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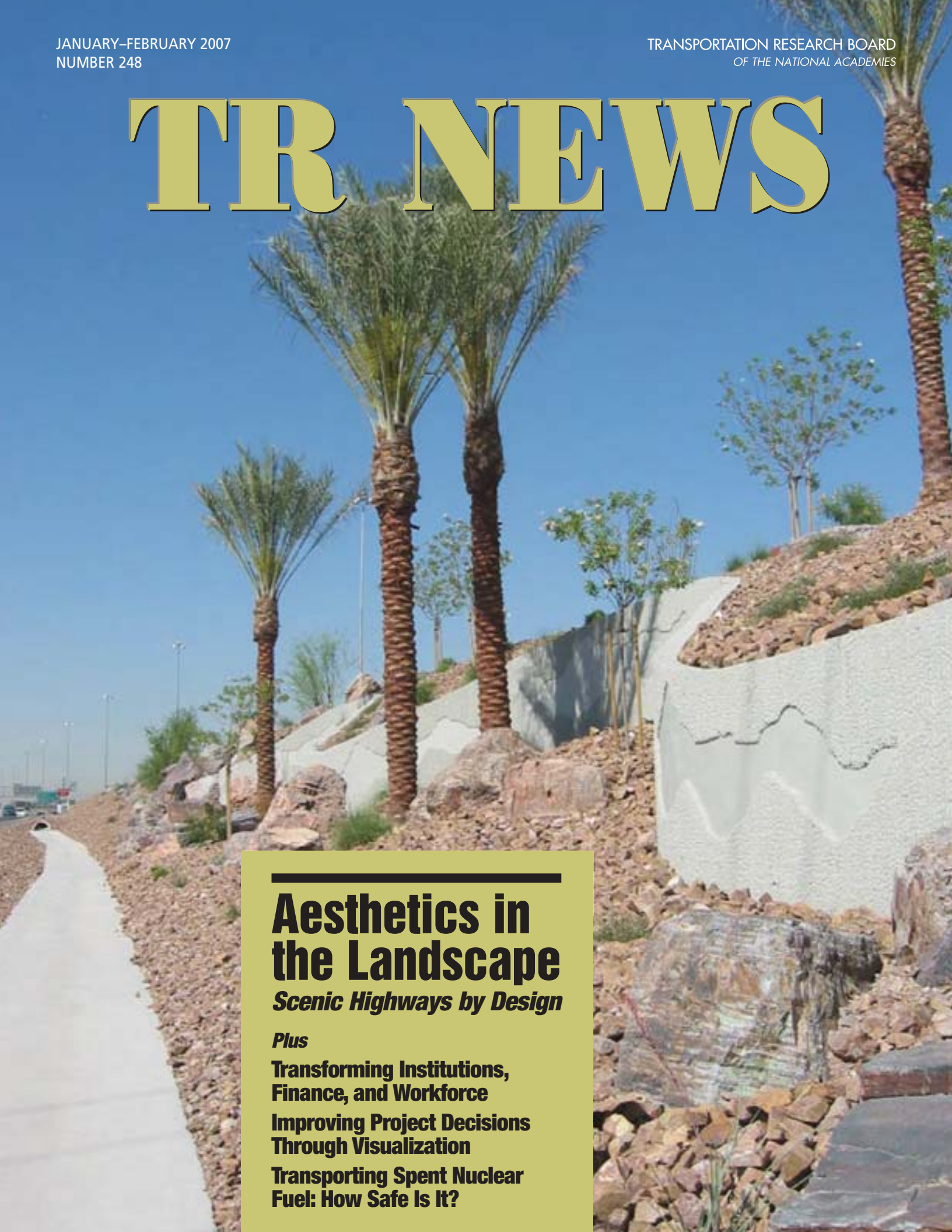
NUMBER 248

TRANSPORTATION RESEARCH BOARD
*OF THE NATIONAL ACADEMIES*

# TR NEWS



## Aesthetics in the Landscape

***Scenic Highways by Design***

***Plus***

**Transforming Institutions, Finance, and Workforce**

**Improving Project Decisions Through Visualization**

**Transporting Spent Nuclear Fuel: How Safe Is It?**

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*Advisers to the Nation on Science, Engineering, and Medicine*

The Transportation Research Board is a division of the National Research Council, which serves the National Academy of Sciences and the National Academy of Engineering. The Board's mission is to promote innovation and progress in transportation through research. In an objective and interdisciplinary setting, the Board facilitates the sharing of information on transportation practice and policy by researchers and practitioners; stimulates research and offers research management services that promote technical excellence; provides expert advice on transportation policy and programs; and disseminates research results broadly and encourages their implementation. The Board's varied activities annually draw on approximately 5,000 engineers, scientists, and other transportation researchers and practitioners from the public and private sectors and academia, all of whom contribute their expertise in the public interest. The program is supported by state transportation departments, federal agencies including the component administrations of the U.S. Department of Transportation, and other organizations and individuals interested in the development of transportation.

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COVER: I-15 and Sahara Interchange in Las Vegas exemplifies the comprehensive approach to highway design at Nevada Department of Transportation, balancing the need for safe, cost-effective highways with the development of context-sensitive solutions. (Photo: Design Workshop)

# 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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## ALSO IN THIS ISSUE:



## COMING NEXT ISSUE

The accomplishments and plans of Minnesota's Transportation Engineering and Road Research Alliance; a highway wildlife crossings project in North America; lessons from the development of the Metrorail system in Washington, D.C.; the rise of ethanol as an alternative fuel in the United States; and photographic highlights from TRB's 2007 Annual Meeting are featured in the March–April issue of *TR News*.

PHOTO: CABLE RISDON, TRB

U.S. Secretary of Transportation Mary E. Peters takes questions from the press after speaking at the TRB Annual Meeting Chairman's Luncheon, January 24. In her address, Peters echoed a theme of President Bush's January 23, 2007, State of the Union Address and challenged transportation professionals to use their ingenuity to help the United States achieve a 15 percent reduction in gasoline usage, reduce congestion, and bring new and alternative sources of energy to the market.

# Aesthetics in the Landscape

## How Nevada and Other States Are Integrating Aesthetics into Transportation Projects

JAMES L. SIPES AND RON BLAKEMORE

Arlee is a small town located on the Flathead Indian Reservation in the sprawling Mission Valley of western Montana, with breathtaking views of the Mission Mountain Range to the east. About half of the 600 residents of the town are Native Americans, for whom the Mission Range has cultural significance.

For all residents, Arlee is a great place to live, with one small problem—the town is split by U.S. Highway 93, a major north–south highway providing access to Flathead Lake and Glacier National Park. The highway is one of the most unsafe in the state because of the volume and the speed of the traffic. A popular local bumper sticker reads, "Pray for me, I drive 93!" School children are bused from one side of town to the other because walking across the highway is unsafe.

Communities across the country are addressing the negative effects of highways. In Maryland, residents of Paynesville are concerned that a new four-lane highway through town would be too congested and too disruptive (*1*). The Amish community in central Indiana objected that a proposed new highway, I-69, would bisect Amish farms and church districts, and would cut off members of the community from each other (*2*).

### Thinking Beyond Pavement

In 1998, as the state of Nevada considered the design of the I-580 freeway between Reno and Carson City, Susan Martinovich, then Deputy Director of the Nevada Department of Transportation (DOT), attended the "Thinking Beyond the Pavement" conference in Maryland.

"The conference was the prelude to what is now known as context-sensitive solutions," she recalls. "It changed my perception of how highways could be designed to have a better fit with their environment." Martinovich brought back the concepts for consideration and implementation on the I-580 project.

*Sipes is a landscape architect and Founding Principal, Sand County Studios, Stanwood, Washington, as well as Senior Associate with EDAW, Atlanta, Georgia. Blakemore is Supervising Landscape Architect, Nevada Department of Transportation, Carson City.*

PHOTO: DESIGN WORKSHOP

This bridge on I-70 near the Continental divide in Colorado was constructed without center piers to frame the view of the mountain range beyond.

At about the same time, Nevada Attorney General Frankie Sue Del Papa proposed a program to plant 2,000 trees in the year 2000. The highway right-of-way was a good location—the land was state-controlled, the problems would be minimal, and the effect would be public. Del Papa enlisted the expertise of Professor Mark Hoversten, head of the landscape architecture program at the University of Nevada–Las Vegas (UNLV).

At the same time, the citizens of Carson City saw plans for a new freeway to bypass the congested downtown. The proposed Carson City bypass, however, included freestanding walls that would block views of the surrounding mountains, did not remedy the split already felt in the community, and included bridges and other improvements lacking in visual quality. Local citizens petitioned the state to improve the aesthetics to make the freeway community-friendly.

## Unifying Strategy

These separate initiatives began to come together—an engineer with a new design method, a plan to plant trees, a citizenry with new priorities and an awareness of what could be, and a professor with a creative approach to highway landscape and aesthetics. Nevada DOT decided to build on the momentum and to develop a strategy to include context-sensitive design methods in transportation projects.

The agency hired Hoversten to lead a team of landscape architects and Nevada DOT engineers to conduct a study that contributed to the development of a comprehensive guide, *Pattern and Palette of Place: A Landscape and Aesthetics Master Plan for the Nevada State Highway System* (*3*). The master plan set a new standard for the aesthetic quality of all transportation projects within the state.

## Aesthetic Highways in Other States

In 1997, the Federal Highway Administration (FHWA) and the American Association of State Highway and Transportation Officials (AASHTO) published *Flexibility in Highway Design*, a companion guide to the AASHTO Green Book, which covers the geometric design of highways and streets. The premise is that design plays a major role in enhancing the quality of communities (*4*). The introduction of context-sensitive design and context-sensitive solutions by FHWA has helped promote the idea of designing safe transportation solutions in harmony with communities (*5*).

The Thinking Beyond the Pavement workshop focused on context-sensitive design and explored ways to integrate highway projects with communities and natural resources while still maintaining safety and performance goals. Maryland DOT, AASHTO, FHWA, and the Maryland State Highway Administration (SHA) cohosted the workshop (*6*).

The Maryland SHA Office of Environmental Design works to incorporate environmental design into highway planning by addressing wetland mitigation, stream restoration, sound barriers, streetscapes, highway landscaping, rest areas and welcome centers, greenways, scenic byways, trees and forest conservation, and highway aesthetics. The office comprises three divisions responsible for (*a*) wetland mitigation, stream restoration, and applicable environmental regulations; (*b*) reforestation and tree preservation, turf management, roadside maintenance, and wildflower programs; and (*c*) the development of concepts and designs for landscape architectural projects.

For the Nevada project, UNLV analyzed 32 state

programs, including those in Florida, Maryland, Massachusetts, New Jersey, Ohio, Texas, Arizona, and California, and found a variety of approaches. Some states take a general, broad-brush approach; some are developing detailed design standards; and others focus on design solutions at the local level (see sidebar, page 6). UNLV identified five states with programs similar to what Nevada was trying to do: Arizona, California, Minnesota, New Jersey, and Washington. The five states had developed comprehensive approaches to managing roadside activities, addressing a range of topics and presenting the information in easy-to-access formats.

## Aesthetics in Nevada

Although an aesthetics manual had been introduced in Nevada in 1968, the approach was not enforced and had little impact on the design of highways and adjacent lands. A lack of dedicated funding and public support contributed to the program's lack of success. Policies addressed specific purposes, such as enhancement and betterment projects; erosion control; replacement after construction; landscaping for safety and for rest areas, buildings, and facilities; and reclamation. Unless identified under one of these categories, aesthetic improvements to the landscape were not an integral part of the highway planning or engineering. Project funding did not adequately support aesthetic improvements.

Many U.S. roads were designed with the utilitarian approach that characterized the World War II years—the emphasis was on safety and operations, to move as many vehicles as possible. Aesthetic issues often were limited to those directly related to a highway structure, such as an overpass or a noise wall. Until recently, some states—like Nevada—still followed that approach. In an effort to keep up with the pace of development, Nevada DOT has worked to build as much road as was possible, meeting the goals of safety and cost-effectiveness. This approach produced projects such as the Carson City bypass.

## Master Plan

The rapid expansion of population in Nevada has increased transportation needs and stimulated interest in doing more than building as much roadway as possible. In May 2000, the State Transportation Board and Nevada DOT embarked on a master plan to define a vision for landscape and aesthetics in the state. The agencies contracted with the landscape architecture program at UNLV, which already had been working across the state on a range of community-oriented planning projects.

"The original concept was to design every highway in the state, but it did not take long to realize that we needed policies, procedures, and funding," Hoversten recalls. "The first master plan became a mechanism to start an entire program."

The *Landscape and Aesthetics Master Plan* developed by UNLV established a vision, policies, procedures, and guidelines for Nevada's highway system. It also defined a planning process for future projects and emphasized the need to conserve water in arid places, to adapt designs to the varied ecosystems within the state, to build more sustainable projects, and to celebrate the people and places of Nevada.

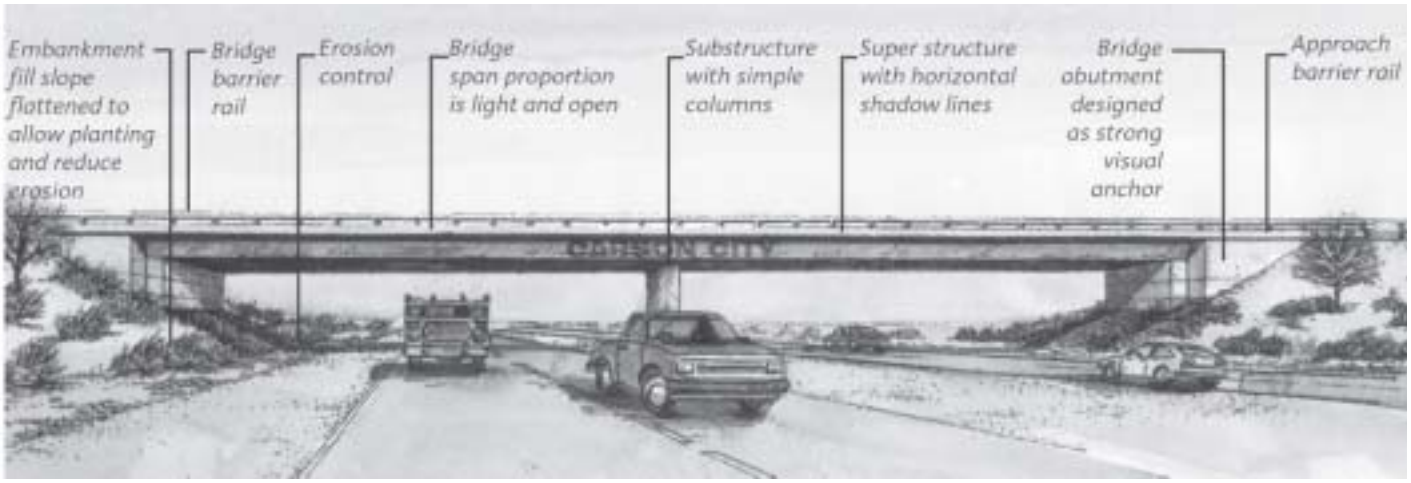
"The UNLV master plan clearly stated the vision and put in place the mechanisms necessary to carry out the whole program," notes Rand Pollard, Assistant Chief Roadway Design Engineer, Nevada DOT. The plan convinced the state legislature to authorize funds for startup, for community matching fund and transportation art programs, for continuation of long-range planning, and for the necessary staffing.

The master plan outlined a policy of integrating aesthetics into the design of all of the major highway projects in the state and provided a blueprint and a framework for Nevada DOT and the citizens of

PHOTO: D. A. HORCHNER, DESIGN WORKSHOP

The drainage system at the Rocks at Pinnacle Peak, Phoenix, Arizona, served as a model in the Nevada corridor plans for an alternative way to deal with drainage. The rock bed reduces erosion, allows some water to infiltrate, and reduces the velocity of runoff; the naturalized channel design and infiltration methods enhance the visual appearance of the highway.

