit review; advanced research activities should be pursued; past research cuts should be restored and additional funding made available; stakeholder-supported programs should be continued; a robust program for dissemination of research results should be undertaken; and a process should be established to engage the entire highway community in setting highway research priorities.

Systemic Stresses

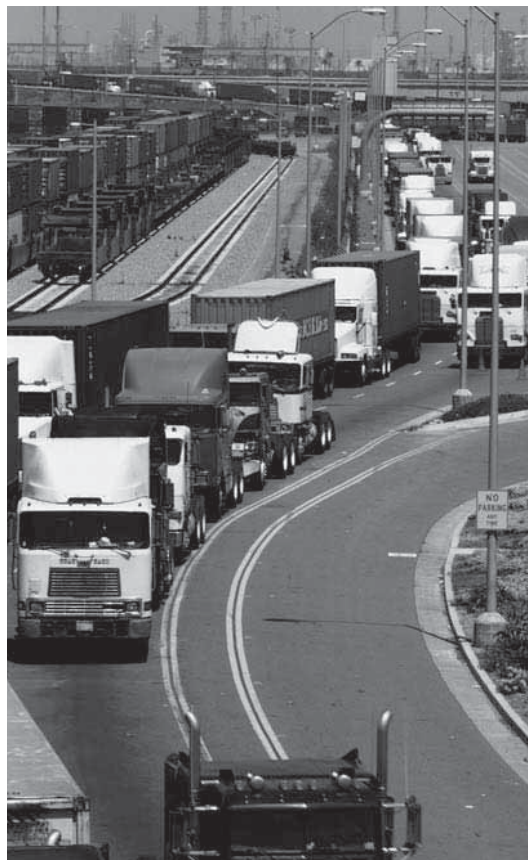
Highway transportation is the principal circulatory system for the national economy. It has contributed to national economic growth in recent decades but is under severe stress because of heavy demand, the aging of capital stock, environmental impacts, and shortages of funding to address these problems.

The American lifestyle depends on highway transportation. Americans use personal vehicles for 87 percent of daily trips and 90 percent of long-distance trips. Moreover, highways are the backbone of the decentralized U.S. economy, which could not function without the access that highways provide for motor carriers. Truck ton-miles constitute approximately 30 percent of the total U.S. ton-miles of freight, but that tonnage accounts for nearly 75 percent of the value of all freight shipped.

Innovation's Role

Public-sector highway research has been the primary source of innovation and insight in meeting the national need for highway transportation. Continued innovations to make highways safer, perform better, last longer, and cost less are essential in sustaining the contributions of highways to national prosperity.

Successfully addressing the highway system's challenges will require new and more efficient ways of doing things—new materials, better and faster construction techniques, safer designs, better infor-



Highways are vital to the nation's economy—trucks carry 75 percent of the value of all freight shipped in the United States; yet significant gaps remain in understanding the nature and extent of commercial trucking.



The use of prefabricated components in highway construction and reconstruction has expanded. The Central Artery–Tunnel Project (or “Big Dig”) in Boston relied extensively on prefabricated applications. For the Ted Williams Tunnel, twelve 35-foot-long steel tunnel sections were constructed in Baltimore, shipped to Boston, floated into place, and then submerged.

mation for drivers, new financing mechanisms, options for pricing the use of the system, and more. Research, development, deployment, and training must fill this role.

Since 1992, the Research and Technology Coordinating Committee (RTCC) of the Transportation Research Board (TRB) has served as an independent adviser on national and federal highway research; the members are appointed by the National Research Council of the National Academies (see box, page 31). The Federal Highway Administration (FHWA) has supported the committee’s work over the past 15 years. The newly released Special Report 295,

The Federal Investment in Highway Research 2006–2009: Strengths and Weaknesses, presents the findings and recommendations of the RTCC after assessing the highway research programs funded under the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU).

For the assessment, the committee applied the principles for research articulated by Congress in the preamble to SAFETEA-LU Title V: Research, as well as additional principles that the committee considers important in sustaining a vital highway research program (see box, below).

Principles for Research Based on SAFETEA-LU Title V

1. The federal portfolio should cover the full innovation cycle, including the following:
 - a. Agenda setting,
 - b. Conduct of research,
 - c. Support of research and technology transfer by the states,
 - d. Sharing of results, and
 - e. Deployment (including education and training).
2. Justification for federal investment requires that
 - a. Activities be of national significance,
 - b. There be public benefit and suboptimal private investment,
 - c. Efficient use of federal funds by states and local governments be encouraged, or
 - d. The activity be the best means to support federal objectives.
3. The content of the federal research, development, and technology (RD&T) program includes the following:
 - a. Fundamental, long-term research;
 - b. The filling of significant gaps; and
 - c. Policy or planning.
4. Stakeholder input is addressed.
5. Awards are almost always made on the basis of competition and merit review.
6. Programs include performance review and evaluation.

Note: This list represents a distillation of eight principles included in Title V: Research; two principles that overlap are combined and one principle not relevant to this report is eliminated.

Application of Superpave on I-94 in Illinois. Developed under the first Strategic Highway Research Program, Superpave is used in all 50 states and the District of Columbia; a study projects that net savings over 20 years nationwide should approach \$1.8 billion annually.



Main Findings

Despite increases under SAFETEA-LU, highway research programs remain significantly underfunded in comparison with the levels of investment in industry. Public and private highway research receives approximately one-quarter of the amount that industry spends on research, development, and technology (RD&T) in the United States—highway RD&T represents only 0.9 percent of revenues provided to highway agencies; in contrast, industrial investment in RD&T is equivalent to 3.3 percent of revenues from sales.

Extensive legislative earmarking violates the SAFETEA-LU principle of awarding research funds through competition and merit review. For example, earmarks affect 62 percent of the Title V University Transportation Centers (UTC) program, and additional earmarks scattered across FHWA programs amount to at least 18 percent of the agency's funding.

The programs funded under SAFETEA-LU do not include all the content areas Congress requested. Because of funding constraints in Title V, FHWA was forced to cut important research in safety, operations, planning and environment, and policy. Funding was eliminated for research and data collection to support policy decisions, and funding for planning was greatly reduced. Although funding is provided in other areas—such as deployment and technology transfer—the levels are inadequate.

A 50-50 matching requirement biases the UTC program toward highly applied research and away from advanced research, which is one of the main rationales for a university research program. In addition, because of funding constraints, FHWA has not been able to follow through on commitments in its

Corporate Master Plan for Research and Deployment of Technology and Innovation to engage stakeholders more broadly in agenda setting, merit review, and program evaluation.

The Strategic Highway Research Program 2 (SHRP 2) adheres to all the research principles of Title V, but the program has received funding at only 36 percent of the intended level—and for two years less than stakeholders requested. The downscaled program will not be able to meet all of the originally envisioned goals.

Recommendations

Principles for Research

To the maximum extent practicable, research funding should be awarded through competition and merit review. Sole-source funding should be allowable in the relatively rare circumstances in which it is appropriate—for example, when only a single agency has the capability required.

All UTC funds should be awarded to universities competitively. The 50-50 matching requirement for UTC research should be reduced to a 20 percent university match to allow universities to conduct more advanced research. Competition should be open to all universities and should not be limited by previous levels of transportation research activity.

Funding

FHWA should be provided with the resources it needs to fulfill the commitments in its Corporate Master Plan to involve stakeholders more substantively in its RD&T program, specifically in agenda setting, merit review, and peer review.