The master plan's design guidelines for bridge structures integrate landscape and aesthetics at the outset; this sketch illustrates preferred landscape and aesthetic treatments that improve the appearance of a bridge.

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## Highway Aesthetics Initiatives

### *A Sampler*

Many states are at work to create highways that are more community-friendly:

◆ **Arizona** has implemented landscape design guidelines for urban areas, freeway mitigation and enhancement, erosion and pollution control, integrated natural resource management, and urban forestry. Some cities are requiring a more detailed look at highway aesthetics; for example, Scottsdale advocates planning and design in accord with "character areas," to maintain the visual character of the city (*1*).

◆ **California** has developed and organized a system for planning and designing landscape and aesthetic improvements. California DOT (Caltrans) has been a leader in incorporating aesthetics and environmental planning into highway projects. Caltrans has implemented programs that create context-sensitive highway designs, use native plant materials, incorporate transportation art and aesthetics into highway structures, and ensure consideration of community values along with safety, economics, and mobility. The state's *Highway Design Manual* includes sections on landscape and aesthetics, and the landscape architecture program provides direction and coordination for context-sensitive solutions; training development; erosion control and highway planting policies, standards, and guidelines; landscaped freeway designations; roadside management; and research and new technology (*2*).

◆ **Michigan** DOT's *Aesthetic Project Opportunities Inventory* lists approximately 2,000 opportunities for improving the visual quality of the environment along state highways. The inventory identifies eight types of aesthetic projects: landscape treatment opportunities, streetscaping opportunities, site or corridor management plans, scenic easement acquisitions, scenic turnout sites, structure removal or improvements, vegetation management opportunities, and landform improvements (*3*). Communities, agencies, and other stakeholders also use the inventory. Michigan DOT, however, does not guarantee financial support for implementing aesthetic opportunities.

◆ **Minnesota**'s *Highway Project Development Process* provides technical guidance on subjects such as vegetation, visual quality, noise, and soils (*4*). Another document defines the state's vision for addressing landscaping and aesthetics through case studies from the past 25 years and describes 10 characteristics that contribute to noteworthy environmental effects (*5*).

◆ **New Jersey**'s *Landscape and Urban Design Unit Procedure Manual* integrates landscape and aesthetics with highway design, community participation, and construction. The manual includes checklists and forms for plan reviews, landscape design, soil erosion and sedimentation, noise barrier aesthetics, wetlands design, final plan review, and monitoring scenic lands (*6*).

PHOTOS: KENTUCKY TRANSPORTATION CABINET

*Kentucky Transportation Cabinet integrated aesthetic considerations into the design of the Paris Pike, which runs through horse country between Lexington and Paris. The roadway was expanded from two to four lanes for 12 miles* (photo, opposite page, above right). *The realignment avoided historic properties, including stone fences* (photo, opposite page, below right)*; incorporated steel-backed timber guardrail for aesthetics and safety* (photo, above)*; and stripped, stockpiled, and restored the original topsoil, among other preservation measures.*

◆ **Ohio** DOT's design standards and guidelines incorporate patterns, colors, texture, and landscaping to increase the visual appeal of highways, noise barriers, and bridges for motorists and residents (*7*). The agency estimates that the cost for improved aesthetics amounts to less than 1 percent of a project's total cost. Ohio DOT's Gateway Landscaping Program helps towns and cities improve landscaping along the highways leading into their communities. The $500,000 set aside for the program is funded by Federal Transportation Enhancement Funds (*8*).

◆ **Texas** DOT addresses the visual characteristics of highways in the *Landscape and Aesthetics Design Manual* (*9*), which describes aesthetic approaches for highway design and provides general guidance on the applications. A supplement, *Develop Cost-Effective Plans to Add Aesthetically Pleasing Features to Transportation Projects*, guides Texas DOT designers and consultants in developing and constructing aesthetic treatments. *Aesthetics in Transportation Design* illustrates the

range of aesthetic opportunities and alternatives for transportation enhancements, with color photographs of completed projects (*10*).

◆ **Washington** State's *Design Manual* presents policies, procedures, and methods for developing and documenting design improvements to the transportation network (*11*). Seattle is developing plans to replace the Alaskan Way Viaduct, a 3.5-kilometer (2.2-mile)-long highway along the west side of the city, parallel to the Puget Sound shoreline, with a new underground highway. The areas above the proposed highway would include public spaces and development connecting Seattle to the waterfront. The viaduct project is controversial, partly because of a $4.1 billion price tag (*12*).

Many DOTs consider aesthetics in roadway design at the local level. For example, the **Kentucky** Transportation Cabinet (KTC) spent $70 million to design and construct the 19-kilometer- (12-mile)-long Paris Pike to fit comfortably into the surrounding horse country. Initially proposed in 1966, the project met resistance from stakeholders who believed it would destroy the road's rural beauty and historic significance. Construction finally began in the mid-1990s after KTC adopted a more context-sensitive design approach (*13*). Experts in highway design and landscape architecture have hailed the Paris Pike as a model of highway design and historic preservation.

*—James L. Sipes*

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CREDIT: DESIGN WORKSHOP

Proposed design for a sound wall along approximately 305 meters (1,000 feet) of a Nevada highway corridor. Characteristics include staggered wall planes, landscape planting in front of the wall face, and patterning on the wall face.

Nevada to turn their vision into a reality. Nevada DOT and UNLV completed the master plan in 2002, and the State Transportation Board adopted it as policy. Nevada DOT immediately began implementing the policy by establishing a landscape architecture program.

Nevada DOT staff manages the planning and design, hiring consultants or preparing the plans in-house. A team of professional landscape architects and engineers prepares landscape and aesthetic plans to implement the concepts. The master plan had specified four distinct phases: master planning; corridor planning; project design; and construction, operations, and maintenance. Each level or phase added detail to the preceding phase.

## Corridor Plans

Corridor planning determines the design segments for each corridor—areas with common characteristics such as topography, plant communities, urban development, culture, and history. Objectives, themes, a program of development, and priorities are established for each design segment. Corridor plans provide design guidance for the day-to-day decisions on each project.

Each corridor plan includes final recommendations and a detailed vision for the landscape and aesthetics. The vision takes into account the historic, current, and future conditions, and synthesizes the information into a comprehensive guide for improving the corridor's visual character. The corridor plans also identify major design themes and materials to determine the landscape and aesthetic recommendations for each project.

The corridor planning has been completed for three of Nevada's 11 corridors, and three others are in progress. The first phase targeted three high-priority corridors along Nevada's Interstates—the Interstate 15 corridor that includes Las Vegas, the Interstate 80 urban corridor that includes Reno and Sparks, and the Interstate 80 rural corridor east of Fernley.

PHOTO: D.A. HORCHNER, DESIGN WORKSHOP

The revegetative palette of the Nevada master plan includes native plant materials, as well as regionally adapted trees, shrubs, and other materials for diversity. Recommendations for creating a sustainable highway environment emphasize the use of plants that do not require supplemental water. Water conservation—efficiency, protection, and reuse—is a central concept.

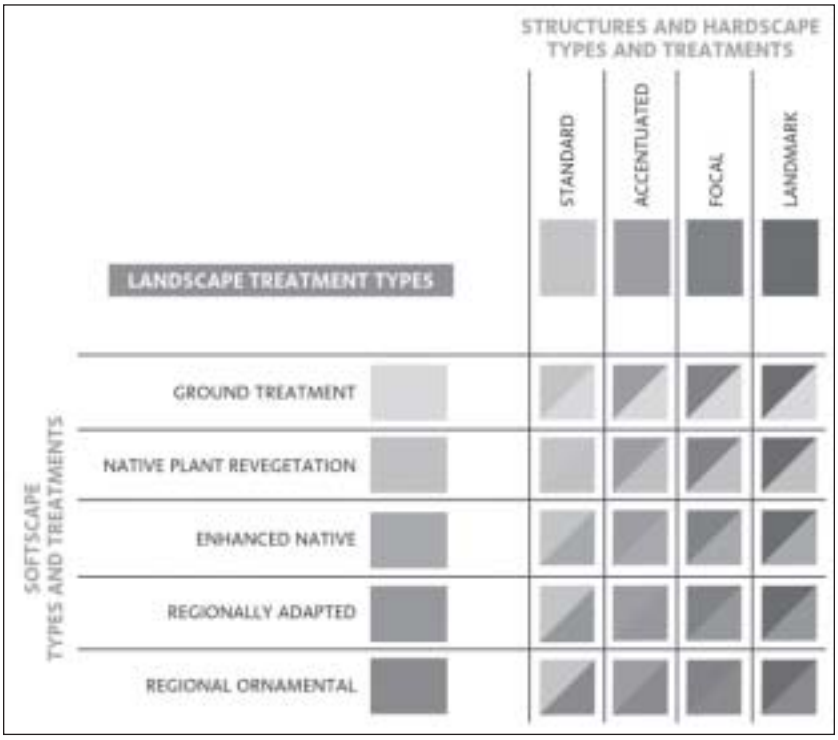
The initial planning for each corridor focuses on producing an inventory of data, including history, settlement patterns, anticipated urban changes, travel and tourism, natural resources, wildlife habitat, "viewsheds" or the visible area, the landscape character, and applicable Nevada DOT standards and practices. The design team bases recommendations about landscape and aesthetics on valid engineering practices.

The corridor plans define landscape types and a hierarchy of treatment levels that Nevada DOT can apply to landscape segments with common characteristics. The corridor plans serve as the foundation for all discussions about what happens along a particular section of highway. The treatments are arranged in a matrix from standard approaches to landmark approaches for the most striking and memorable landscape segments. Each level consists of combinations of treatments for softscape features—such as trees, shrubs, perennials, grasses, and ground treatments—and for hardscape features, including bridges, retaining walls, acoustic walls, pedestrian crossings, railings, barrier railings, lighting, and transportation art.

For example, the matrix that describes the treatment for the segment of Interstate 15 along the Las Vegas Strip is called "Dynamic Desert Metropolis."

"The longitudinal section for the location has the theme, 'Flamboyant Resort Corridor,' with a softscape treatment of 'Regional Ornamental' and hardscape treatment of 'Landmark,'" notes Lucy Joyce-Mendive, Nevada DOT Senior Landscape Architect. "The matrix offers specific information for each—the softscape includes a high diversity of plants, taller and denser, and in patterns that have cultural meaning. The hardscape calls for the most enhanced structures that require extensive aesthetic treatments and one-of-a-kind surfaces with special lighting and transportation art."

The corridor plan includes extensive photographic examples of the treatments to guide the designer and to provide direction for the engineers.




CREDIT: JONES & JONES–DESIGN WORKSHOP

Matrix of possible combinations of four landscape types and five treatments in Nevada's master plan. Separately, or in combination, the treatments are used to establish a design character for each corridor.

## Project Design

During the project design phase, Nevada DOT selects projects for site-specific planning. These projects will change the visual quality of the residential neighborhoods and will add bicycle trails, parks, other green space, trees, public art, and enjoyable driving experiences. The projects also will promote tourism by protecting natural resources and by connecting visitors with local people, places, events, and community stories.

One of the first site-specific aesthetics projects was the central Las Vegas Spaghetti Bowl Interchange, a $92-million, three-year reconstruction of the junctures of I-15, I-515, and U.S. 95. Nevada DOT completed the Spaghetti Bowl Interchange in 2000, six months ahead of schedule. The original

PHOTO: DESIGN WORKSHOP

PHOTO: DESIGN WORKSHOP

Two examples of the enhanced native softscape, which provides greater coverage and plant densities, including adapted trees, along with scattered native rock mulch; special ground treatments are included for drainage and erosion control.

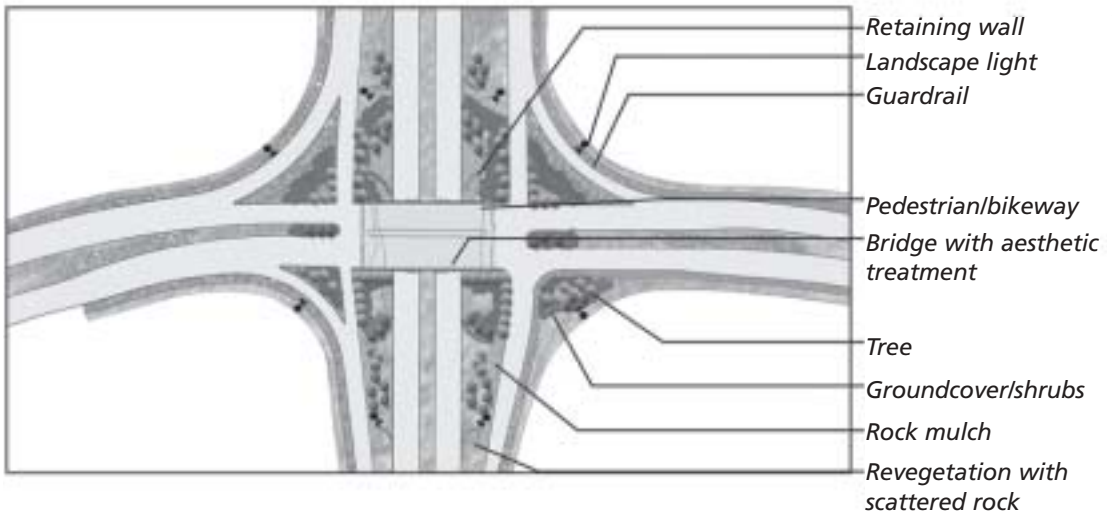
Photo: Design Workshop

Landscape planting along a median right-of-way.

construction did not include aesthetics or landscaping—although functional, it was not visually appealing. In 2004, Nevada DOT applied the corridor plan for I-15 to make new aesthetic and landscape improvements to the interchange. The result has been the most popular highway improvement in Southern Nevada.

"We are engaging Nevada's citizens throughout the design process," former Nevada DOT Director Jeff Fontaine observes. "The planning includes cities, politicians, special interest groups, and a range of ordinary citizens to ensure that the highways reflect the state's distinctive heritage, landscape, and culture."

More projects are under way, such as the St. Rose Parkway Interchange, a dry native landscape enhanced with bold graphics and colorful symbols imprinted in concrete; the water harvesting test areas along I-15 south of Las Vegas; the Nevada Gateway and rest stops on U.S. 95 south, with views, water harvesting, and solar power; and the




Credit: Design Workshop

The Nevada DOT master plan developed designs for hardscape treatments on prototypical interchanges, along with cost estimates for each level of treatment; shown here is the regionally adapted softscape type.

Henderson city gateway near Las Vegas, with sculpture, cast concrete images, plantings, and colorful stone ground art.

One of the most interesting and challenging projects is a segment of the I-15 freeway in Las Vegas, north of the Strip. Project Neon includes less than 3 miles of replacement freeway but will cost more than $1 billion. Already one of the nation's busiest roadway sections, its projected average daily traffic in 2030 will exceed 500,000 vehicles. Project features include 30 bridges, several braided ramps, pedestrian and bicycle accommodations, and multilevel roadways with retaining walls more than 50 feet high.

Because of the limited right-of-way and the extreme levels of traffic, the landscape and aesthetic treatments aim for a carefully controlled continuum that avoids the distraction of feature objects. Still in the conceptual stage, Project Neon will require new techniques, innovative uses of new and old materials, and a design that reflects the culture, the people, and the places of Nevada.

## Construction, Operations, and Maintenance

The members of the design team are attentive to construction and maintenance concerns, such as the lifecycle costs of each project. The team has prepared detailed cost estimates for each combination of softscape and hardscape for the prototype designs of each landscape segment, working from data collected by UNLV, Nevada DOT, local engineering and landscape architecture firms, contractors, and product manufacturers.

A separate UNLV report examines long-term maintenance costs, such as graffiti removal, pruning, and irrigation. UNLV is developing a technical support document analyzing the day-to-day program work needed to manage a project.

The matrix of treatment combinations also was valuable in estimating long-term maintenance costs, because each hardscape and softscape element could be analyzed for the maintenance required; this allowed Nevada DOT to develop a maintenance demand analysis. The analysis in turn led UNLV to produce a *Landscape and Aesthetics Maintenance Cost Manual*. In preparation is a cost-tracking system that will allow maintenance and operations to improve budgeting and planning for staff needs.

"The funding for corridor planning for the first 5 years of the program was identified in the master plan," Hoversten notes. "Most research indicates that it takes 7 to 10 years to change institutional culture—but institutional culture will follow after the program is set up. With the amount of construction going on, we had to get the program in place."

The master plan requires that up to 3 percent of the state's construction budget for new and capacity improvement projects be used to implement landscape and aesthetic treatments. New construction and capacity improvements, however, were concentrated in the two metropolitan areas around Reno and Las Vegas. A retrofit program was created, therefore, to enable rural areas to take advantage of the landscape and aesthetics treatments. The state set aside $2 million annually for the retrofit of landscape and aesthetic improvements to rural highways, and local communities have contributed matching funds.

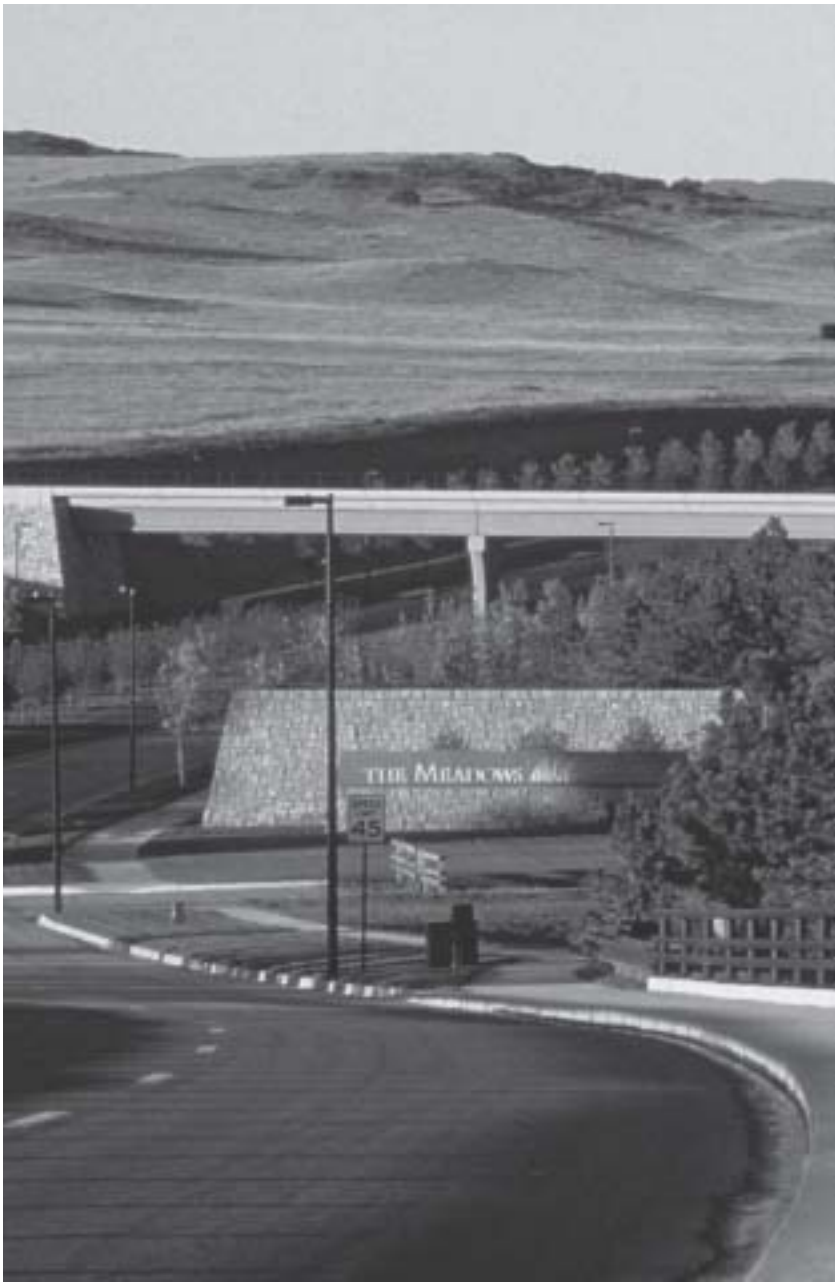



PHOTO: DESIGN WORKSHOP

Nevada DOT's corridor plans emphasize integrating landscape and aesthetics at the outset of projects to create context-sensitive solutions, so that the roadway and its facilities blend into the surrounding landscape.

## Public Involvement

Implementation of Nevada's *Landscape and Aesthetics Master Plan* is still in the beginning stages, but the plan's impact will be dramatic. The corridor planning process calls for public participation through outreach meetings, community workshops, newsletters, and the establishment of a website. Nevada DOT has held meetings to solicit information, local knowledge, and ideas from the public.

Technical review committees of key stakeholders and representatives of public agencies and organizations also have conducted regular meetings. The committees have served as a conduit for local communities to become involved in the planning process.

Early in the corridor planning, rural communities expressed concern that Nevada DOT was not addressing local issues. In response, Nevada DOT developed several key components to promote local communities to tourists traveling through rural areas—such as community gateways, promotional radio broadcasts, place name signage, roadside rest opportunities with a focus on the communities, and several other initiatives.

## Dynamic Partnership

The state has gained not only a new, comprehensive approach to highway design but also a greater awareness and understanding of how highways should be designed. Embracing landscaping and aesthetics as a critical part of the planning process has required a change in the agency's culture, and the evolution continues. But the change has been rapid, with the landscape and aesthetics program merged into the full highway planning and design effort after only three years.

Nevada's landscape and aesthetics master plan has been successful because of the dynamic partnership between Nevada DOT and other state agencies, UNLV, and policy makers who are committed to building improved highways. The plan will be the primary management tool that guides funding allocations, appropriate aesthetic design, and the incorporation of highway elements that uniquely express Nevada's landscape, communities, and cities.

"We have learned a lot in the last few years and we are continuing to learn—we are going to continue to make our roads fit better with the environment," says Pollard. "Everything we are doing today will have an effect for the next 50 years on how highways are developed."

PHOTO: DESIGN WORKSHOP

The Truckee River corridor and adjacent vegetation patterns provide scenic interest for motorists traveling along I-80 in western Nevada.

PHOTO: DESIGN WORKSHOP

A technical review committee, representing local interests and a range of stakeholders, reviews plans for I-15. Nevada DOT has fostered extensive public dialog at every stage of planning and development; committees like this have helped shape corridor plans.

## Related Websites

Nevada DOT Corridor Plans
www.ndothighways.org

Nevada Landscape and Aesthetics Master Plan
www.ndothighways.org/MasterPlan-July3.pdf

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# Transforming Transportation Institutions, Finance, and Workforce

## *Meeting the Needs of the 21st Century*

Specialists in the Transportation Research Board's Technical Activities Division identify current issues, collect and generate information about the issues, and then 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 about all modes of transportation.

A major source of this information is the annual field visit program. TRB staff meet on-site with representatives of each state department of transportation and also with representatives of universities, transit and other modal agencies, and industry.

This report presents a summary of what the TRB staff learned from these visits and activities in 2006.

"Transportation Institutions, Finance, and Workforce: Meeting the Needs of the 21st Century" was the spotlight theme of the TRB 2007 Annual Meeting in January. The theme represented three of the Critical Issues in Transportation that were foremost for state departments of transportation (DOTs) and other agencies visited by TRB staff in 2006. Following are reports on ways that transportation agencies are working to transform their institutions, financing, and workforce. The reports also identify the areas most in need of innovation, with examples of some of the latest innovations that states are pursuing.

## Institutional Issues

### *Policy and Organization*

Even as the roles and responsibilities of state DOTs are being redefined, baby boomers are retiring and changing the composition and dynamics of the workforce. Many state agencies are preparing a new generation of transportation professionals to meet the evolving needs and are working to attract staff who are knowledgeable about finance, public–private partnerships, and concessionaire agreements.

Retaining the institutional memory to sustain a strong technical

PHOTO: UNIVERSITY OF HAWAII

Civil and Environmental Engineering students from the University of Hawaii visit a Hawaii DOT traffic control center.

workforce is a major objective. The Minnesota legislature passed an innovative bill that enables its DOT and other state agencies to rehire on a part-time basis retired employees who can contribute critical skills. The postretirement option—also known as the PRO—program enables retirees to work up to 1,044 hours annually for a maximum of five years. This allows for a gradual transition of seasoned department veterans from the workforce and enables the transfer of institutional knowledge and expertise to their successors.

Hawaii DOT has rehired retirees for some of its top positions. Because only a small number of engineers graduate from the University of Hawaii each year, filling positions vacated through retirement or attrition is difficult. Younger professionals are likely to seek better remuneration in the private sector or from the federal government, which provides a 25 percent cost-of-living adjustment. To hire qualified staff, Hawaii DOT has designated job categories with shortages and has made salary adjustments.

### *Planning*

In 2006 state DOTs and metropolitan planning organizations (MPOs) focused on satisfying the changes specified in the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) for the surface transportation planning process. Consultation requirements were expanded significantly. Requirements also were added for plans to address environmental mitigation, performance improvements, multimodal capacity, and enhancement activities, with representation from tribal, bicycle, pedestrian, and disabled persons' interests.

In June 2006, the Federal Highway Administration (FHWA) and the Federal Transit Administration jointly issued a proposed revision of the regulations for the development of metropolitan and statewide transportation plans and programs. Comments on the rules were due in September 2006, and the final rules are expected for release this summer. As of July 1, 2007, however, state and metropolitan plans submitted for federal approval must comply with SAFETEA-LU.

The provisions in SAFETEA-LU most critical for planning include the following:

- **Fiscal constraint.** Transportation planning and programming must identify the revenues that "are reasonably expected to be available" for implementing metropolitan long-range transportation plans, state transportation improvement plans, and transportation improvement plans, while still providing for the operation and maintenance of the highway and transit systems.
- **Consultation.** Depending on the details of the plan or project, consultations may be required, for example, with nonmetropolitan officials responsible for transportation, with resource agencies, or with federally recognized tribal agencies.
- **Visualization.** State DOTs and MPOs should use a range of visualization techniques in developing transportation plans.
- **Consistency of transportation plan with planned growth and development plans.** SAFETEA-LU promotes the connection between transportation and land use plans and economic development.
- **Environmental considerations in planning and project development.** The legislation calls for increased environmental mitigation, consultation with resource agencies, and the consideration of conservation plans and of maps and inventories of natural and historic resources, if these are available.

### *Energy and Environment*

Public pressure and more rigorous requirements for environmental documentation are shaping the way that transportation agencies view and approach environmental stewardship. Stormwater management,

CREDIT: WASHINGTON STATE DOT

Proposed wildlife crossing over I-90 at Rock Knob, at the east end of Keechelus Lake, Washington.

PHOTO: ELAINE KING

Nevada DOT wetland mitigation site prohibits public access during nesting season.

noise control, hazardous materials management, and wildlife crossings—along with emerging issues such as air toxics and global warming—are key environmental challenges.

The intermodal nature of state transportation systems adds to the complexity of environmental regulation. The increase in freight transportation by plane, train, automobile, and ship is leading agencies to rethink their approach to environmental analysis to meet regulatory demands for a thorough examination of project alternatives.

Public pressure to reduce local and global emissions is spurring research into applications of alternative fuels and into ways to reduce fuel consumption. Biodiesels, hydrogen fuel cells, ethanol, solar, and electric fuel options are being studied as ways to reduce emissions affecting local air quality and human health—such as particulate matter and other air toxics, carbon monoxide, and nitrogen oxides—and to reduce emissions affecting the global climate, such as carbon dioxide.

Agencies are taking a holistic approach through the development of comprehensive environmental management systems to ensure that environmental policies, programs, and research are addressing public concerns and regulatory requirements.

### *Data and Information Technologies*

States are recognizing that information and data are important assets for decision making. With revenues constrained and construction costs on the rise, states are improving their data resources to serve as timely, flexible, and cost-effective guides to selecting solutions.

As the issues facing DOTs become more complex, the effective use of data across different application areas and systems—within the DOT and with outside partners—becomes more important. Transportation environmental applications, for example, require extensive use of data from external sources. DOTs are developing partnerships to use the data generated by natural resource and environmental agencies. This seemingly straightforward sharing is complicated, however, because the data requirements for transportation applications often differ from those for the resource agency, which may have different goals, culture, and geographic scale.

Developing effective partnerships with resource agencies is the key to success. Pennsylvania DOT helped the state's historic preservation office make its resources available online with geographic referencing. Pennsylvania DOT's minor investment allows the transportation community to gain quicker access to historic preservation information, saving trips for staff and consultants and accelerating project reviews.

The data sharing is enhanced through written descriptions of data resources and their sources—that is, through improved metadata. Building better metadata foundations is a key to extending the use of expensive data resources.

Geographic information systems (GIS) continue to evolve as a tool for integrating data within DOTs and with other agencies. GIS applications are proving effective in asset management, performance measurements, and safety.

Consistent national datasets and information sources serve states for benchmarking, calibrating travel models, understanding the flows of people and freight into and through a region, and evaluating the effect of improvements. The availability of those datasets and the maintenance of their quality, however, has become a concern, as federal research funding sources face constraints. Funding for the National Personal Travel Survey—a basic source for personal travel behavior—is unclear, and the Census Bureau has not funded the Vehicle Inventory and Use Survey of freight and truck flows; but after a period of doubt, the Commodity Flow Survey has received funding for 2007.

## Aviation

State aviation officials face continuing concerns about the airline industry, as well as about the funding of the national aviation system. In the meantime, state and federal aviation-related budgets are shrinking, and regulatory and paperwork requirements are becoming more complex, adding to the challenges.

Airlines must reckon with the cost of fuel, and uncertainty about the Essential Air Service program affects most airports nationwide. The advent of very light jets, which are expected to open a large market, will change the national airspace system and the airports that the new jets serve.

The federal government is reviewing the funding for the infrastructure needs of the national aviation

PHOTO: JOSEPH R. MORRIS

The Port of Long Beach continues to grow as a hub of freight and intermodal freight transportation.

system as the next cycle of congressional reauthorization approaches. A significant concern is that the current fuel taxes, user fees, and other charges will not be sufficient to cover future needs; moreover, the equitability of these charges for all users of the system is a subject of debate.

Many airports are struggling to accommodate the increased regulatory controls over all levels and types of operations. Sources of increased paperwork requirements include the State Block Grant Program and the Federal Aviation Administration's evaluation process for the implementation of new technologies—such as Global Positioning Systems (GPS) and other NAVAID or navigational aid approaches. These added administrative requirements, in turn, affect airports' ability to serve aircraft operator customers and the surrounding communities.

## Freight Systems

Freight transportation volumes—fueled by international trade, as well as by domestic growth—continue to put pressure on the capacity of all modes, and projections show a similar picture for the future. States are recognizing that the connections for freight transportation between highway systems and other modes—particularly to ports and railroads—are critical, as is the problem of increased truck traffic in many corridors and urban hubs. With primarily Chinese imports crowding West Coast ports, the states of California, Washington, and Oregon have created freight-related offices within their DOTs and are addressing freight issues in the planning process.

Several states, including Colorado and Minnesota, have established freight advisory committees to coordinate with private-sector shippers and carriers. Freight movements are not confined by political boundaries, and many states have developed multijurisdictional—as well as multimodal—corridor approaches to identify, plan for, and invest in ways to add freight system capacity.