FHWA should receive additional funding for mission-related activities, such as program support for

regulations and oversight, technical assistance, information sharing, technical exchange, and other deployment activities. Funding should be restored for program areas that were cut back significantly in SAFETEA-LU—including operations, safety, and environmental research. Funding for policy research also should be restored and expanded to meet pressing national needs.

FHWA should be given the resources for technical assistance and deployment activities for stakeholders in the planning and environmental area. These resources previously were supplied under the Transportation Equity Act for the 21st Century.

Specific programs supported by stakeholders require additional attention. The RTCC recommends that

- ◆ Congress consider extending the SHRP 2 program for two years in the next authorization, with funding under Title I: Federal-Aid Highways, as states have requested;¹

- ◆ The Long-Term Pavement Performance Program be funded to complete the data collection, support the analysis to realize the benefit of the investment, and preserve the massive database on pavement performance;

- ◆ The Long-Term Bridge Performance Program and other programs with broad-based stakeholder support established under SAFETEA-LU be reauthorized;

- ◆ The surface transportation environmental research program, supported by stakeholders, be authorized as a cooperative research program, as recommended in TRB's 2002 report, *Surface Transportation Environmental Research: A Long-Term Strategy* (2); and

- ◆ Funding for research programs to improve travel forecasting models and practice be authorized, as recommended in TRB's 2007 report, *Metropolitan Travel Forecasting: Current Practice and Future Direction* (3).

Data Collection

Greater emphasis on data collection is necessary. The

¹ The RTCC endorsed the funding of SHRP 2 in its 2001 report, *The Federal Role in Highway Research and Technology* (1). The program subsequently was authorized in SAFETEA-LU, and TRB was asked to manage the program. The committee believes that the program meets all the principles of research laid out in SAFETEA-LU. The program received much less funding and time than were requested and therefore is a candidate for continued funding. Even so, the committee does not wish to be perceived as recommending future work for TRB to manage. The committee's recommendation therefore urges Congress to consider the program's merits and to fund an extension.

ability to answer many of the most important policy questions in highway transportation requires much better data. Research and better data are needed in the planning area also to develop advanced modeling tools to meet federal and local planning and environmental mandates.

Agenda Setting

Establishment of communitywide consensus on national highway research priorities would help focus all highway research programs on the most important areas. FHWA should be given the resources to establish an ongoing process for the highway community to set priorities.

Research Dividends

Even within current constraints, the federal investment in highway research is sound. Publicly funded highway research programs have developed innovations that have produced more durable assets at lower costs, have reduced environmental impacts, have saved lives, and have improved economic efficiency.

Adoption of the recommendations in the RTCC report would provide the nation with an improved program that would yield even greater dividends. These additional payoffs from research are urgently needed to meet the demands on the highway system today and in the future.

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TRB Special Report 295, *The Federal Investment in Highway Research 2006–2009: Strengths and Weaknesses*, is available from the TRB online bookstore, www.trb.org/bookstore/; to view the book online, go to <http://onlinepubs.trb.org/onlinepubs/sr/sr295.pdf>.

Research and Technology Coordinating Committee (FHWA)

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- Albert H. Teich, American Association for the Advancement of Science



Safer Nighttime Construction Zones Through Better Lighting

Illinois Develops and Applies Practical Guidelines

DENNIS A. HUCKABA

The author is Policy Engineer, Bureau of Design and Environment, Illinois Department of Transportation, Springfield.

Daytime lane closures causing motorist delays and queues have become unacceptable. For the past several years, therefore, the Illinois Department of Transportation (DOT) has scheduled construction on expressway projects in the Chicago area at night. The nighttime repair and resurfacing of roadways has expanded to other urban facilities and to most rural Interstates. For many of the nighttime construction projects, portable light towers had been the primary source of illumination.

Problem

In 2001, Illinois DOT sponsored research to evaluate lighting requirements and to recommend a lighting specification for nighttime construction. The resulting specification stipulated lighting requirements that were similar to those recommended by the Occupational Safety and Health Administration. The contractor had to submit a detailed lighting plan drawn up by a professional engineer, a lighting layout for each work area, and lighting design calculations, along with standards for uniformity and for the measurement of the lighting levels by the engineer.

The design, installation, and operation of the lighting had to avoid glare, which can interfere with traffic on the roadway.

The specification was good, but it was not practical for design, installation, or inspection. The review and approval of the required lighting plan, for example, could take up to 30 days—some projects could be near completion in that time. In addition, department engineers, inspectors, and contractors found that the lighting requirements were not easy to understand; moreover, no procedures for measuring glare and determining what was acceptable were readily available. As a result, the specification would be rewritten for different contracts, meeting the minimum requirements, but allowing the contractors to install and provide lighting to suit their needs.

During the next few years, traffic control reviewers observed a variety of lighting schemes in nighttime work zones. Many times, the placement of portable tower lighting or spotlights was blinding to motorists and workers. Department inspectors and materials personnel also filed complaints about insufficient lighting—but increasing the number of light towers only increased the glare for the workers and motorists.



Flaggers shield their eyes to distinguish oncoming traffic.



Raised headlights and roller lighting generate a blinding glare for oncoming traffic in the adjacent lane.

Solution

In 2006, the Illinois Center for Transportation, a research partnership between Illinois DOT and the University of Illinois, sponsored another research project to develop an easy way to measure glare and to rewrite the lighting specification to be more user-friendly and practical. The researchers visited nighttime construction projects that included patching, milling and resurfacing, and bridge beam replacement. Some work sites were in urban locations with existing roadway lighting and others were on rural Interstates.

The researchers' observations included the following:

- ◆ Patching is a fast-moving operation across many locations along several miles of highway. In a closed lane on a rural Interstate, for example, workers had difficulty moving the lighting with the patching operations; some work locations, therefore, were lit only with the headlights of the equipment or the pickup truck. Tower lighting, when used, produced significant glare for the workers.

- ◆ Milling and paving projects consistently used a new type of balloon lighting on each paving machine—that is, a light source enveloped in a balloon-shaped, translucent material, diffusing the light; other projects, however, had no consistent lighting sources. Rollers, sweepers, milling machines, flagger stations, and materials testing locations relied on the equipment lighting, makeshift lighting, and other creative lighting sources. The lighting often was nonexistent or poor—yet even poor lighting could create a blinding glare for workers and motorists.

- ◆ The researchers measured the veiling luminance ratio—that is, the glare—from some of the lighting sources on the construction sites. The ratio ranges were as follows:

- For extended headlights on a roller: 2.74 to 3.55;
- For a portable light tower: 1.31 to 5.01; and
- For balloon lighting on a paving machine: 0.02 to 0.51.

The balloon lighting produced substantially less glare—10 percent to 15 percent of the ratios from the other sources; for minimizing glare, therefore, the balloon lighting was superior. The balloon lighting also provided a larger diameter of light for those working around the perimeter of the paving equipment and on the shoulders.

Calculation of the veiling luminance ratio in and around construction sites requires measuring the vertical luminance and the pavement luminance. On roadway construction sites, however, the locations at which these measurements can be taken are often constrained by safety considerations—such as adjacent traffic—and by the layout of barriers on the site.

Researchers gained more insight into the problem through meetings with district traffic control supervisors and other groups and through discussions about nighttime construction projects. Consequently, one of Illinois DOT's districts developed a specification that required balloon lighting on all equipment used in paving operations (see photo, page 34)—the milling machine, the paving machine, the sweepers, the rollers, and the flagger stations—and at all work locations within the work zone.