As states make investments for freight transportation, they are looking for analytical tools to support decision making. Several states, including Ohio, Oregon, and Florida, are developing sophisticated freight modeling tools.

The public sector clearly has roles and responsibilities in freight transportation, and state DOTs are aware of the need to coordinate public- and private-sector timelines, priorities, and analytical approaches. State DOTs and other transportation agencies are seeking staff who can offer a range of knowledge and skills to deal effectively with freight matters.

## Highways

### *Design*

An aging infrastructure and a heightened public awareness of the importance of a reliable and safe transportation system is creating demand for the redesign of roadways, the rehabilitation of pavements and bridges, and the use of innovative materials and techniques to complete the task efficiently.

States depend on contractors for the design and inspection of infrastructure projects. States often require the contractor to perform the quality control and a contract inspection service to handle the quality assurance. Several states are looking into automated techniques for inspection, data collection, and reporting to compensate for a reduced in-house inspection workforce.

Many states are developing implementation plans for the recently piloted Pavement Design Guide from the American Association of State Highway and Transportation Officials (AASHTO). States are conducting calibration and training efforts and are looking for additional information from the National Cooperative Highway Research Program (NCHRP) to assist in training.

Use of the load and resistance factor design

PHOTO: CALTRANS

View of construction on the new skyway span of the San Francisco–Oakland Bay Bridge, scheduled for completion in 2013.

(LRFD) method for the subsurface part or foundation of bridges and other structures has increased; October 1, 2007, is the deadline for DOTs to meet the federal mandate for implementation. The level of adoption among the states, however, varies from full to none. Many states are calibrating the substructure aspects, with full implementation to follow. Some states are providing training to their staff on LRFD through National Highway Institute courses.

States are applying innovative materials—such as high-performance concrete and structural fiber-reinforced plastics—and are relying on innovative design and construction techniques—such as precast pavement and bridge members—to build structures more efficiently and with greater durability. The goal is to reduce work zone construction periods, as well as maintenance activities, in travel lanes.

### *Construction and Materials*

State DOTs are focusing construction efforts on infrastructure renewal, congestion relief, and safety improvements. States are encountering shortages of materials and an escalation in bid prices. Several states report project delays caused by shortages of aggregates, portland cement, asphalt binder, and steel. Some have developed price-adjustment clauses for steel, asphalt, and fuel. Because of higher construction costs, a few states have scaled back the number of projects let.

At the same time, competition among contractors is decreasing in many states—often only one or two bidders respond. States with large construction programs over the next several years, such as Utah and California, are especially concerned about the lack of contractors. In some cases, contractors and suppliers have consolidated; in others, the work has increased, but the number of contractors has not.

In addition, highway contractors often are competing with homebuilders for labor, and transportation construction is only a fraction of the construction dollars in each state. Idaho reports that contractors are not willing to bid on transportation projects because of the many regulations and specifications with which they must comply; at the same time, much more work is available in the building industry, which has less stringent requirements.

Pavement noise remains a concern in many states; Arizona has used asphalt rubber extensively to reduce tire–pavement noise. Warm-mix asphalt continues to gain interest, as does self-consolidating concrete.

### *Geotechnical Engineering*

Landslide and rockfall hazards remain a problem. The number of states that have a rockfall hazard rating system increases each year. Many use the rating system to make hazard and risk assessments along highway corridors. Results of the analysis are generally used for prioritizing the mitigation work and for budgeting.

PHOTO: SASOL WAX AMERICA

Application of a warm-mix asphalt known as Sasobit, which hardens at ambient temperatures.

Interest in the acceleration of construction projects has prompted states to consider use of innovative materials such as geofoam. Approximately 50 percent of the states have applied geofoam in roadway projects; the construction of large sections of the embankments on I-15 in Utah is a notable example.

States also are interested in intelligent compaction—achieving the required level of compaction of subgrade, aggregate, and embankment materials is a key to a transportation facility's durability. An NCHRP project is determining the reliability of intelligent compaction systems and is developing construction specifications. Minnesota DOT is one of the first states to use intelligent compaction on a full-scale field project.


PHOTO: MINNESOTA DOT

Intelligent compaction equipment, tested by Minnesota DOT, measures and records the quality of compaction with a global positioning system and increases and modulates the force as needed, preventing overcompaction.

### *Maintenance*

The recruitment, training, and retention of the highway maintenance workforce are challenges for many agencies. Several agencies reported high numbers of vacancies and noted the difficulty of attracting and retaining qualified employees with pay rates below those for similar positions in other sectors.

DOTs continue to explore and evaluate maintenance outsourcing with mixed results. Limited in-house resources, the need for specialized expertise or equipment, statutory requirements, seasonal work, and contractor availability are some of the reasons for outsourcing.

Procurement practices include short-term "input models" with payments for labor, equipment, and materials; one- to five-year "output models" for an area or roadway corridor, with payments for accomplishments such as acres mowed or ditch-miles cleaned; and longer-term, lump-sum corridor or network "outcome models" that measure a level of service such as roadway smoothness, skid resistance, structural capacity, or time-to-bare-pavement after a snowfall. Several agencies noted the need for the maintenance community to share information on the effectiveness of the various types of contracts, including guidelines for warranties, penalties, and emergency contracting.

Maintenance management systems have incorporated such information as the condition of assets; customer feedback and surveys; workload planning and forecasting; measuring and evaluating input, output, and outcomes; and GPS to record work locations. Many agencies are using statistical sampling within a quality assurance program to measure levels of service for maintenance within and across jurisdictional boundaries.

The safety of the traveling public and of roadway workers is a priority for transportation agencies. States are implementing the FHWA Rule on Work Zone Safety and Mobility, a holistic approach to improve safety from project planning through design, implementation, and performance evaluation. Controlling traffic speeds in work zones remains a problem.

PHOTO: NEW MEXICO DOT

Ignition interlock devices are connected to a car's ignition system and serve as alcohol breath screening mechanisms. A vehicle may be prevented from starting if the device detects that the operator's blood alcohol concentration is above a preset limit.

### *Operations*

Congestion is ever-growing, particularly in metropolitan corridors. In the new joint NCHRP–Transit Cooperative Research Program (TCRP) report, *Commuting in America III*, author Alan Pisarski notes that the average work commute is now more than 25 minutes.[1] In addition, almost 8 percent of daily work trips now take more than 1 hour. The percentage of work trips outside of the 6:00 a.m. to 9:00 a.m. peak hours increased dramatically between 1990 and 2000.

Other recent surveys have found that motorists and businesses are frustrated by the unreliability of journey time. Traffic operations professionals therefore are focusing on strategies to achieve travel time reliability through improvements in traffic signal control, incident management, freeway operations control strategies, the management of work zones, and managed lanes.

The private sector is providing traffic information to the public. Yahoo, Inc., and Microsoft's MSN offer e-mail alerts and interactive online maps that detail traffic congestion. Satellite radio providers XM and Sirius are providing traffic information in select markets. OnStar from General Motors offers weather and traffic bulletins. Handheld computer maker Palm, Inc., has introduced Traffic for Treo Smartphones in 10 metropolitan areas to help users avoid congestion.

Through a public–private partnership, Kansas DOT recently compared determinations of travel times and congestion based on the use of cell phones as traffic probes with measurements based on loop detector data. Preliminary findings indicate a high level of correlation between the two methods.

### *Safety*

Traffic deaths were up slightly to 43,443 in 2005, compared with 42,636 in 2004. The fatality rate of 1.47 per hundred million vehicle miles increased from 1.46 in 2004. Motorcycle fatalities rose 13 percent in 2005, from 4,028 to 4,553. Pedestrian fatalities increased from 4,675 to 4,881 in 2005.

SAFETEA-LU mandated that each state develop a strategic highway safety plan. Many states submitted a plan in 2006, and all others expect to comply in 2007. In February 2007, states will conduct the third peer exchange to share successes, implementation strategies, and ways to overcome barriers.

Some states are using ignition interlocks for people who have had several convictions for driving while intoxicated. New Mexico has applied the law to first offenders; in conjunction with other tactics, this produced an 11.3 percent drop in alcohol-related fatalities during the second half of 2005.

Crash rates for teenage drivers continue to decline. Graduated licensing laws are a major reason. Strong laws, such as California's, show positive results. An independent evaluation of California's law by the Insurance Institute for Highway Safety showed a 23 percent reduction in the per capita crash rate of 16-year-old drivers. The restriction on driving by teenagers after 11 p.m. has reduced nighttime

[1] *NCHRP Report 550–TCRP Report 110: Commuting in America III: The Third National Report on Commuting Patterns and Trends*. Transportation Research Board of the National Academies, Washington, D.C., 2006.

crashes by 27 percent. With the no-teen-passengers restriction, the teen-passenger-related crash rate dropped 38 percent.

## Marine

### *Ports and Waterways*

Ambitious port and waterway projects were in the works in 2006. Florida DOT issued a request for proposals for a public–private partnership project to design, build, finance, operate, and maintain a 1-mile tunnel between I-395 and the Port of Miami–Dade County, so that trucks could bypass surface streets, easing downtown traffic congestion.

In California, ports began competing for funds after the passage of the state's transportation bond. This included $1.7 billion worth of projects at the Ports of Los Angeles and Long Beach and a $600 million project to improve rail at the Port of Oakland. The Port of Oakland also is looking into a freight ferry service that would remove as many as 400 trucks from I-80, transporting the cargo via barges over the Sacramento River Delta to Sacramento. On the environmental front, Maersk, Inc., completed a pilot program under which the company's ships that call at California ports would no longer burn bunker fuel when approaching the coast.

On the inland waterways, Tennessee broke ground near the Mississippi River for a new slackwater port that should boost the economy of the northwestern part of the state with up to 3,000 new jobs. The approval and funding of infrastructure improvements are among the challenges for inland waterways.

### *Ferries*

Ferry transportation received considerable attention in 2006. New York City has implemented a safety management system, with procedures affecting all aspects of ferry service, including pilot house operations and crew member training. Bridgeport, Connecticut, is reviewing plans to start a new ferry service along the coast and across Long Island Sound, as well as a container-on-barge service to haul freight between Bridgeport and New York. The Miami–Dade County MPO plans to present proposals for a water-transit system that could add water-taxi and water-ferry routes on Biscayne Bay.

## Rail

Although much of the U.S. rail system is privately owned by freight railroads, most states have an active interest in passenger and freight services as key elements of the transportation system. Demand for commuter rail service for congestion relief is growing in many areas. An example is the New Mexico Rail Runner Express, which opened in the Albuquerque area in July. Most commuter and intercity passenger services operate on freight-owned rail lines that already are approaching capacity with increases in freight traffic, despite substantial capital investments by the freight railroads.

PHOTO: NEW MEXICO DOT

New Mexico's Rail Runner commuter train leaves Lamy station, 70 miles north of Albuquerque.

In late October, Amtrak started running new higher-speed express trains between Harrisburg and Philadelphia, substantially reducing trip times. The new service was made possible through $145 million in improvements funded equally by Pennsylvania DOT and Amtrak; the commuter line runs on an Amtrak-owned extension of the Northeast Corridor. Pennsylvania DOT also issued grants totaling $20 million to help Class I, regional, short-line railroads, shippers, and local transportation agencies fund improvements in freight rail infrastructure.

As freight volumes increase in all modes, states are seeking opportunities for freight railroads to absorb more intermodal traffic from congested Interstates. Virginia is looking for possible opportunities in the heavily traveled I-81 corridor. Funding continues to be a challenge for larger, regional, or corridor projects, such as CREATE in Chicago and the Mid-Atlantic Operations Study.

Public agencies and private industry share concerns about congested facilities, but frequently have different goals in developing joint solutions. Understanding which investment benefits accrue to the public and the private sectors is critical for improving the transportation system at all levels.

## Public Transportation

According to *Commuting in America III,* congestion and gridlock will continue to develop in urban areas that require new or rehabilitated urban infrastructure,

## Did You Know?

◆ Wyoming DOT has teamed with the University of Wyoming to create the Design Squad. The DOT offers the top 10 to 15 engineering students at the university part-time positions. The students gain real-world experience, and Wyoming DOT gains a head start in recruiting the next-generation workforce to full-time positions after graduation.

◆ After the passage of SAFETEA-LU, the Alaska Department of Transportation and Public Facilities published a brochure, *Federal Highway Earmarks: Frequently Asked Questions and Answers*, to help project sponsors understand how earmark projects are implemented through the agency.

◆ Idaho has a seaport. The Port of Lewiston, approximately 500 miles inland at the upper end of the Columbia–Snake River waterway system, handles barge and intermodal connections.

◆ Maine has the largest percentage of older persons of any state.

◆ Minnesota is the state with the most highway lane-miles dedicated to express buses.

◆ The Washington Metropolitan Area Transit Authority's Metrorail has 588 escalators, plus 230 elevators in stations, and another 30 serving shops and facilities. The system boasts the longest escalator in the Western Hemisphere, at the Wheaton, Maryland, station—508 feet (70 meters).

◆ In Iowa, any local agency—planning, municipal government, or law enforcement—can receive traffic crash data software and training to perform basic data analyses. The Center for Transportation Research and Education, funded by Iowa DOT and the office of the Governor's Representative for Highway Safety, provides the services and offers the agencies free assistance with additional data analysis.

◆ Rhode Island DOT's Traffic Management Center serves 39 cities and towns, which encompass rural, metropolitan, and tourist areas.

◆ The University of Delaware has a Center for Innovative Bridge Engineering that has 22 undergraduate students and 18 graduate students.

◆ The Mississippi River delta plain has the highest rate of relative sea-level rise of any region in the nation—3 feet per century—mostly because of rapid geologic subsidence.

Washington Metrorail's escalator at Wheaton, Maryland, is a commute in itself.

The Metro Rapid BRT, operated by the Los Angeles County Metropolitan Transit Authority, speeds up commuter time by making fewer stops and running more frequently; special transponders cause traffic signals to favor the bus, and low-floor designs allow faster boarding and alighting.

including transit. State and local ballot measures have begun to address these transportation issues and needs; as of November 8, 2006, more than $40 billion in transit-related initiatives has been authorized in 23 states.[2]

In addition to long-term needs, more immediate concerns arose from energy prices and hurricane preparations. By fall, however, fuel prices had peaked and dropped by nearly one-third, and the record number of hurricanes had not occurred as predicted. This removed substantial short-term financial stress from transit budgets; but long-term financial obligations are increasing as the workforce begins to retire. Many of the larger transit operators face unfunded pension liabilities, along with operating deficits and work agreements.

Nevertheless, services and systems expanded in 2006, and new technologies were applied. In California, commuter rail systems added service and amenities—including wireless personal computer connections aboard Caltrains. The New York Metropolitan Transportation Authority has a $21 billion capital plan under way for 2005 through 2009. New Jersey Transit's $7.2 billion plan includes a new, two-track tunnel under the Hudson River to Manhattan's Pennsylvania Station. Light rail systems are under construction in Phoenix, with expansions in Los Angeles and St. Louis. Bus propulsion technology is developing with electrification, fuel cells, and cleaner emissions. Eighteen cities are now providing bus rapid transit service.

[2] Preliminary November 7, 2006, Results. APTA Press Release, Nov. 8, 2006. www.apta.com.

POINT OF VIEW

# It's About Decisions

## *Improving Transportation Project Development with Visualization Technologies*

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Actions require decisions. Our private and professional lives consist of multitudes of decisions ranging from the simple—which shirt shall I purchase?—to the highly complex—should I specify a custom steel girder structure or a stayed-cable design for this river crossing? If we counted the number of decisions made in a day, we would wonder how we maintained a sense of perspective on the world in which they were made or on the many reasons behind the decisions.

In the world of transportation, the complexity and diversity of the institutions, professionals, and organizations required to scope, fund, plan, design, fabricate, construct, and maintain the infrastructure are overwhelming. Add to that the associated laws, specifications, rules of engagement, and stakeholder needs—it is a wonder that the multitudes of necessary decisions ever get made. How do all parties know if the decision was correct?