At one project applying this specification, the researchers and the review panel found that the lighting was adequate where needed, was glare-free, and provided an atmosphere that felt safer to the workers. The lighting on this project, therefore, served as the model, and balloon lighting became the preferred lighting system.



Buoy light in the back of a pickup shone directly into the eyes of approaching workers and drivers.



Balloon lighting in use on paving equipment.

Applications

Some projects employed an early version of the balloon lighting specification. The results were favorable from the motorists' and workers' points of view. The workers noted that the work environment was safer; moreover, the sites were basically glare-free on drive-through inspections.

The researchers have finalized the lighting specification, which has gained approval for all nighttime construction projects. Luminaries on light towers are still allowable but must be aimed downward at the work to minimize the glare and can be rotated outward no more than 30 degrees from the straight-down position.

Few restrictions apply to balloon lighting. The

specification describes lighting levels for specific nighttime construction operations, such as work areas for layout, testing, and inspection personnel; traffic control setup and removal; and pavement marking and raised reflective pavement marker installation. Many of these operations previously were isolated and were not considered for lighting.

Benefits

The research goal of providing a means for measuring glare was accomplished. The many variables of placement, types of lighting, location on the roadway, and aiming of luminaries, however, make the preparation of a simplified table or calculation for contractors and construction inspectors almost impossible. The final specification, "Nighttime Work Zone Lighting," provides a safer work environment that offers the visibility for higher quality work. The specification can be easily understood, inspected, monitored, and applied in the field; application on several projects has gained positive feedback from workers on site and from Illinois DOT inspectors.

In addition, the research increased awareness about the problems of lighting in nighttime work zones among all involved with the construction, materials, maintenance, safety, work zone layout, and roadway lighting of highway projects. Portable light tower manufacturers have become more aware of the need for an improved, glare-free system, and more suppliers are now producing different types of balloon lighting.

Applying the new specification is expected to increase safety for workers and for drivers by eliminating or reducing glare; to enhance the quality of work, including inspection, through sufficient lighting; and possibly increase productivity as a result of the improved work conditions on the construction site.

For further information, contact Dennis A. Huckaba, Policy Engineer, Bureau of Design and Environment, Illinois Department of Transportation, 2300 South Dirksen Parkway, Springfield, IL 62764; telephone: 217-557-3405; e-mail: Dennis.Huckaba@illinois.gov.

EDITOR'S NOTE: Appreciation is expressed to Amir Hanna and Pete Shaw, Transportation Research Board, for their efforts in developing this article.

Night Lights for Highway Work

NCHRP Report 498, *Illumination Guidelines for Nighttime Highway Work* (2004), presents the findings of a research project conducted by the University of Florida, Gainesville. The report makes recommendations for (a) illumination guidelines for nighttime highway work; (b) guidelines for work zone illumination design; and (c) guidelines for the use of temporary roadway lighting for nighttime construction and maintenance. The guidelines address such concerns as visibility requirements, lighting equipment, lighting configuration and arrangement, lighting system design, system operation and maintenance, and economic considerations.

For more information, www.TRB.org/news/blurb_detail.asp?id=2316.

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

TRB Meetings 2009

March

24–25 Midwest Traffic Monitoring Workshop
Columbus, Ohio

April

1–3 Design–Build in Transportation Conference
Baltimore, Maryland
Frederick Hejl

7–8 Workshop on Polyphosphoric Acid Modification of Asphalt Binders*
Minneapolis, Minnesota

15–17 Workshop on Identifying Traveler Information Research Needs to Achieve All Roads, All Modes, All the Time
Irvine, California

19–22 11th Joint Light Rail Transit Conference*
Los Angeles, California

22–24 National Conference on Preservation, Repair, and Rehabilitation of Concrete Pavements*
St. Louis, Missouri

22–24 Teamwork in U.S. Railroad Operations
Irvine, California
Richard Pain

22–24 Strategic Highway Safety Plan Peer Exchange and AASHTO SCHOTS Meeting
(*by invitation*)
Chicago, Illinois
Richard Pain

May

3–5 7th National Aviation System Planning Symposium
Monterey, California

4–6 TRB Annual Ports, Waterways, Freight, and International Trade Conference
Irvine, California
Joedy Cambridge

4–6 4th Bus Rapid Transit Conference*
Seattle, Washington
Peter Shaw

12–14 19th Biennial TRB Visibility Symposium
Blacksburg, Virginia

17–21 12th National Transportation Planning Applications Conference
Houston, Texas

27–29 11th Annual Harbor Safety Committee Conference*
Tampa, Florida
Joedy Cambridge

June

2–3 Data on Goods Movement Impacts on Air Quality
Irvine, California
Thomas Palmerlee

14–17 26th International Bridge Conference*
Pittsburgh, Pennsylvania

21–24 2nd International Symposium on Freeway and Tollway Operations*
Honolulu, Hawaii

22–24 North American Transportation Statistics Interchange (*by invitation*)
Washington, D.C.
Thomas Palmerlee

22–26 5th International Driving Symposium on Human Factors in Driver Assessment, Training, and Vehicle Design*
Big Sky, Montana
Richard Pain

28–July 1 Earthquake Engineering in a Multihazard Environment*
Oakland, California

29–July 2 8th International Conference on the Bearing Capacity of Roads, Roadways, and Airfields*
Champaign, Illinois

July

8–10 6th International Conference on Maintenance and Rehabilitation of Pavements and Technological Control*
Politecnico, Di Tornio, Italy

19–22 48th Annual Workshop on Transportation Law
Denver, Colorado
James McDaniel

19–23 12th AASHTO–TRB Maintenance Management Conference*
Annapolis, Maryland

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

*TRB is cosponsor of the meeting.

Sandra Q. Larson

Iowa Department of Transportation

Director of the Research and Technology Bureau at the Iowa Department of Transportation (DOT), Sandra Larson oversees the planning, development, and implementation of the department's research and intelligent transportation systems program. She also has served the department as director of the Engineering Bureau, director of the Office of Bridges and Structures, resident construction engineer, and bridge design engineer.

"We have a rich history at Iowa DOT—and in the United States—of performing transportation research that makes a difference in our world," Larson comments. "As our national transportation challenges grow, it is imperative that transportation research continues to help provide a long-lasting, safe, and efficient transportation system. Our infrastructure is

and to achieve commonly held goals in this pooled-fund project, technology transfer and buy-in from the participants was greatly facilitated," Larson recalls. "We were able to demonstrate that by working together from the early-concept stage to the final project technology transfer and implementation, we were more successful in meeting challenges."

Iowa DOT has adopted the approach, Larson notes: "We continue to use that philosophy at Iowa DOT for research projects in the conceptual stage—whether for small, in-house projects, or for the drafting of new, pooled-fund proposals on subjects such as concrete pavements, teen drivers, structural health monitoring of bridges, and winter maintenance."

Larson observes that "implementation is a natural step when researchers have been working with practitioners from a project's outset," and she maintains that "the future of transportation research lies in partnership initiatives." At Iowa DOT, she has worked to build partnerships with states, agencies, universities, and industry to address shared challenges, as well as encouraged colleagues to work to advance the state of practice quickly and efficiently by building partnerships within the agency.

Larson has been active in TRB since 2002. She chairs the National Cooperative Highway Research Program (NCHRP) Project Panel on Innovations Deserving Exploratory Analysis, and she is a member of the Portland Cement Concrete Pavement Construction Committee, the General Structures Committee, and the Surface Transportation Weather Committee. She also serves on the Committee for the Strategic Highway Research Program 2: Implementation and on the National Research Council-appointed Committee for Pavement Technology Review and Evaluation.

In addition to her work with TRB, Larson is a member of the recently formed FHWA Long-Term Bridge Performance Program Expert Working Group, led by the Center for Advanced Infrastructure and Transportation at Rutgers University, New Jersey. She is Iowa DOT's state representative and chair of the American Association of State Highway and Transportation Officials' (AASHTO) Research Advisory Committee; vice chair of the AASHTO Standing Committee on Research; and is a past vice chair of the AASHTO Highways Subcommittee on Bridges and Structures. A licensed civil and structural engineer in Iowa, she holds bachelor's degrees in civil engineering and in general science and biology from Iowa State University.



"[I]mplementation is a natural step when researchers have been working together from a project's outset."

aging, our buying power is diminishing, and our traffic volume—over the long term—is increasing. Striving to achieve research that leads to meaningful results, working hard to be a driving force that leads to innovation, and helping our agencies meet the needs of the traveling public are focal points for our department."

A highlight of Larson's career was her role as the lead state project administrator on Material and Construction Optimization for Prevention of Premature Pavement Distress in portland cement concrete pavements, a pooled-fund project that started in 2003 and was completed in 2007. The project advanced a model for the collaboration and leveraging of time, expertise, and funds between diverse organizations—state DOTs, the Federal Highway Administration (FHWA), industry, and Iowa State University's Concrete Pavement Technology Center at the Center for Transportation Research and Education.

"Because different groups joined together to solve problems

Steven D. DeWitt

North Carolina Turnpike Authority

As Chief Engineer for the North Carolina Turnpike Authority (NCTA), Steve DeWitt is responsible for all activities related to the planning, design, and construction of major NCTA toll projects and for a toll program valued at approximately \$5 billion.

DeWitt works to ensure quality design of roadway and structure elements, to procure contracts in design-build, and to manage all contract construction administration. He is also involved with the development and implementation of financial plans, the development of technology for toll projects, and with the development of a public-private partnership program for transportation infrastructure.

Before taking a position with NCTA, DeWitt served the North Carolina Department of Transportation (DOT) from

1984 to 2006 in such positions as project engineer, resident engineer, state roadway construction engineer, state construction engineer, and director of construction. He began his career with the department as a hands-on field construction engineer and went on to lead statewide programs in construction, contract procurement, and project delivery. In his diverse roles at North Carolina DOT, he also has worked with private-sector organizations—he credits these working relationships with reshaping his view of transportation research.

DeWitt maintains that research is crucial for moving transportation projects from concept to reality and he credits the design-build concept as an example of an effective, research-based, problem-solving tool for transportation projects.

“The design-build movement began less than 10 years ago, when states were seeking solutions to problems related to project delivery, including schedule assurances, cost overruns, and other issues,” DeWitt explains. “The TRB Design-Build Task Force—now the Project Delivery Methods Committee—realized early on that practitioners needed more information on concepts, their applicability, and their possibilities, and they embraced membership from private-sector contractors and consulting agencies, which helped increase understanding of the entire process. Design-build has proved to be an essential tool for solving problems in many important state transportation projects.”

Active in TRB since 1994, DeWitt has chaired the Construction Management Committee; the Construction Section; the Project Delivery Methods Committee; and the National Cooperative Highway Research Program Project Panel on Best-Value Procurement Methods for Highway Construction Projects. He is a member of the Strategic Highway Research Program 2 (SHRP 2) Technical Coordinating Committee for Renewal Research; the Expert Task Group on Performance Specifications; and the Expert Task Group on Geotechnical Solutions for Soil Improvement, Rapid Embankment Construction, and Stabilization of the Working Platform. He has attended TRB Annual Meetings since 1993.

“What I often share with young transportation professionals and students of transportation is that the world of transportation research offers tremendous opportunities,” DeWitt observes. “Involvement in TRB—especially in its research efforts—provides an opportunity to learn from experts in all areas of transportation. The building of professional relationships can be very rewarding, as can the opportunity to learn from transportation professionals from around the world. Some of my greatest learning experiences at TRB have resulted from attending presentations and speaking engagements by individuals working in areas of transportation that were unrelated to my specialty at the time.”

In addition to TRB, DeWitt has contributed his time and expertise to other professional organizations. He is a cochair of the American Association of State Highway and Transportation Officials’ (AASHTO) Construction Management Expert Technical Group and a past cochair of the Design-Build Task Force and of the 2004 Federal Highway Administration–AASHTO industry scanning tour on construction management in Europe and Canada. He has been active in the AASHTO Highways Subcommittee on Construction since 1993.

DeWitt earned a bachelor’s degree in civil engineering from the University of North Carolina, Charlotte, in 1984. He is a registered professional engineer in North Carolina, and he is a certified public manager. He serves the community of Raleigh as a youth basketball coach; as a youth mentor at Holland’s United Methodist Church; and as a board member of the Enchanted Oaks Homeowners Association.



“Design-build has proven to be an essential tool for solving problems in many important state transportation projects.”

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Airline Tests Biofuel Derived from Algae

In January, Continental Airlines tested a second-generation, algae- and jatropha plant-derived biofuel in a Boeing 737-800 at Bush Intercontinental Airport, Houston, Texas. The fuel is one of several sustainable alternatives to the Jet A-1 fuel used in commercial aviation.

The 90-minute test flight was the first in North America to use an alternative fuel source, and it was the first such test to use a twin-engine aircraft. The algae- and jatropha-derived fuel meets and exceeds specifications necessary for jet fuel, including a flash point and a freezing point suitable for aircraft use. Algae is a promising potential source of fuel, because of its sustainability, high energy yield, and low environmental impact.

Motorcoaches à la Mode for Fuel Efficiency

The motorcoach is more fuel efficient and pollutes less than other modes of travel on a per-passenger basis, according to a study by the American Bus Association Foundation, prepared by M. J. Bradley and Associates, Manchester, New Hampshire. Motorcoaches average more than 200 passenger miles per gallon and produce the lowest carbon dioxide (CO₂) emissions per passenger mile of the transportation modes included in the study.

Researchers evaluated the environmental performance of motorcoach operations and compared the energy use and CO₂ emissions of motorcoaches with those of 12 common modes of transportation, including private automobiles; heavy urban, light, commuter, and intercity rail; domestic air travel; urban transit bus; electric trolley bus; ferry; van pool; and demand-response transit service.

Of all the modes included in the study, the modes with the highest average passenger miles per gallon rating and the modes with the lowest CO₂ emissions per passenger mile included motorcoaches (206.6 and 50), van pools (106.1 and 97), heavy rail (160.8 and 151), and commuter rail (92.4 and 164). Private automobiles with one occupant averaged 27.2 passenger miles per gallon and 378 grams of CO₂ per passenger mile.

To view the report, visit tinyurl.com/busstudy.

Oregon Builds First Solar Array on U.S. Highway

The Oregon Department of Transportation's (DOT) Office of Innovative Partnerships has created the first solar array at a U.S. highway interchange as part of the Oregon Solar Highway Demonstration Project—a public-private partnership with Portland General Electric and U.S. Bank.