### Impacts of Ambiguity

People make decisions either analytically through conscious thought or by feeling. Both processes are necessary for survival. Conscious thought may consider the implications of risk in the context of the


Visualization image prepared for the ROC-52 Project, a design–build reconstruction of U.S. Highway 52 near Rochester, Minnesota. The image shows the versatility of visualization, incorporating plan views, 3-D rendering, and final projection.

final goal. For example, a bridge engineer will leverage analysis of data, physics, and engineering methods to decide on the size and makeup of a beam configuration. A public stakeholder, in contrast, most likely will make a decision on alternatives A, B, or C based on feelings about how the bridge looks from the living room window. To the engineer, the risk is whether the structure will be stable; to the homeowner, the risk may be to the property value or even to the quality of life. These two separate thinking processes are both necessary for the ultimate decisions about what to build and how much to spend.

A California Institute of Technology study examined the impacts of ambiguity on decision making. Functional magnetic resonance imaging enabled researchers to see which parts of the brain were active when subjects attempted to make decisions from incomplete or ambiguous information. In most of the subjects, the amygdala and the orbital-frontal cortex were active; both were involved in processing the emotion spawned by an awareness of impending risk.

How does this relate to highway project development? A traditional approach at a stakeholder or public information meeting is to present decision makers with a wealth of the engineering and environmental reasoning—along with the data—that led the project team to the alternatives at hand. A homeowner in the audience is trying to decide on an alternative based on well-intended information that may seem ambiguous or confusing. The homeowner at that moment is experiencing levels of emotion—mostly stress—which will have an impact on the decision and on the subsequent confidence that the best choice has been made. For the engineer, planner, or contractor, the conscious understanding that the analysis has led to the best decision is important—but also important for each is the gut-level, instinctive feeling of being able to live with the decision professionally.

## Enter Visualization

Visualization technologies can reduce the ambiguities that arise in transportation projects and can improve decision making across the spectrum of participants, stakeholders, and professionals. Visualization technologies can help maintain a shared awareness about the collective implications of decisions.

In highway project development, visualization is not only about three-dimensional (3-D) geometric images made to look realistic, so that an engineer can communicate better with the public. Visualization also may include such examples as the following:

- Driving simulators that incorporate roadway geometry and traffic flows to measure human safety performance;
- Traffic models for capacity analysis and performance evaluation;
- Steel bridge models that can be used for design, in public meetings, and by steel fabricators;
- Laser and image scans of functioning bridges to facilitate bridge maintenance and rehabilitation;
- 3-D models distributed to a project team for interactive collaboration;
- Subterranean modeling of strata and buried utilities;
- 3-D geographic information system displays of terrain, infrastructure, land use trends, and environmentally sensitive areas to facilitate transportation improvement projects; and
- 3-D models of subgrade designs made available to construction teams for electronic stakeout and machine control.

## Enhancing Collaboration

On a recent visit to the Federal Highway Administration's Turner-Fairbank Highway Research Center in McLean, Virginia, I observed the highway driving simulator, an immersive and interactive visual technology for assessing the human factors in a unique highway design—for example, a diverging diamond interchange. I sat in a real car that was interactively linked to a computer displaying the proposed roadway design on a 180-degree wraparound screen. As a driver, I quickly became accustomed to the environment and experienced sensations similar to being on the road. As an engineer, I began thinking of my driving performance in relation to turn radii, sign placements, and line of sight.

Tom Granda of FHWA related that a few months earlier, several engineers from the Missouri Department of Transportation (DOT) were considering a diverging diamond interchange but had some design concerns. The team members took turns driving on the simulated interchange; while in the simulator, they spontaneously began collaborating on changes and additions and moved seamlessly into collective decision making. The iterative decision-making process consisted of driving on the simulated roadway, suggesting design changes to the interchange, implementing the design changes, and then returning the next day to test-drive the implemented changes. After several cycles, the design team left with confidence in the workability of the final design.

If the team had employed the traditional approach of 2-D computer-aided drafting and design, with numeric analysis, the collective concept of the design would have taken longer. Because

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the Missouri DOT engineers were interacting with the design, their conscious thoughts were more preoccupied with developing solutions to problems than with imagining the design from 2-D geometry and solving the problems at the same time.

Other research with driving simulators—such as the projects performed by the University of Minnesota's Center for Transportation Studies and Minnesota DOT in 1999 (*1*) and most recently in the European transportation community (*2*)—provide insight into the potential value of these tools for engineers regarding human factors and for stakeholders engaging public involvement (*3*).

When visualization is employed throughout the entire process of project development, similar exchanges among decision makers may be realized at every stage. For example, the model used in the simulator for human factors evaluation could have come from the design process involving the bridge engineer and the homeowner described earlier. The engineers in the simulator may be making a different set of decisions from those of the bridge engineer or the homeowner, but the decisions all relate to the same project. A breakdown in any one of these components could delay the project, lead to the building of a project that is unsafe, or prompt litigation.

## The Larger Picture

As traffic engineers evaluate the performance of a proposed alternative, or as utility engineers decide what gets moved and by how much, they perform functions specific to their roles. With traditionally flat methods, they do not have the ability to observe their decisions in the context of the entire project or of the community outside the right-of-way. Balanced with traditional processes, visualization can provide a more comprehensive approach to global and subject-specific decision making.

Employing appropriate visualization technologies in transportation project development changes the activities that contribute to problem solving and decision making by engaging more of the brain. At the same time, visualization removes many of the ambiguities that surface when diverse teams and stakeholders try to move collectively and confidently to decide what needs to be built.

The National Science Foundation (NSF) recognizes the value that visualization brings to science and engineering. NSF provides practical perspectives and publications and promotes the use of the technology through the international Science and Engineering Visualization Challenge.[1] By stepping beyond the technology into cognitive science, neuroscience, and human behavior, we can approach a more comprehensive understanding of how visualization can improve our abilities to make decisions in addressing highway transportation needs.

IMAGE: TOM GRANDA, FHWA

The driving simulator at Turner-Fairbank Highway Research Center.

## The Opportunity

The Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) contains evidence of a recent and new awareness at our nation's executive level of the need to promote the use of visualization and simulation technologies. The legislation includes sections addressing

- Visualization Techniques in Plans and Metropolitan Transportation Improvement Project Development,[2]
- Transportation Analysis Simulation System,[3] and
- Demonstration of Digital Project Simulation.[4]

The language in SAFETEA-LU is general and open to interpretation in the diverse world of visualization technologies. FHWA already has completed the Notice of Proposed Rulemaking and should be close to publishing a final rule. Researchers have the opportunity to enhance the collective understanding of visualization, its potential applications, the corresponding returns on investments, and the benefits to transportation in general. Moreover, researchers can address the tasks specified in SAFETEA-LU.

[1] www.nsf.gov/news/special_reports/scivis/index.asp.
[2] Amended 23 U.S.C. 134(i)(5)(C)(ii) and 49 U.S.C. 5303(i)(5)(C)(ii); plus Amended 23 U.S.C. 135(f)(3)(B)(ii) and 49 U.S.C. 5304(f)(3)(B)(ii).
[3] Section 5512.
[4] Section 10210.

Any research or demonstration efforts can and should be performed in direct cooperation with organizations such as the American Association of State Highway and Transportation Officials, the American Society of Civil Engineers, the Associated General Contractors of America, the Association of Metropolitan Planning Organizations, FHWA, the Federal Transit Administration, the Design–Build Institute of America, and others, which can act as industry conduits to develop guidelines and to maintain resources of best practices for agencies, consultants, and practitioners.

To date, activities through the National Cooperative Highway Research Program (NCHRP) have looked at the subject primarily through syntheses, assembling information about the state of need and practice in the highway industry.[5] The next step should establish an orchestrated understanding of visualization that "gets under the hood." Research and demonstration activities are needed to

- Define visualization for the transportation industry—too many different perspectives are competing;
- Determine and define how and why visualization technologies work in transportation—for example, the effect on the cognitive implications of problem solving, team dynamics, and decision making;
- Determine which technologies best apply to which stage or component of the project development process, from project scoping through planning, design, fabrication, and construction, and on to operations and maintenance;
- Discover and document the clear and measurable benefits and returns on investments to be realized at various stages;
- Determine the data, network, and systems implications of working in visual-centric environments;
- Identify the visualization tools that are most conducive to spawning advancements by technology providers, data managers, and network administrators; and
- Sponsor research into other areas of consideration jointly through NCHRP, NSF, and the Learning Federation to examine the potential for
  - Visual learning environments to enhance analytical and creative problem solving—in addition to communication and team collaboration skills—for engineers; and
  - Visualization technology applications in knowledge management for transportation organizations.

The opportunities for research and for the industry are considerable. The advantages that the aerospace, chemical, medical, petroleum, automotive, and other industries have been enjoying for some time through visualization technologies are becoming more readily available to highway transportation. Invaluable reductions in time, cost, and effort to define problems, exchange ideas, communicate concerns, identify alternative solutions, and make optimal decisions leading to action are the gains to be expected.

*Presentations from the 5th International Visualization in Transportation Symposium and Workshop, sponsored by TRB, the Federal Highway Administration, and the Federal Transit Administration, October 23–25, 2006, in Denver, Colorado, are available online at www.teachamerica.com/viz/viz2006.html.*

[5] For example, *NCHRP Synthesis of Highway Practice 361, Visualization in Project Development*, Transportation Research Board of the National Academies, Washington, D.C., 2006, http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_syn_361.pdf.

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NEW NATIONAL RESEARCH COUNCIL REPORT

# Going the Distance?

## *The Safe Transport of Spent Nuclear Fuel and High-Level Radioactive Waste in the United States*

NANCY HUDDLESTON AND BRANDON JONES

*Huddleston is Senior Communications Officer, Division on Earth and Life Studies (DELS), National Research Council of the National Academies, Washington, D.C. Jones, a student at Haverford College, was an intern with DELS in 2006.*

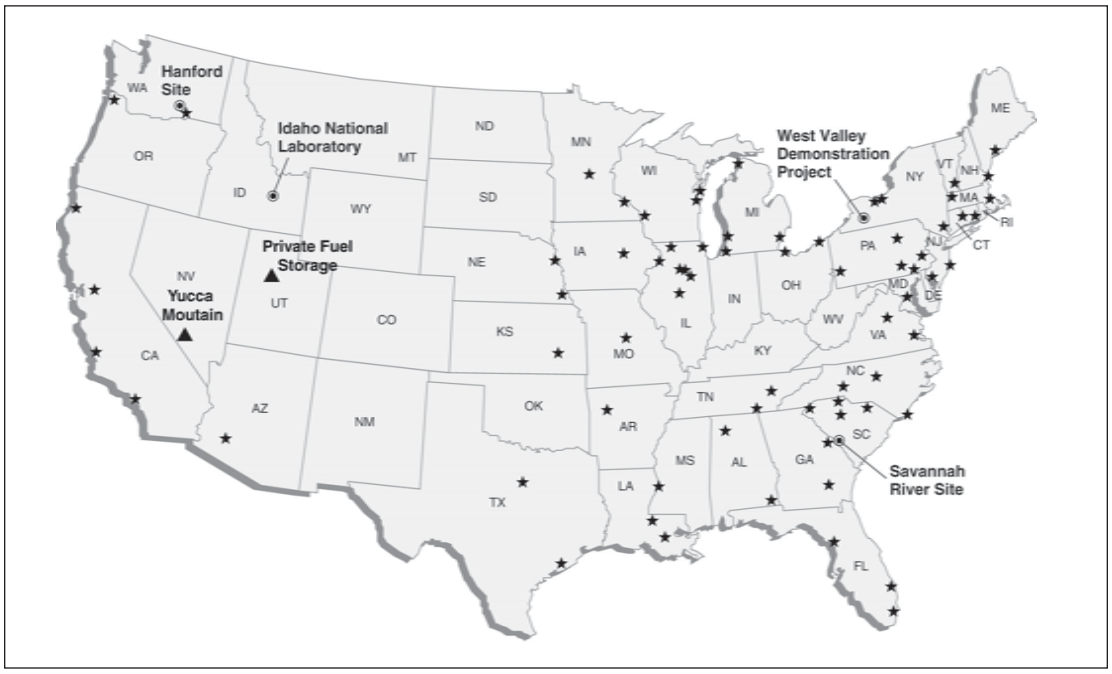
There are no fundamental technical barriers to the safe transport of spent nuclear fuel and high-level radioactive waste in the United States. When conducted in strict adherence to existing regulations, the transport of spent fuel and high-level waste poses low radiological risk, and the safety, health, and environmental consequences are manageable. The successful initial implementation of large-quantity shipping programs, however, faces social and institutional challenges.

Spent fuel and high-level waste are byproducts of nuclear power production, defense-related activities, and research activities. Approximately 55,000 metric tons of the waste are now stored at more than 70 sites throughout the United States (see Figure 1). The majority consists of commercial spent fuel stored at nuclear power plants. The remainder is defense-related spent fuel and high-level waste stored at four government-owned sites. Spent fuel and high-level waste are highly radioactive and—without the proper shielding—can be harmful or fatal to those exposed to it.

All of the U.S. sites are considered interim storage solutions. The federal plan is to transport spent fuel and high-level waste from those sites to permanent disposal in a geologic repository to be built at Yucca Mountain, Nevada. The U.S. Department of Energy (DOE) is responsible for transporting spent fuel and high-level waste to the repository.

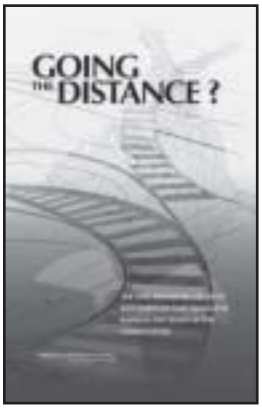
## Larger Shipments

Since the 1950s, spent nuclear fuel has been transported on U.S. railways and highways in small amounts from a variety of sources, including nuclear-powered naval ships, research facilities, and nuclear




SOURCE: DOE

**FIGURE 1 Locations of spent fuel and high-level waste storage sites, Yucca Mountain, and Private Fuel Storage, LLC, in Utah.** (Stars indicate nuclear power plant sites; circles are government-owned sites for defense-related waste.)




*Going the Distance? The Safe Transport of Nuclear Fuel and High-Level Radioactive Waste in the United States* is available from National Academies Press, www.nap.edu.

To receive reports and news from the Nuclear and Radiation Studies Board, go to http://dels.nas.edu.

power plants that have shut down or that have run short of storage. Many other countries have transported spent fuel in much larger quantities. In the United States, only about 3,000 metric tons of the total inventory have been transported; the inventory increases by approximately 2,000 metric tons per year.

With the Yucca Mountain site scheduled to open in 2017, attention has turned to safely transporting much larger quantities of spent fuel and high-level waste. A challenge for a large-scale transportation program is that the storage sites for much of the commercial spent fuel in the United States are near large population centers. Moreover, shipments will pass through 31 states, including many major population centers, to reach the repository.

Recognizing the need for an independent examination of the risks and of the key concerns associated with this transport, the National Research Council's Nuclear and Radiation Studies Board and Transportation Research Board jointly initiated a study (see box, below). A key finding is that the transport of small-quantity shipments by highway and of large-quantity shipments by rail is an activity with low radiological risk from a technical viewpoint; the safety, health, and environmental consequences are manageable with strict adherence to existing regulations. Nevertheless, the initial implementation of large-quantity shipping programs will encounter social and institutional challenges. In addition, the study committee notes that the challenges of sustained implementation should not be underestimated.

## Assessing Risks

Risk is multidimensional. It includes the health and safety risks that can arise from the exposure of workers and the public to radiation from spent fuel and high-level waste. It also includes the social risks that arise from social processes and people's perceptions. Risks also can arise from incidents such as terrorist attacks, which the report does not address.