At the interchange of Interstates 5 and 205 near Tualatin, a 104-kilowatt, ground-mounted array of 594 solar panels is generating electricity to feed Portland General Electric's (PGE) systemwide grid. The panels will account for approximately 28 percent of the energy needed for nighttime illumination of the interchange, as well as displace the production of nearly 43 metric tons of carbon dioxide equivalent.

The project gives PGE its first ownership stake in a solar project and will generate business for Oregon solar manufacturers SolarWorld and PV Powered. This year, Oregon DOT will seek proposals for similar highway projects that could generate up to 2 million kilowatt-hours annually, as well as for demonstrations of new solar panel technologies.

For more information, visit www.oregon.gov/odot/hwy/oipp/inn_solarhighway.shtml.

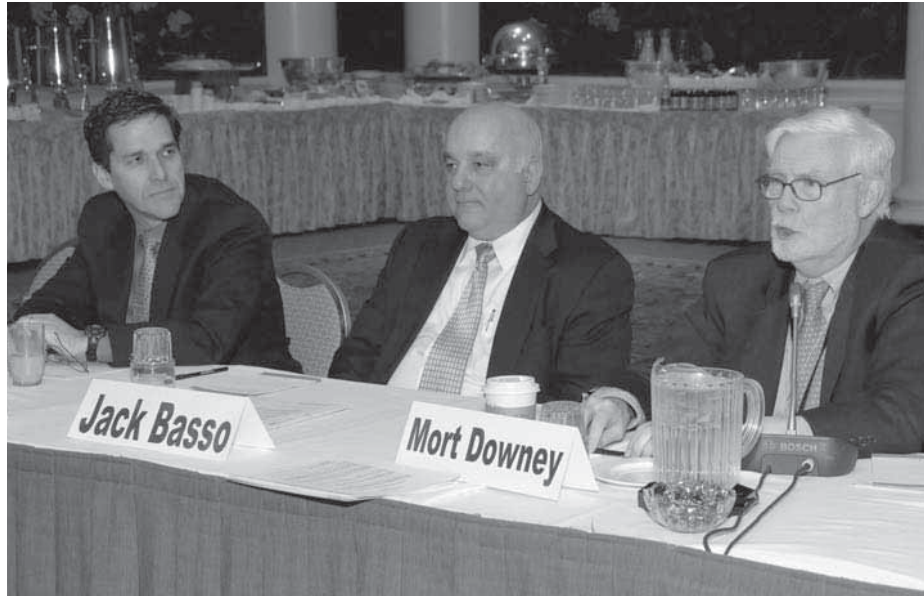


A ground-mounted array of 564 solar panels at the intersection of Interstates 5 and 205, near Tualatin, Oregon, generates 28 percent of the power required to light the interchange at night and reduces pollution.

TRANSPORTATION IN TRANSITION—

Members of President Barack Obama's Department of Transportation Transition Team (*left to right*) Jeff Morales, Peter J. Basso, and Mortimer L. Downey briefed the TRB Executive Committee on the incoming Administration's plans for U.S. transportation on January 15, during the TRB Annual Meeting in Washington, D.C. The team developed policy documents for the Administration and worked to ensure that senior appointees received the necessary information to complete the confirmation process, lead their departments, and implement signature policy initiatives.

Morales, a past member of the TRB Executive Committee, is an expert in strategic planning and program implementation and has served as a transportation consultant, PB Consulting, LLC; as Director, California Department of Transportation; and as Executive Vice President, Chicago Transit Authority. Basso is Chief Operating Officer and Business Development Director, American Association of State Highway Transportation Officials, and has served as the Assistant Secretary for Budget Programs and as the Chief Financial Officer for the U.S. Department of Transportation. Downey is transportation consultant, PB Consulting, LLC, and served as Deputy Secretary of Transportation from 1993 to 2001, and as Assistant Secretary of Transportation from 1977 to 1981.



Downey has also served as Executive Director and Chief Financial Officer of the New York Metropolitan Transportation Authority, and has held planning positions at the Port Authority of New York and New Jersey. A past ex officio member of the TRB Executive Committee, he received the Frank Turner Medal for Lifetime Achievement in Transportation at the 2001 TRB Annual Meeting and was a member of the National Academies' Committee on Science and Technology for Countering Terrorism, chairing the panel on transportation.



PREPARATIONS—The Airport Cooperative Research Program (ACRP) Oversight Committee met in January at the National Academies' Keck Center, Washington, D.C., to review the status of the ACRP program, determine the emphasis areas for FY 2010 ACRP problem statement solicitation, address funding requests, and hear presentations on several in-progress and recently completed ACRP projects. (*Left to right*) Richard Marchi, Airports Council International, North America; Robert E. Skinner, Jr., TRB; Christopher Jenks, TRB; Oversight Committee Chair James Wilding, Metropolitan Washington Airports Authority (retired); Jeffrey Hamiel, Minneapolis–St. Paul Metropolitan Airports Commission; James White, Federal Aviation Administration (FAA); Paul Friedman, FAA; and Carl Burleson, FAA.



TRANSIT IDEAS—Members of the Transit Cooperative Research Program Project J-4: Innovations Deserving Exploratory Analysis—the Transit IDEA program—receive a report from Phil Winters, Transportation Demand Management Program Director, University of South Florida, on Transit IDEA Project 52: Travel Assistant Device to Help Transit Riders. (*Left to right*) Phil Winters; Harvey Berlin, TRB; Panel Chair Fred Gilliam, Capital Metropolitan Transportation Authority; Paul Messina, consultant; and Frank Lonyai, Los Angeles County Metropolitan Transportation Authority.

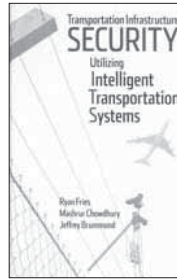
Transportation Infrastructure Security: Utilizing Intelligent Transportation Systems

Wiley, 2008; 285 pp.; \$135; 0-47028-629-6.

In ten chapters, authors present a comprehensive introduction to intelligent transportation systems (ITS) and to issues in transportation infrastructure security, with a focus on computer systems, risk analysis, and multimodal transportation systems.

Also presented are current ITS approaches to rail and freight security, disaster and evacuation response, hazardous materials incidents, and wide area alerts. Guidance is provided for the development of a regional transportation security plan, and privacy concerns for the collection and use of personal tracking data are discussed.

Multidisciplinary in approach, this volume provides insight into the security challenges and the management of challenges in computerized transportation systems. It is suitable for transportation students and professionals.



Two Billion Cars

Daniel Sperling and Deborah Gordon. Oxford, 2008; 304 pp.; \$24.95; 978-0-19-537664-7.

Transportation experts and authors Daniel Sperling and Deborah Gordon detail the history of the car in the United States; provide an overview of the global oil and automobile industries; contrast the United States' auto-related emissions and car-centric society with the increasingly car-centric cultures in developing nations; and make a case for increasing and expanding both affordable and low-impact transportation options to deal with the worldwide increase in automobile ownership and use.

Other subject areas addressed include expanding the search for low-carbon fuels, environment-friendly transportation planning, advances in fuel efficiency, changes in travel behavior, strategies for dealing with increased transportation emissions, and more.

Sperling is Founding Director, Institute of Transportation Studies, and Professor of Engineering and Environmental Science and Policy, University of California, Davis. He is a member of the TRB Special Task Force on Climate Change and Energy, the Transportation and Sustainability Committee, and is an emeritus member of the Alternative Transportation Fuels Committee. Gordon is a transportation policy and energy analyst and consultant, a past



member of the TRB Energy Committee, and a recipient of the TRB Fred Burggraf Award.