## Health and Safety Risks

The two potential sources of radiation exposure during the transport of spent fuel and high-level waste are

- Emitted radiation, or radiation "shine," from packages during routine transport; and
- Potential increases in radiation shine and the release of radioactive materials in a severe accident that compromises the robust containers—also referred to as packages.

According to the report, the radiological risks associated with the transportation of spent fuel and high-level waste are well understood and generally are low. The report credits several factors, including

- Rigorous international standards and U.S. regulations covering the design, construction, testing, and maintenance of spent fuel packages;
- Full-scale crash testing of transport packages under severe accident conditions;
- A series of sophisticated analytical and computer modeling studies on the performance of the packages for transporting spent fuel; and
- Reconstructions of the mechanical and thermal loading conditions from severe accidents that did not involve spent fuel, to assess how spent fuel packages would have performed.

Extreme accidents generating fires of long duration that fully engulf the transportation package for hours or days, however, may compromise the radioactive contents. Although the likelihood of such extreme accidents appears to be small, the occurrence cannot be ruled out based on historical data for other types of hazardous materials shipments.

### Committee on Transportation of Radioactive Waste

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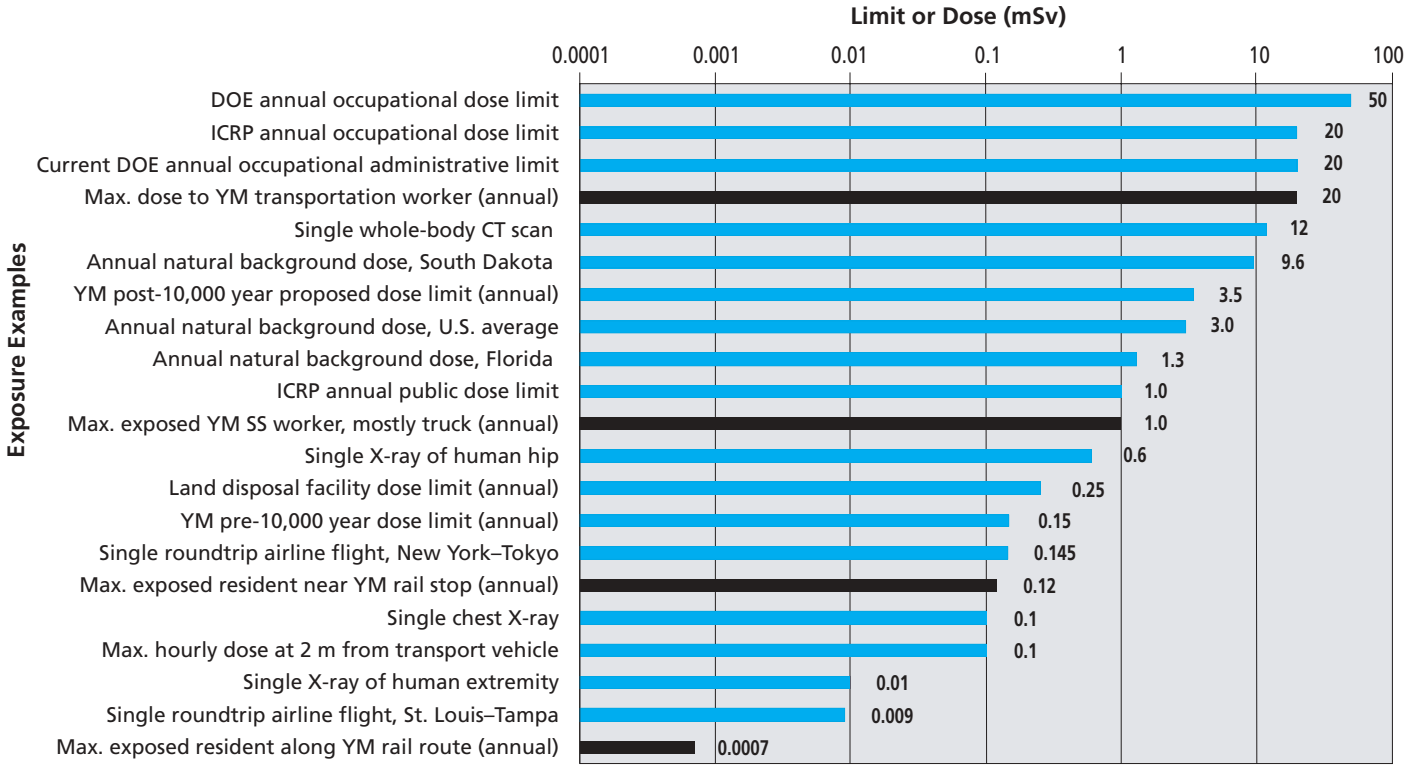


**FIGURE 2 Estimates of radiation exposure from the transport of spent fuel and high-level waste under routine conditions.** (mSv = millisievert; YM = Yucca Mountain; DOE = Department of Energy; ICRP = International Commission on Radiological Protection; SS = service station.)

The likelihood of occurrence and consequences can be reduced, however, with relatively simple operational steps and route-specific analyses. The report recommends that transportation planners and managers undertake detailed surveys of routes to identify potential hazards that could lead to or exacerbate extreme accidents involving long-duration, fully engulfing fires and take steps to avoid or mitigate the hazards. The report also recommends that the Nuclear Regulatory Commission conduct additional analyses to build on recent progress in understanding package performance in long-duration fires.

## Radiation Exposure

Transportation packages contain heavy shielding to protect workers and the public from the radiation emitted by the spent fuel or high-level waste. The packages are effective in shielding more than 99 percent of the emitted radiation, but a small amount of radiation, primarily gamma rays, can escape from the packages and expose workers and the public to small doses that are below the regulatory limits. Under routine transportation conditions, the workers responsible for loading, inspecting, and transporting the packages also may receive doses. In addition, individuals who travel, work, and live along the shipping routes may receive small doses of radiation when loaded packages are transported in the vicinity.

Figure 2 compares estimated radiation doses from a Yucca Mountain transportation program with doses received in the course of other daily activities. The report also estimates exposures for severe accident conditions and concludes that expected fatalities from exposure to severe accidents involving spent fuel are significantly lower than for exposure to severe accidents involving other types of hazardous materials.

## Managing Social Risks

Social risks can result in a variety of effects—for example, reduced property values along the transportation routes, declines in tourism, increased anxiety, or the stigmatization of people and places. The social risks pose important challenges to the successful implementation of programs for transporting spent fuel and high-level waste in the United States.

The committee recommends early and proactive steps to establish formal mechanisms for gathering high-quality, diverse advice about social risks and the ongoing management. The committee advises DOE to gather information about the social risks associated with the Yucca Mountain transport program:

1. Expand the membership and scope of the current advisory group to obtain outside advice on social risks; and
2. Establish a transportation risk advisory group to

PHOTO: DOE

South portal of the Exploratory Studies Facility, Yucca Mountain, Nevada.

provide guidance on characterizing, communicating, and mitigating the social, security, and health and safety risks that arise from the transport of spent fuel.

Although addressed to DOE, these recommendations apply to any large-quantity shipping program, including the program to ship commercial spent fuel to a central interim storage such as Private Fuel Storage, LLC, in Utah.

## Route Selection

One of the most controversial issues in the transport of spent fuel has been the selection of highway and rail routes. The report examines DOE's procedures to select rail and highway routes for transporting spent fuel from research reactors to its facilities. According to the report, the procedures appear adequate and reasonable—they are risk-informed; they use standard risk-assessment methodologies to identify a suite of potential routes; and they select final routes taking into account security, preferences of state and tribal governments, and information from states and tribes on local transport conditions.

The report recommends that DOE continue to ensure the systematic, effective involvement of states and tribal governments in decisions about the routing and scheduling of spent fuel shipments from research reactors. The U.S. Department of Transportation (DOT) should ensure that states support the designations of routes with sound risk assessments and that all potentially affected states are aware of and prepared to fulfill their responsibilities for the designated routes.

PHOTO: DOE

Tunnel into Yucca Mountain was excavated with 25-foot-diameter, laser-guided boring machine.

## Malevolent Acts

The report notes that malevolent acts against spent fuel and high-level waste shipments are a major technical and societal concern. The study committee does not provide an in-depth technical examination of transportation security because of information constraints. Instead, the committee recommends that an independent examination of the security of spent fuel and high-level waste transportation be carried out before the commencement of large-quantity shipments to a federal repository or to an interim storage. This examination should provide an integrated evaluation of the threat environment, the response of packages to credible malevolent acts, and the operational security requirements for protecting spent fuel and high-level waste during transport.

## Additional Recommendations

The report offers several other recommendations for improving DOE's program for transporting spent fuel and high-level waste; some are summarized below. Many of the recommendations would apply to the implementation of any large-quantity shipping programs in the United States:

- **Rail shipments and routing.** The report strongly endorses DOE's plan to ship spent fuel and high-level waste to a federal repository using a mostly rail option. The report recommends that DOE fully implement this option before commencing large-quantity shipments. DOE also should identify and make public its suite of preferred highway and rail routes for transporting spent fuel and high-level waste to a federal repository as soon as practicable to support state, tribal, and local planning, especially for emergency response.
- **Emergency response planning.** DOE should begin immediately to execute its emergency responder preparedness responsibilities, defined in Section 180(*c*) of the Nuclear Waste Policy Act.
- **Information sharing.** DOE, the Department of Homeland Security, U.S. DOT, and the Nuclear Regulatory Commission should develop, apply, and disclose consistent, reasonable, and understandable criteria for protecting sensitive information about the transport of spent nuclear fuel and high-level waste. These agencies also should commit to openly sharing information that does not require such protection and should facilitate timely access to that information.
- **Organizational structure.** The Secretary of Energy and the U.S. Congress should examine options for changing the organizational structure of DOE's program to improve the chances of its success.

# Eliminating Cross-Median Fatalities

## *Statewide Installation of Median Cable Barrier in Missouri*

BRIAN CHANDLER

*The author is Traffic Safety Engineer, Missouri Department of Transportation, Jefferson City.*

Missouri awarded the first contracts for highway construction under U.S. Interstate funding in 1956. The state boasts 17 Interstate highways, with Interstate 70 the most heavily traveled. I-70 is an east–west route connecting the state's two largest metropolitan areas, Kansas City and St. Louis. Construction of I-70 followed the standards of the day and has provided a safe and efficient freeway for 50 years.

### Problem

The 1950s standards that applied to the original Interstate roadways now must reckon with 80,000-pound commercial vehicles and hundreds of thousands of vehicles traveling at 70 miles per hour. Although the rural Interstate system is the safest in the nation in terms of crash rate, the high speeds and ever-increasing traffic volumes contribute to the loss of thousands of lives each year nationwide.

To combat this threat, safety professionals at the Missouri Department of Transportation (DOT) analyzed crash data to determine crash types and locations. A Missouri DOT internal report identified cross-median crashes on Interstates as a category to address, with hundreds of motorists endangered in the state each year.

Concern about cross-median crashes is increasing nationwide. Missouri researchers observed that as high-speed Interstate volumes increase, the likelihood of severe crashes also increases.

PHOTO: MISSOURI DOT

Cable median barrier prevented a truck from crossing a median into oncoming traffic.

Thirty years ago, a driver crossing the median had a good chance of crossing over the opposing lanes without conflict. Today, according to Missouri data, a motorist crossing the median is more likely to collide with another vehicle, and the chances are high that the opposing vehicle will be a large truck. Because several vehicles often are involved, traveling in opposite directions, the crashes cause multiple fatalities and disabling injuries.

## Solution

In the 1980s, Missouri DOT undertook a research project and literature search to improve safety by preventing cross-median crashes. Studies by other states and an internal study led Missouri DOT to consider median cable barriers as a solution (*1*). Median cable barriers have been in use for many years and had come into use in Missouri as early as the 1980s at spot locations. For long-distance installation on rural Interstates, the cable barrier is a more cost-effective safety device than a concrete barrier or a guard rail.

After researching various options, Missouri decided to install a median cable barrier system on I-70 and on other Missouri Interstates. When the cable is struck, the posts yield and the cable deflects up to 12 feet, effectively catching and decelerating the vehicle and keeping it in the median. This effect gives cable an advantage over more rigid systems, because the vehicle is less likely to reenter the driving lanes after striking the barrier.

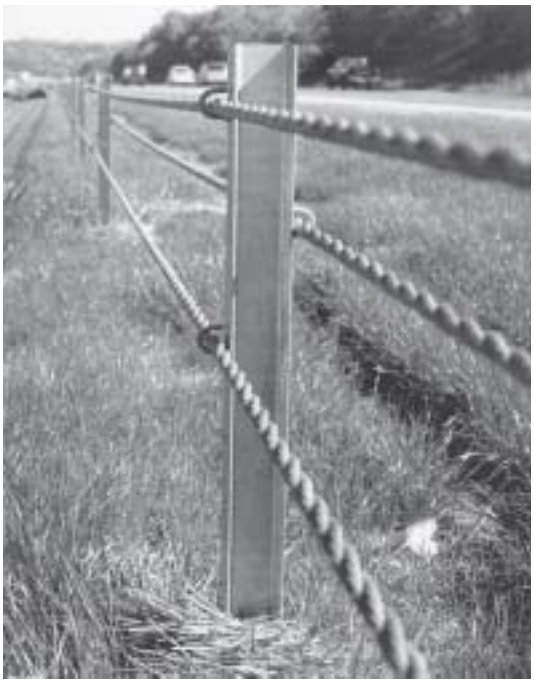

PHOTO: MISSOURI DOT

Closeup of guard cable median barrier installed on an Interstate median in Missouri.

Posts of a cable median barrier are designed to break away when struck; as tread marks indicate, this cable barrier in Washington State prevented the vehicle from crossing the median.

PHOTO: WASHINGTON STATE DOT

## Applications

Early installations of median cable barrier in Missouri were limited to locations that had a history of cross-median crashes. Typically these sites were near interchanges. This strategy, however, was limited in effectiveness, because a significant number of cross-median crashes occurred at locations without cable barriers.

With this experience, metropolitan districts in Kansas City and St. Louis began continuous installation of cable barriers on high-volume segments of Interstates 44, 70, and 435. The success of these early installations led Missouri DOT to begin a systemwide installation of median cable barriers in 2002. Traffic engineers studied crash history statewide to determine the best strategic use of available safety funds. The decision was made to start the program on the Interstate system, to address the routes with the highest traffic volumes and the highest number of cross-median severe crashes.

Additional internal crash analysis by Missouri DOT showed that Interstates with medians that were less than 60 feet wide were overrepresented in cross-median crashes. The medians on Interstate 70, which links Kansas City and St. Louis, and on Interstate 44, which links Springfield and St. Louis, are predominantly 40 feet wide. Missouri DOT proceeded to install cable barriers on all Interstates

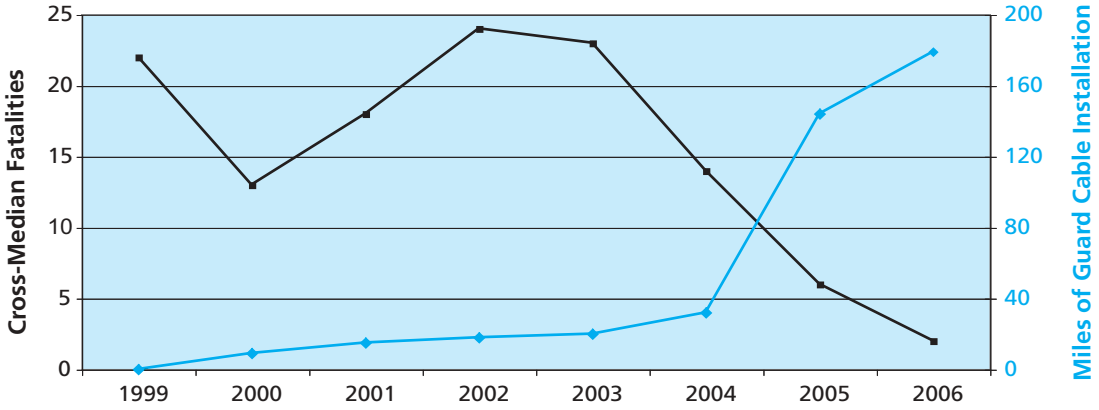


**FIGURE 1 Cross-median fatalities on I-70 in Missouri declined as more miles of cable median barrier were installed. Table below shows data.**

with median widths of less than 60 feet.

The installation of median cable barrier costs $60,000 to $100,000 per mile, depending on the amount of grading work required. After the cable is installed, the maintenance costs range from $6,000 to $10,000 per mile per year, depending on the frequency of hits.

With the improvements in safety from the median cable barriers on Interstate 70, Missouri has started installing the system on other Interstates with median widths less than 60 feet. The statewide installation of nearly 500 total miles of median cable barrier will be complete by the end of 2008.

Missouri DOT safety engineers will study other freeways and expressways to determine the effectiveness of additional cable barrier installations at locations that have wider medians and on non-Interstate routes.

## Benefits

Median cable barriers have performed successfully in Missouri. An internal study determined that the cable catches 95 percent of vehicles entering the median and keeps the vehicles from entering the opposing lanes (2).

On Interstate 70, the number of cross-median fatalities had been increasing, reaching a peak of 24 motorists killed in 2002. The installation of 179 miles of median cable barrier on the freeway has nearly eliminated cross-median roadway deaths. In 2006, only two cross-median fatalities occurred on Interstate 70, a staggering 92 percent decrease. Missouri DOT is completing a study of property damage and personal injury related to vehicle crashes into median cable barriers.

The benefits of median cable barriers in Missouri were quickly apparent. The device has saved lives after a short period of use on Missouri's Interstates; cable barriers have proved to be a valuable safety engineering tool in reducing fatalities and serious injuries on the state's most heavily traveled roads.

| Year | Miles Installed | Accumulative Miles Guard Cable Installed | Cross-Median Fatalities |
|---|---|---|---|
| 1999 | 0 | 0 | 22 |
| 2000 | 9 | 9 | 13 |
| 2001 | 6 | 15 | 18 |
| 2002 | 3 | 18 | 24 |
| 2003 | 2 | 20 | 23 |
| 2004 | 12 | 32 | 14 |
| 2005 | 112 | 144 | 6 |
| 2006 | 35 | 179 | 2 |

*For more information contact Brian Chandler, Missouri DOT, Traffic Division, P.O. Box 270, Jefferson City, MO 65102, phone 573-751-5678, fax 573-634-5977, e-mail Brian.Chandler@modot.mo.gov.*

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2. *Study on Median Guard Cable Performance in Relation with Median Slope: Preliminary Results on I-44.* Missouri Department of Transportation, Jefferson City.

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

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

# Susan Handy

*University of California, Davis*

The relationship between transportation and land use, the impact of land use on travel behavior, and the impact of transportation investments on land development patterns are the focus of studies by transportation researcher and professor Susan Handy.

For the past two decades, Handy's research has focused on developing strategies to enhance accessibility and to reduce dependence on the automobile in everyday life. Although the automobile has brought people the freedom to go where they want, when they want, Handy maintains that, after a century of U.S. policy aimed at making it easier to drive, transportation planners should focus on structuring communities to reduce the need to drive.

Handy's research on the connection between neighborhood design and walking behavior has attracted the attention of persons in the field of public health. "Creating environments that support walking and biking helps to increase physical activity and can be an effective tool in the fight against rising levels of obesity in the United States," she notes.

**"Training students to be better researchers is essential for developing a better understanding of transportation problems, as well as improved solutions to those problems."**

Handy believes that research must be used to address U.S. transportation needs, while also balancing economic, environmental, and societal costs. As a professor in the department of Environmental Science and Policy at the University of California (UC), Davis, she tries to expand students' perspectives on transportation, instill skepticism toward traditional problem-solving approaches, and encourage innovative, original thinking.

"I want to inspire students," Handy explains. "Training students to be better researchers is essential for developing a better understanding of transportation problems, as well as improved solutions to those problems."

In addition to her professorship, Handy is director of the new UC Davis University Transportation Center (UTC). Funded by the U.S. Department of Transportation (DOT) and California DOT, the center supports domestic graduate student fellowships and dissertations, faculty projects that employ graduate student researchers, and technology transfer activities. Handy worked with a group of key transportation researchers at UC Davis to launch the center.

"The theme of our center is sustainable transportation," Handy notes. "Our programs take an interdisciplinary approach to address this theme, and our activities integrate research, education, and outreach. Sustainability will be one of the most critical issues for all modes of transportation in the 21st century."

Although the UTC addresses all aspects of transportation sustainability, the primary focus is on surface transportation and on the environmental effects of transportation. Research and education activities target broad topics such as behavior, infrastructure, land use, energy, and ecology. The center emphasizes cross-disciplinary education and research, building on the success of the Transportation Technology and Policy program at UC Davis. The UTC is slated to receive approximately $500,000 annually in federal funding, to be matched at the same level by the state for four years.

Handy's research activities have led to many professional and advisory committee appointments. She has served on the National Advisory Committee of the Active Living by Design Program for the Robert Wood Johnson Foundation; on the jury for the Transbay Transit Center Design Competition, San Francisco; and on the National Academies' Committee for the Institute of Medicine's study of the Prevention of Obesity in Children and Youth.

Handy's involvement in TRB began in 1997, and her contributions include chairing the Standing Committee on Telecommunications and Travel Behavior and the Transit Cooperative Research Program Project Panel on Integrated Urban Models for Simulation of Transit and Land Use Policies. She is a member of the Women's Issues in Transportation Committee, the Transportation and Land Development Committee, and the Planning Committee for the Conference on Innovations in Travel Demand Modeling.

An author or coauthor of many articles, research papers, and book chapters, Handy has published in the *Journal of the American Planning Association*, *International Regional Science Review*, *New Telecom Quarterly*, the *Journal of Urban Planning and Development*, the *American Journal of Health Promotion*, the *Handbook of Obesity Prevention*, the *Journal of Transportation and Statistics*, and the *Berkeley Planning Journal*.

Handy earned a bachelor's degree in science and engineering from Princeton University in 1984, a master's degree in resource planning and civil engineering from Stanford University in 1987, and a doctorate in philosophy from the University of California at Berkeley in 1992.

Balancing research, teaching, and administrative responsibilities is a constant challenge for Handy, who has two school-age children at home. "It's not easy, but it's worth it," she says. "I can't say no to the interesting opportunities that keep coming my way, particularly if I think I can make a difference."

# Roger M. Larson

*Applied Pavement Technology, Inc.*

A senior engineer with Applied Pavement Technology, Inc. (APTech), Urbana, Illinois, Roger Larson is nationally and internationally recognized for his career work in concrete pavement design, performance, construction, and rehabilitation.

Before joining APTech in 2002, Larson spent more than 40 years with the Federal Highway Administration (FHWA), on projects involving highway research, planning, design, construction, and maintenance. His accomplishments at the highway agency include an update to FHWA general pavement design policy and the development of programs to implement the Strategic Highway Research Program (SHRP), asphalt and concrete pavement research, and the Long-Term Pavement Performance (LTPP) program. In addition, he managed the technical development of many National Highway Institute pavement design, construction, maintenance, and rehabilitation training courses.

**"There is a critical need to focus on safer roads and improvement of poor pavement surface conditions."**

In 1989, Larson promoted the retrofit of load-transfer devices in concrete pavements, implementing FHWA research findings. His efforts resulted in the industry development of equipment to saw multiple slots for retrofitted, dowel-bar installations in concrete pavement rehabilitation. The equipment was tested in Washington State's 1993–1994 dowel-bar retrofit of truck lanes on I-90, east of Seattle, proving the cost-effectiveness of the multiple slot-cutting technique.

The pavement rehabilitation savings in Washington State were approximately $40,000 per kilometer of 2-lane roadway. With the success of the technique, other equipment manufacturers have brought multiple-slot machines to the market, and the technique is now used in more than 25 states and in several other countries.

Throughout his career, Larson has advocated for highway safety. He encourages transportation professionals to take a proactive role in reducing the number of deaths and serious injuries on U.S. highways.

"There is a critical need to focus on safer roads and improvement of poor pavement surface conditions," Larson explains. "According to recent reports, the total road deaths in the United States during the period of 1970 to 2004 decreased by only 19 percent, compared with 59 percent in Western Europe. Clearly, U.S. transportation professionals need to do more to reduce the annual number of deaths and serious injuries."

Larson is serving as principal investigator on an Ohio Department of Transportation research project to evaluate the relationship between pavement surface–tire friction and wet-weather accident rates at 90 signalized and unsignalized intersections and congested freeway segments in Ohio.

"This type of documentation is critically lacking," Larson points out. "Most of the emphasis in U.S. surface–tire skid resistance testing is on a single minimum friction number that is known to be inadequate at locations with high friction demands, such as intersections, curves, and steep grades."

Larson also has made significant contributions to the study of tire–pavement noise and to pavement texturing. During his time at FHWA, he campaigned for the use of effective pavement surface texturing techniques to improve surface friction and reduce tire noise. He coauthored a technical report on pavement–tire noise and safety, and worked to integrate pavement surface texture and noise considerations into the pavement design process.

In his TRB activities, Larson works to increase the visibility of highway safety and pavement research. He participated in the Strategic Highway Research Program II research safety meeting, and he serves as a peer reviewer for research papers submitted to the TRB Annual Meeting. He is the liaison representative on the National Cooperative Highway Research Program (NCHRP) Project Panel on Performance of Subsurface Pavement Drainage and has been a member of the NCHRP project panels on Development of the 2002 Guide for the Design of New and Rehabilitated Pavement Structures, Strategies for Rehabilitating Rigid Pavements Subjected to High-Traffic Volumes, and Evaluation of Unbonded Portland Cement Concrete Overlays. He also has served on many NCHRP Synthesis of Highway Practice panels, and on technical committees on Rigid Pavement Design and on Pavement Rehabilitation.

A registered professional engineer, Larson is a member of the American Society of Civil Engineers, the National Society of Professional Engineers, and the American Concrete Institute. In 2002, he received a Distinguished Engineer Award from South Dakota University. He earned a bachelor's degree in civil engineering from South Dakota State University in 1961 and a master's degree in civil engineering from the University of Minnesota in 1966.

# CALENDAR

## TRB Meetings 2007

### April

17–18 18th Biennial Symposium on Visibility and Traffic Control Devices
College Station, Texas

25–26 National Summit on Agricultural and Food Truck Transport for the Future*
Washington, D.C.

### May

2 Traffic Monitoring Data
Washington, D.C.

6–9 11th National Transportation Planning Applications Conference
Daytona Beach, Florida

6–9 National Conference on Pavement Management*
Norfolk, Virginia
*Stephen Maher*

9–11 9th Annual Harbor Safety Committee Conference*
Chicago, Illinois

15 North American Freight Transportation Data Workshop
Washington, D.C.
*Thomas Palmerlee*

20–23 Freeway and Tolling Operations in the Americas
Houston, Texas

### June

3–8 1st North American Landslide Conference*
Vail, Colorado

18–21 11th International Conference on Mobility and Transport for Elderly and Disabled People: TRANSED 2007*
Montreal, Quebec, Canada

24–27 9th International Conference on Low-Volume Roads
Austin, Texas

24–27 3rd Urban Street Symposium
Seattle, Washington

### July

TBD Transforming Transportation Organizations: Tools and Techniques for Organizational Development
Chicago, Illinois
*Martine Micozzi*

7–9 TRB 2007 Summer Conference
Chicago, Illinois

8–11 46th Annual Workshop on Transportation Law
Philadelphia, Pennsylvania
*James McDaniel*

9–11 2007 Transportation Planning and Air Quality Conference*
Orlando, Florida

9–12 4th International Driving Symposium on Human Factors in Driver Assessment, Training, and Vehicle Design*
Stevenson, Washington
*Richard Pain*

10 Meeting Freight Data Challenges
Chicago, Illinois
*Thomas Palmerlee*

16–18 Water Resources and the Highway Environment: Impacts and Solutions
Sanibel Island, Florida

22–24 2007 International Conference of Transportation Engineering*
Chengdu, China
*Thomas Palmerlee*

### August

8–10 5th International Conference on Maintenance and Rehabilitation of Pavements and Technological Control*
Park City, Utah

26–28 Meaningful Transit Input into Transportation Planning and Land Use: Best Practices
Denver, Colorado

### September

10–12 3rd National–1st International Conference on Performance Measurement
Irvine, California
*Martine Micozzi*

25–27 8th International Symposium on Cold Region Development: ISCORD 2007*
Tampere, Finland

### October

22–23 Research Issues in Freight Transportation: Congestion and System Performance
Washington, D.C.
*Thomas Palmerlee*

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.

**TRANSIT IDEAS**—Among the participants discussing the evaluation and selection of proposals at the Transit IDEA panel meeting, December 19, in Washington, D.C., were (*clockwise from left:*) panel member Pamela McCombe, Greater Cleveland Regional Transit Authority; John "Bruce" Louryk, U.S. Department of Homeland Security; Henry Nejako, Federal Transit Administration; and panel chair Fred Gilliam, Capital Metropolitan Transportation Authority, Austin, Texas. In addition to evaluating and selecting proposals, the panel heard presentations and discussed a completed Transit IDEA project designed to improve wheelchair accommodation on bus rapid transit and an active Transit IDEA project designed to improve safety and efficiency on commuter rail.

Funded by the Federal Transit Administration as part of the Transit Cooperative Research Program, the Transit IDEA Program promotes innovative approaches to improving the efficiency, safety, security, and ridership of transit systems by supporting applied research and prototype testing.

*For further information, visit the IDEA website at www.trb.org/idea.*

**RESEARCH BRIEFING**—Federal Highway Administration (FHWA) staff member John Bukowski briefs TRB's Research and Technology Coordinating Committee (RTCC) in November on the infrastructure research programs authorized in the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users. Pictured are (*seated, from background*) Gary Henderson, FHWA; Dennis Judycki, FHWA; Kevin Womack, RTCC; Arthur Dinitz; Frances Banerjee; and Paul Wells.

**FOSTERING DIALOG**—Gene Griffin, North Dakota State University, speaks at the Research Initiatives in Radio Frequency Identification (RFID) Transportation Applications Conference. The conference, held at the National Academies' Keck Center in October, brought together university researchers, government transportation professionals, and RFID industry representatives to assess the latest research in applications of RFID technologies in transportation.

## COOPERATIVE RESEARCH PROGRAMS NEWS

### Pavement Condition and Vehicle Operating Costs

Highway agencies must consider vehicle operating costs when evaluating pavement investment strategies. For conventional vehicles, operating costs include fuel and oil consumption, tire wear, repair and maintenance, and depreciation. Operating costs depend on the vehicle class and are influenced by vehicle technology, pavement surface type, pavement condition, roadway geometrics, environment, speed of operation, and other factors.

Although a large body of research addresses the effects of pavement condition on vehicle operating costs and on models to estimate these effects, much of this research is outdated and has been conducted in countries with vehicle fleets and roadways that differ from those in the United States.

This raises a need to review information and to develop models applicable to emerging vehicle technology, to traffic, and to environmental conditions in the United States. Such models will provide highway agencies with the tools necessary for considering vehicle operating costs in evaluating pavement investment strategies and in identifying options that yield economic and other benefits.

Michigan State University has been awarded a $500,000, 36-month contract [National Cooperative Highway Research Program Project 1-45, FY 2006] to recommend models for estimating the effects of pavement condition on vehicle operating costs. These models will represent the current vehicle technology in the United States and will be adaptable to emerging vehicle technology.