IHT Road Safety Audit Guidelines

The Institution of Highways and Transportation, 2008; 90 pp.; £35; 978-0-902933-40-8.

This 3rd edition updates the *IHT Road Safety Audit Guidelines* and provides information on qualifications for road safety auditors, as well as on legal issues in road safety auditing.

Authors provide a general introduction and an overview to road safety auditing; put road safety auditing in context and make distinctions between safety auditing and safety assessment; describe safety auditing in practice and set out processes; discuss auditing in countries outside the United Kingdom; describe issues in safety auditing on local streets; address flexibility in auditing; and examine legal issues in safety auditing.

Planning for Place and Plexus

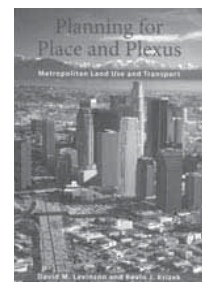
David M. Levinson and Kevin J. Krizek. Routledge, 2008; 334 pp.; \$49.95; 978-0-203-93539-2.

As the transportation infrastructure in the United States continues to carry increasing traffic volumes, and as land development continues to expand, coordinated land use and transportation planning for metropolitan areas are potential—and heavily scrutinized—solutions to the problem.

Coauthors Levinson and Krizek bring a new perspective to metropolitan land use and transportation networks, challenge planning strategies, and offer suggestions for future urban growth. Comprising 14 chapters—accompanied by supporting figures, tables, and text boxes—this book is a useful resource for transportation students, researchers, practitioners, and policy advisors working in transportation land use and planning.

Levinson is the R. P. Braun—Center for Transportation Studies Chair in Transportation Engineering, Department of Civil Engineering, University of Minnesota. He is a member of the TRB Transportation Demand Forecasting Committee and the National Research Council—appointed Committee on Equity Implications of Alternative Transportation Finance Mechanisms.

Krizek is Associate Professor, Planning and Design, University of Colorado, Denver. He chairs the TRB Telecommunications and Travel Behavior Committee and is a member of three other committees in the Travel Analysis Section.



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

TRB PUBLICATIONS

Innovations in Travel Demand Modeling

Conference Proceedings 42, Volume 1

Summarized are the sessions of a May 21–23, 2006, conference that examined advances in travel demand modeling, explored opportunities and challenges associated with the implementation of advanced travel models, and reviewed skills and training necessary to apply new modeling techniques.

2008; 70 pp.; TRB affiliates, \$45; nonaffiliates, \$33.75. Subscriber category: *planning and administration (IA)*.

Innovations in Travel Demand Modeling

TRB Conference Proceedings 42, Volume 2

This volume gathers papers from a May 2006 conference. Papers include Levels of Disaggregation and Degrees of Aggregate Constraint in Transportation System Modeling; Development of New York Metropolitan Transportation Council Tour-Based Model; Validation of Atlanta, Georgia, Regional Commission Population Synthesizer; Modeling Short-Term Dynamics in Activity-Travel Patterns: From Aurora to Feathers; Lifelong Education as a Necessary Foundation for Success in Travel Modeling; and more.

2008; 196 pp.; TRB affiliates, \$65; nonaffiliates, \$48.75. Subscriber category: *planning and administration (IA)*.

Key Issues in Transportation Planning

TRB Conference Proceedings 43

Presented are summaries of plenary and breakout sessions from a November 2006 conference that explored the state of the practice and long-term implementation experience associated with the programming process, successful practices in linking planning and programming, and the linking of programming processes to the development of performance measures and asset management systems. Also examined are programming and politics, data requirements and data manageability, and effective approaches to public involvement for programming.

2008; 74 pp.; TRB affiliates, \$45; nonaffiliates, \$33.75. Subscriber category: *planning and administration (IA)*.

Developing Countries 2007

Transportation Research Record 2038

This volume presents studies on pedestrian behavior and traffic characteristics at unsignalized mid-block crosswalks in Beijing, China; the increase in vehicle ownership and changes in mode choice over time in Chennai, India; a field evaluation of a new

pedestrian crossing in Trinidad and Tobago; the effects of public transit improvement on residential land use and on residential property prices in Bangkok, Thailand; and the differences in travel behavior and location characteristics across different income groups in Chengdu, China, and in Santiago, Chile.

2007; 174 pp.; TRB affiliates, \$46.50; nonaffiliates, \$62. Subscriber category: *safety and human performance (IVB)*.

Network Modeling 2007

Transportation Research Record 2039

Authors present measures for improving the efficiency of data collection in transportation networks through optimal traffic sensor placement; a methodology for increasing the reliability of route suggestions in route guidance systems; a flexible multipath search algorithm for multipurpose location-based activities; associative memory techniques for quick estimation of transportation network performance measures; and more.

2007; 90 pp.; TRB affiliates, \$36.75; nonaffiliates, \$49. Subscriber category: *planning and administration (IA)*.

Construction 2007

Transportation Research Record 2040

Comprising 5 parts—Construction Management, Quality Assurance, Bridges and Structures, Portland Cement Concrete Pavement, and Asphalt Pavement—this volume includes papers on a method for establishing a model for determining incentive and disincentive amounts for contractors in highway construction projects; quality assurance of mix properties in hot-mix asphalt concrete; the launching of the San Cristobal bridge in Chiapas, Mexico; an evaluation of alternative dowel bars for use in portland cement concrete pavement construction; and assessing the potential for the adoption of warm-mix asphalt technology to reduce emissions and energy consumption by producers of hot-mix asphalt.

2007; 136 pp.; TRB affiliates, \$41.25; nonaffiliates, \$55. Subscriber category: *materials and construction (IIIB)*.

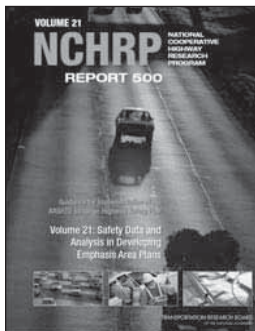
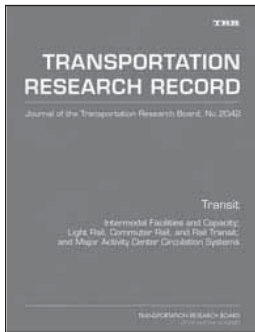
Transportation Security; Emergency Response and Recovery 2008

Transportation Research Record 2041

Presented are 10 papers that explore reliability and security in transportation networks; cooperation in a local government continuity-of-operations exercise; a transportation network risk profile for an origin–destination pair; an integrated urban evacu-



TRB PUBLICATIONS (continued)



ation planning framework; and empirical characterization of mass evacuation traffic flow. Also examined are the impact of a hurricane on mobilization time; an emergency evacuation system for Washington, D.C.; the emergency preparedness of the Rhode Island transportation system; a simulation-based framework for transportation network management in emergencies; and microscopic versus mesoscopic simulation for the assessment of I-4 contraflow plans.

2008; 97 pp.; TRB affiliates, \$40.50; nonaffiliates, \$54. Subscriber category: security (X).

Transit: Intermodal Facilities and Capacity; Light Rail, Commuter Rail, and Rail Transit; and Major Activity Center Circulation Systems
Transportation Research Record 2042

Authors explore transit intermodal facilities and capacity; light rail, commuter rail, and rail transit; and major activity center circulation systems. Specific paper topics include airport ground access, consistency in transit passenger arrivals, transit quality of service and employment accessibility, process management in public transit planning, active transit signal priority for streetcars, successful historic streetcar service, light rail cost functions and technical inefficiency, boarding and alighting experiments, bus–rail service integration, and commuter rail circulator route network design. Also examined are new-generation personal rapid transit technologies and cluster-based optimization of urban transit hub locations.

2008; 116 pp.; TRB affiliates, \$41.25; nonaffiliates, \$55. Subscriber category: public transit (VI).

Railways 2008

Transportation Research Record 2043

High-speed rail interaction with air transportation in Japan; maintenance costs of high-speed lines in Europe; barriers to improving rail interoperability in European countries; and train slot cooperation in multicarrier, international rail-based intermodal freight transport are some of the topics explored in this volume.

2008; 82 pp.; TRB affiliates, \$39; nonaffiliates, \$52. Subscriber category: rail (VII)

Infrastructure Maintenance

Transportation Research Record 2044

Included are papers on relating cost to condition in highway maintenance; a sampling procedure for road maintenance evaluations; shaping the future of the workforce for intelligent transportation systems; bridge inspection in Europe; bridge deck assessment by ground-penetrating radar, chain

drag, and ground truth; electrical injection of a corrosion inhibitor for reinforced concrete; cathodic protection systems on Virginia bridges; the effects of aggregate and emulsion application rates on asphalt surface treatments; the safety effect of preventive maintenance; and more.

2008; 123 pp.; TRB affiliates, \$41.25; nonaffiliates, \$55. Subscriber category: maintenance (IIC).

Soil Mechanics 2008

Transportation Research Record 2045

Presented are findings on the implementation of intelligent compaction specifications, in situ tests for compaction control of a bottom ash embankment, evaluation of in situ density and moisture content by using elastic and electromagnetic wave propagation, compaction-induced earth pressures against a sheet pile wall in peat, and resistance factors for axially loaded concrete piles driven into soft soils. Also included are papers on flowfill and mechanically stabilized earth bridge approaches, resistance factors for drilled shafts in weak rock, analysis of a 3-m-diameter induced trench culvert under a 19.4-m soil cover, long-term performance of pavement drainage layers, wrapped-face mechanically stabilized earth walls with inadequate compaction near facing, geocell-reinforced sand behavior under a vertical load, and geogrid in flexible pavements.

2008; 109 pp.; TRB affiliates, \$41.25; nonaffiliates, \$55. Subscriber category: soils, geology, and foundations (IIIA).

Guidance for Implementation of the AASHTO Strategic Highway Safety Plan: Safety Data and Analysis in Developing Emphasis Area Plans

NCHRP Report 500, Volume 21

Guidance is provided on data sources and analysis techniques to assist transportation agencies with the allocation of safety funds.

2008; 95 pp.; TRB affiliates, \$37.50; nonaffiliates, \$50. Subscriber category: safety and human performance (IVB).

The TRR Journal Online website provides electronic access to the full text of more than 9,000 peer-reviewed papers that have been published as part of the Transportation Research Record: Journal of the Transportation Research Board (TRR Journal) series since 1996. The site includes the latest in search technologies and is updated as new TRR Journal papers become available. To explore the TRR Online service, visit www.TRB.org/TRROnline.

TRB PUBLICATIONS (continued)

Forecasting Statewide Freight Toolkit

NCHRP Report 606

This report provides transportation planners with information for the preparation of freight transportation forecasts by highlighting techniques successfully developed by state agencies across the United States.

2008; 158 pp.; TRB affiliates, \$41.25; nonaffiliates, \$55. Subscriber categories: *planning and administration (IA); rail (VII); and freight transportation (VIII).*

Recommended Construction Specifications and Process Control Manual for Repair and Retrofit of Concrete Structures Using Bonded FRP Composites

NCHRP Report 609

Construction specifications to facilitate highway agencies' use of bonded fiber-reinforced polymer (FRP) composites for the repair and retrofit of concrete structures are explored. Specifications cover the construction of externally bonded or near surface-mounted reinforcement FRP systems to enhance axial, shear, or flexural strength of a concrete member.

2008; 61 pp.; TRB affiliates, \$31.50; nonaffiliates, \$42. Subscriber category: *bridges, other structures, and hydraulics and hydrology (IIC).*

Refining the Simple Performance Tester for Use in Routine Practice

NCHRP Report 614

This report explores the development of a practical, economical simple performance tester (SPT) for use in routine hot-mix asphalt (HMA) mix design and in the characterization of HMA materials for pavement structural design with the *Mechanistic-Empirical Pavement Design Guide*.

2008; 142 pp.; TRB affiliates, \$39.75; nonaffiliates, \$53. Subscriber category: *maintenance (IIIC).*

Evaluation of the Use and Effectiveness of Wildlife Crossings

NCHRP Report 615

The development of an interactive, web-based decision guide protocol for the selection, configuration, and location of wildlife crossings is examined.

2008; 161 pp.; TRB affiliates, \$42; nonaffiliates, \$56. Subscriber categories: *planning and administration (IA); energy and environment (IB); hydrology and facility design (IIA); maintenance (IIIC).*

Multimodal Level of Service Analysis for Urban Streets

NCHRP Report 616

This report explores how effectively streets serve street users. The multimodal level of service is evaluated through estimates of auto, bus, bicycle, and

pedestrian levels of service on an urban street, using a combination of available data and data gathered by an agency to assess auto and transit levels of service.

2008; 110 pp.; TRB affiliates, \$39; nonaffiliates, \$52. Subscriber categories: *planning and administration (IA); highway and facility design (IIA); highway operations, capacity, and traffic control (IVA).*

Accident Modification Factors for Traffic Engineering and ITS Improvements

NCHRP Report 617

Authors investigate the development of accident modification factors (AMFs) for traffic engineering and intelligent transportation system improvements. AMFs, or crash reduction factors, provide a simple and quick method for estimating the safety impacts of traffic engineering improvements, encompassing the areas of signing, alignment, channelization, and other traffic engineering solutions.

2008; 74 pp.; TRB affiliates, \$33.75; nonaffiliates, \$45. Subscriber category: *safety and human performance (IVB).*

Cost-Effective Performance Measures for Travel Time Delay, Variation, and Reliability

NCHRP Report 618

This report explores methods to predict, measure, and report travel time delay and reliability from a customer-oriented perspective.

2008; 69 pp.; TRB affiliates, \$33.75; nonaffiliates, \$45. Subscriber category: *planning and administration (IA).*

Modernize and Upgrade CANDE for Analysis and LRF Design of Buried Structures

NCHRP Report 619

Information on the development, modernization, and upgrading of the CANDE (culvert analysis and design) program to a new program, CANDE-2007, is presented. CANDE-2007 installation files are included on a CD-ROM.

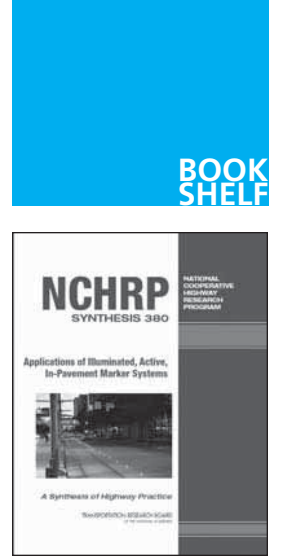
2008; 26 pp.; TRB affiliates, \$33.75; nonaffiliates, \$45. Subscriber category: *bridges, other structures, and hydraulics and hydrology (IIC).*

Applications of Illuminated, Active, In-Pavement Marker Systems

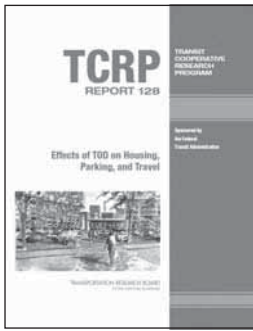
NCHRP Synthesis 380

The state of in-pavement markers (IPM) technology is explored, as are experiences with IPM applications and IPM research needs.

2008; 72 pp.; TRB affiliates, \$33.75; nonaffiliates, \$45. Subscriber categories: *highway operations, capacity, and traffic control (IVA); safety and human performance (IVB).*



TRB PUBLICATIONS (continued)

**Falling Weight Deflectometer Usage****NCHRP Synthesis 381**

Investigated is the use of the falling weight deflectometer by state departments of transportation to measure pavement deflections in response to a stationary dynamic load, similar to a passing wheel load.

2008; 121 pp.; TRB affiliates, \$39; nonaffiliates, \$52. *Subscriber categories: pavement design, management, and performance (IIB); materials and construction (IIIB).*

**Estimating Stiffness of Subgrade and Unbound Materials for Pavement Design****NCHRP Synthesis 382**

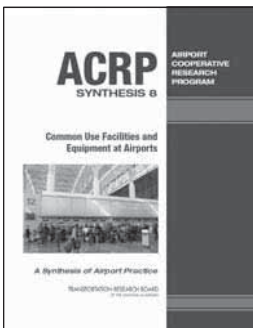
This synthesis examines the significance of the resilient modulus property and provides methods for determining the property in subsoils and unbound bases.

2008; 129 pp.; TRB affiliates, \$40.50; nonaffiliates, \$54. *Subscriber category: soils, geology, and foundations (IIIA).*

**Effects of TOD on Housing, Parking, and Travel****TCRP Report 128**

Research is provided on the demographics of areas of transit-oriented development (TOD) along with findings about residents and employers and their motives for locating in areas of TOD. Described are travel characteristics of residents before and after relocation to a TOD, as well as ways to increase transit ridership among residents. In addition, the potential effects of land use and design features on travel patterns, transit ridership, and the decision to relocate to an area of TOD are reviewed.

2008; 58 pp.; TRB affiliates, \$31.50; nonaffiliates, \$42. *Subscriber category: planning and administration (IA); public transit (VI); rail (VII).*

**Integration of Paratransit and Fixed-Route Transit Services****TCRP Synthesis 76**

This synthesis explores the experiences of transit agencies that have integrated services by departing from the traditional, binary model of separate fixed-route and paratransit services. Specific topics include the provision of paratransit feeder services, community buses or circulators, connectors, fixed-route fare incentives, and route deviation.

2008; 48 pp.; TRB affiliates, \$30; nonaffiliates, \$40. *Subscriber category: public transit (VI).*

Passenger Counting Systems**TCRP Synthesis 77**

This synthesis presents analytical tools and technologies for collecting transit ridership and other

subsidiary data and examines issues of concern for transit agencies considering the use of automatic passenger counter systems.

2008; 73 pp.; TRB affiliates, \$33.75; nonaffiliates, \$45. *Subscriber category: public transit (VI).*

Transit Systems in College and University Communities**TCRP Synthesis 78**

Practices and trends in campus transit operations, policies, and planning are examined, with a special focus on technology and environmental innovations. Also examined are innovative partnership strategies to enhance services for students, faculty, staff, and the community.

2008; 88 pp.; TRB affiliates, \$35.25; nonaffiliates, \$47. *Subscriber category: public transit (VI).*

Summarizing and Interpreting Aircraft Gaseous and Particulate Emissions Data**ACRP Report 9**

Presented are findings from a series of government-sponsored tests on gaseous and particulate emissions from aircraft engines.

2008; 58 pp.; TRB affiliates, \$31.50; nonaffiliates, \$42. *Subscriber category: aviation (V).*

Common Use Facilities and Equipment at Airports**ACRP Synthesis 8**

Examined is common use technology to aid airport operators in reassigning space formerly exclusive to a single airline for use by multiple airlines and their passengers.

2008; 121 pp.; TRB affiliates, \$39; nonaffiliates, \$52. *Subscriber category: aviation (V).*

Effects of Aircraft Noise: Research Update on Selected Topics**ACRP Synthesis 9**

This synthesis includes an annotated bibliography and summary of new research on the effects of aircraft noise. The report updates and complements the U.S. Federal Highway Administration's 1985 Aviation Noise Effects report.

2008; 90 pp.; TRB affiliates, \$50; nonaffiliates, \$40. *Subscriber category: aviation (V).*

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FEATURES are timely articles of interest to transportation professionals, including administrators, planners, researchers, and practitioners in government, academia, and industry. Articles are encouraged on innovations and state-of-the-art practices pertaining to transportation research and development in all modes (highways and bridges, public transit, aviation, rail, and others, such as pipelines, bicycles, pedestrians, etc.) and in all subject areas (planning and administration, design, materials and construction, facility maintenance, traffic control, safety, geology, law, environmental concerns, energy, etc.). Manuscripts should be no longer than 3,000 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.

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- ◆ All manuscripts should be supplied in 12-point type, double-spaced, in Microsoft Word 6.0 or WordPerfect 6.1 or higher versions, on a diskette 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.

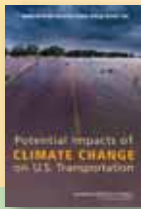
- ◆ Use the units of measurement from the research described and provide conversions in parentheses, as appropriate. The International System of Units (SI), the updated version of the metric system, is preferred. In the text, the SI units should be followed, when appropriate, by the U.S. customary equivalent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

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Transportation, Energy, and Climate Change

The twin issues of energy and climate change are among the most significant public policy issues facing the transportation profession, not only today but in the coming decades. To address these challenges, it is critical to develop and share knowledge and experiences on ways to mitigate the adverse impacts of transportation on energy and climate, and to adapt transportation to the realities of a new energy and climate change environment.

TRB has examined a variety of issues related to transportation, energy, and climate change. In addition to a website that highlights activities of TRB in the area of climate change (<http://trb.org/climatechange>), TRB has developed a bookshelf of resources to inform transportation professionals, decision makers, and members of the general public. Here are some of the latest energy and climate change titles produced by TRB and other parts of the National Academies:



Potential Impacts of Climate Change on U.S. Transportation

<http://books.trbbookstore.org/sr290.aspx>



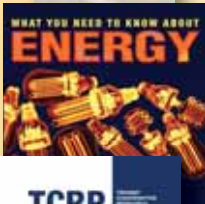
Transitions to Alternative Transportation Technologies: A Focus on Hydrogen

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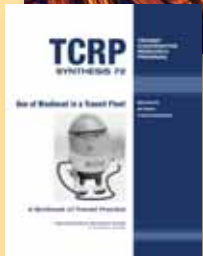
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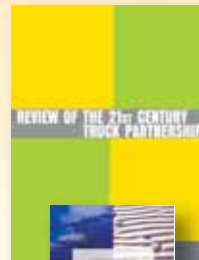
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http://dels.nas.edu/dels/rpt_briefs/climate_change_2008_final.pdf



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