*For further information, contact Amir N. Hanna, TRB, 202-334-1892, ahanna@nas.edu.*

## Vehicle Crash Test Reforms Proposed

The federal government is working to reform its automobile crash tests and strengthen its five-star vehicle safety rating system under a plan recently unveiled by U.S. Transportation Secretary Mary E. Peters. Changes to the 27-year-old New Car Assessment Program (NCAP) will include more rigorous standards for frontal, side-impact, and rollover crash tests.

The proposal will upgrade frontal-impact test standards to rate vehicles on protection from upper-leg injuries and will revise side-impact test standards to address protection by side airbags against vehicle occupant chest and head injuries.

Also included in the proposal are short- and long-term strategies to improve vehicle safety and to provide more detailed and useful information to aid consumers. Under consideration are ratings for high-tech crash avoidance systems such as electronic stability control, adaptive cruise control, and lane departure warning systems. In September the National Highway Traffic Safety Administration proposed including electronic stability control on all new vehicles sold in the United States starting with the 2012 model year.

*For more information, visit www.dot.gov/affairs/dot0507.htm.*

## Research Aids Assessment of Landslide Risk

BY LOREN TURNER

Researchers at the California Geological Survey (CGS), under the supervision of the California Department of Transportation (Caltrans) Geo Research Group in the Division of Research and Innovation, have developed a standard methodology for integrated archive and display of landslide hazards along highway corridors to aid in risk assessment. Work on the project began in December 1999, and was completed in June 2006.

The project team delivered a variety of mapping products that identify the location and severity of landslide threats along selected highway corridors. User guidelines and region-specific mitigation strategies were developed for a variety of geologic, climatological, and environmental conditions. The resulting maps and guidelines provide planners, designers, and responders with a readily accessible and fully synthesized resource that summarizes the geologic setting of a corridor from a broad perspective.

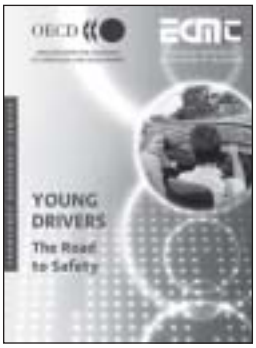
The Geo Research Group ensured that the CGS work met Caltrans' user needs by establishing a project advisory panel of Caltrans geoprofessionals and district representatives. The advisory panel guided the project by assembling a list of more than 1,200 miles of slide-prone highway corridors and aided in prioritizing 187 route miles along seven corridors in five districts for mapping. Criteria included route importance, diversity of districts, and consideration of a representative variety of geologic and climatological environments.

California and other states along the Pacific Coast, the Rocky Mountains, and the Appalachian Mountains regularly incur high costs from landslides. Each year, hundreds of landslides affect public safety, trip quality, and the reliability and maintenance costs of the transportation network. Caltrans expends approximately $22 million annually in managing landslides. By reducing the need for future extensive geologic information-gathering efforts and landslide cleanup and reconstruction efforts, researchers estimate an annual cost savings of approximately $3 million.

*Turner is with the Geo Research Group, Division of Research and Innovation, California Department of Transportation.*

California Department of Transportation employees participate in cleanup and reconstruction efforts after rubble from a Confusion Hill landslide blocks U.S. Route 101 in Mendocino County.

***Young Drivers: The Road to Safety***
*OECD and ECMT Transportation Research Center, 2006; 216 pp.; $94; 92-821-1334-5.*
Traffic safety researchers working in member countries of the Organization for Economic Cooperation and Development (OECD) and the European Conference of Ministers of Transport (ECMT) have produced a report on the high levels of risk associated with young and novice drivers of passenger vehicles. Among the findings is the over-representation of young drivers—particularly, of young male drivers—in crashes and road fatalities across OECD countries. Key elements of young driver risk are investigated, including age, inexperience, excessive speeding, nighttime driving, driving while intoxicated, and lax seatbelt use, as well as contributing factors and appropriate countermeasures.




***Standard Specifications for Transportation Materials and Methods of Sampling and Testing, 26th Edition***
*American Association of State Highway and Transportation Officials, 2006; 4,316 pp.; $192; 15-605-1344-6.*
This four-volume book is divided into two parts and contains a total of 415 materials specifications, standards, and test methods for use in the construction of highways and highway facilities. The specifications have been developed and maintained by state departments of transportation through participation in the Subcommittee on Materials of the American Association of State Highway and Transportation Officials (AASHTO).


Part I: Specifications contains 165 materials specifications and 36 recommended practices, including 60 standards revised since the 2005 edition. Part II: Tests contains 214 test methods and equipment standards, with 38 standards incorporating technical revisions since the previous edition. A companion publication, *AASHTO Provisional Standards*, 2006 edition, includes an additional 41 provisional standards.

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

## TRB PUBLICATIONS

***Simplified Shear Design of Structural Concrete Members***
**NCHRP Report 549**
Findings are presented from research to develop practical equations for design of shear reinforcement in reinforced and prestressed concrete bridge girders. Recommended specifications, commentary, and examples illustrating application of the specifications also are included. The material in this report is of immediate interest to bridge designers.

*2005; 54 pp.; TRB affiliates, $15; nonaffiliates, $20. Subscriber category: bridges, other structures, hydraulics and hydrology (IIC).*

***Performance Measures and Targets for Transportation Asset Management***
**NCHRP Report 551**
This report provides the state of the practice on the use of performance measures in transportation asset management and identifies and sets target values for performance measures. The contributing research not only assessed the usefulness of technical performance measures in trade-off analyses and investment decisions, but also developed performance measures for security, social, environmental, and economic issues.

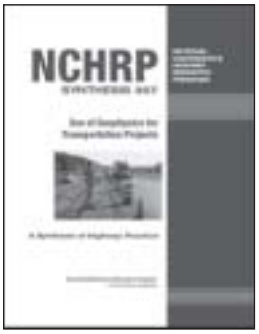
*2006; 159 pp.; TRB affiliates, $31.50; nonaffiliates, $42. Subscriber categories: planning and administration (IA); pavement design, management, and performance (IIB); maintenance (IIIC).*


***Guidelines for Analysis of Investments in Bicycle Facilities***
**NCHRP Report 552**
Methodologies and tools to estimate the cost of various bicycle facilities and to evaluate their potential value and benefits are described to help transportation planners make effective decisions about integrating bicycle facilities into transportation plans project by project.

*2006; 110 pp.; TRB affiliates, $27; nonaffiliates, $36. Subscriber categories: planning and administration (IA); highway and facility design (IIA).*

***Crashworthy Work-Zone Traffic Control Devices***
**NCHRP Report 553**
Presented are findings from a research project to develop nonproprietary, crashworthy work-zone

## TRB PUBLICATIONS *(continued)*




traffic control devices constructed of readily available material. The project yielded designs and successful crash tests for two Type III barricades with attached sign panel; three low-mounting-height, portable sign supports, and a high-mounting-height, portable sign support. Along with detailed drawings and specifications for the successfully crash-tested systems, the report traces out other design concepts for future consideration and testing.

*2006; 119 pp.; TRB affiliates, $27; nonaffiliates, $36. Subscriber category: highway operations, capacity, and traffic control (IVA).*

***Aesthetic Concrete Barrier Design***
**NCHRP Report 554**
Aesthetic treatments for concrete safety shape barriers are the subject of the information and design guidelines in this report. For the convenience of aesthetic designers, guidelines previously developed by the Federal Highway Administration for stone masonry guardrails and by Caltrans for single-slope and vertical-face concrete barriers are also included.

*2006; 77 pp.; TRB affiliates, $25.50; nonaffiliates, $34. Subscriber category: highway and facility design (IIA).*

***Design and Construction Guidelines for Geosynthetic-Reinforced Soil Bridge Abutments with a Flexible Facing***
**NCHRP Report 556**
A rational design method and construction guidelines for using geosynthetic-reinforced soil systems in bridge abutments are developed and described, including an extensive literature review, full-scale experiments, and an analytic study. The report also documents examples illustrating the design computation procedure.

*2006; 142 pp.; TRB affiliates, $18.75; nonaffiliates, $25. Subscriber categories: highway and facility design (IIA); bridges, other structures, and hydraulics and hydrology (IIC); soils, geology, and foundations (IIIA).*

***Aggregate Tests for Hot-Mix Asphalt Mixtures Used in Pavements***
**NCHRP Report 557**
This report examines performance-based procedures to test aggregates for use in pavements with hot-mix asphalt mixtures. Guidance is provided for using these procedures to evaluate and select aggregates for specific mixture applications.

*2006; 38 pp.; TRB affiliates, $22.50; nonaffiliates, $30. Subscriber categories: pavement design, management, and performance (IIB); materials and construction (IIIB).*

***Communicating Changes in Horizontal Alignment***
**NCHRP Report 559**
Guidelines are developed for the use of traffic control devices to communicate changes in horizontal alignment for two-lane, two-way rural roads. The recommendations include three changes to the *Manual on Uniform Traffic Control Devices,* along with topics for additional research into (*a*) the development of a system for assessing the need for different traffic control devices at specific locations and (*b*) motorist reaction to changes in advisory speeds.

*2006; 35 pp.; TRB affiliates, $22.50; nonaffiliates, $30. Subscriber category: highway operations, capacity, and traffic control (IVA).*

***Guide to Contracting ITS Projects***
**NCHRP Report 560**
Guidance is offered on the procurement of intelligent transportation systems (ITS), including hardware and software encompassing applications of advanced electronics and information management to regulate and facilitate traffic flow. This guide recommends contracting strategies and contract types, terms, and conditions for ITS development, integration, system acceptance, warranty, maintenance, and upgrades.

*2006; 37 pp.; TRB affiliates, $22.50; nonaffiliates, $30. Subscriber category: highway operations, capacity, and traffic control (IVA).*

***Best-Value Procurement Methods for Highway Construction Projects***
**NCHRP Report 561**
Proposed procurement methods, award algorithms, and rating systems are described for awarding best-value highway construction contracts. Screening criteria for selecting projects for best-value procurement, implementation strategies, and a model best value specification are also included.

*2006; 192 pp.; TRB affiliates, $33.75; nonaffiliates, $45. Subscriber categories: transportation law (IC); highway and facility design (IIA); materials and construction (IIIB).*

***Use of Geophysics for Transportation Projects***
**NCHRP Synthesis 357**
Who is using geophysics and why, which methods and applications are most common, how the in-house expertise compares with that of private con-

## TRB PUBLICATIONS *(continued)*

sultants, and how geophysical service contracts are procured and implemented for transportation projects are addressed in this report. The scope was limited to geophysical applications by geotechnical engineers during highway planning and construction.

*2006; 108 pp.; TRB affiliates, $27; nonaffiliates, $36. Subscriber category: soils, geology, and foundations (IIIA).*

***Statewide Travel Forecasting Models***
**NCHRP Synthesis 358**
Statewide travel forecasting models that address planning needs and provide forecasts for statewide transportation, including passenger vehicle and freight movements, are examined. The synthesis explores the types and purposes of models in use, the integration of state and urban models, data requirements, computer needs, resources—including time, funding, training, and staff—limitations, and benefits. Five case studies are included—two that focus on passenger components, two on freight components, and one on both passengers and freight.

*2006; 116 pp.; TRB affiliates, $27; nonaffiliates, $36. Subscriber category: planning and administration (IA).*

***Public Transportation Security: Security Measures for Ferry Systems***
**TCRP Report 86, Volume 11**
This volume is designed to assist U.S. ferry system operators in evaluating and selecting general security measures (GSM) for their operations consistent with the National Incident Management System. A seven-step GSM evaluation process is included, plus a description of the characteristics of the U.S. ferry system, to enhance the understanding, the effective adoption, and the implementation of security measures.

*2006; 62 pp.; TRB affiliates, $24; nonaffiliates, $32. Subscriber categories: planning and administration (IA); public transit (VI); marine transportation (IX); security (X).*

***Using Archived AVL-APC Data to Improve Transit Performance and Management***
**TCRP Report 113**
Guidance is provided on analyzing automatic vehicle location–automatic passenger counter (AVL-APC) data to improve management and performance; AVL-APC system design to capture data with accuracy and detail for off-line analysis; data structures and analysis software for analyzing of AVL-APC data; screening, parsing, and balancing automatic passenger counts; and use of APC systems for estimating passenger miles for National Transit Database reporting.

*2006; 83 pp.; TRB affiliates, $25.50; nonaffiliates, $34. Subscriber category: public transit (VI).*

***Transit Agency Participation in Medicaid Transportation Programs***
**TCRP Synthesis 65**
This synthesis documents and summarizes the tasks necessary for a successful partnership of public transit nonemergency medical transportation (NEMT). Real and perceived barriers to NEMT and public transit coordination are examined. Case studies detail transit agency experience partnering in the Medicaid transportation program.

*2006; 48 pp.; TRB affiliates, $23.25; nonaffiliates, $31. Subscriber category: public transit (VI).*

***Alternative Truck and Bus Inspection Strategies***
**CTBSSP Synthesis 10**
Various alternative inspection strategies used by law enforcement agencies are identified, described, and characterized for commercial trucks and buses. This synthesis examines the effectiveness of the inspection strategies, documenting the benefits—such as reduced costs and improved resource allocation.

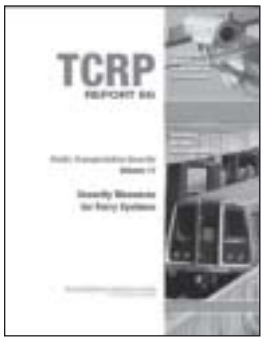
*2006; 43 pp.; TRB affiliates, $31; nonaffiliates, $23.25. Subscriber categories: operations and safety (IV); public transit (VI); freight transportation (VIII).*

***Human Performance: Simulation and Visualization***
**Transportation Research Record 1937**
Research reports include findings from studies of drivers' eye glance patterns before lane changes are made in straight-ahead driving, episodes of driver drowsiness and associated factors observed from video data, video advertising signs as driver distractions, and the design of simulators to test the performance of drivers with vision impairments.

*2005; 166 pp.; TRB affiliates, $39.75; nonaffiliates, $53. Subscriber category: safety and human performance (IVB).*

***Security***
**Transportation Research Record 1938**
Security issues include the use of biometric technologies to identify individuals at transportation facilities and border crossings, advanced vehicle identification technologies, and risk assessment methods for transportation management centers.

*2005; 44 pp.; TRB affiliates, $29.25; nonaffiliates, $39. Subscriber category: security (X).*






## TRB PUBLICATIONS *(continued)*


***Bicycles and Pedestrians; Developing Countries 2005***
**Transportation Research Record 1939**
The influence of pavement markings on the distance between bicyclists and parked cars, the characteristics of successful push-button–integrated accessible pedestrian signals, the design of a survey about shared-use path safety, and the development of an international vehicle emissions model are among the studies described.

*2005; 191 pp.; TRB affiliates, $41.25; nonaffiliates, $55. Subscriber category: safety and human performance (IVB).*

***Pavement Management; Monitoring, Evaluation, and Data Storage; and Accelerated Testing 2005***
**Transportation Research Record 1940**
How five states apply pavement management system data to monitor the performance of pavements under warranty is among the subjects in this volume. In other papers, authors address the development of customer-based standards for ride quality, report on ultrasonic technology to evaluate top-down cracks in asphalt pavement, and examine findings from accelerated fatigue tests on full-scale concrete slabs under constant cyclic loading.

*2005; 155 pp.; TRB affiliates, $39.75; nonaffiliates, $53. Subscriber category: pavement design, management, and performance (IIB).*

***Energy and Environmental Concerns 2005***
**Transportation Research Record 1941**
Authors examine how light-duty-vehicle efficiency improvements since 1975 relate to fuel consumption, quantify the emission effects of toll facilities, and measure public acceptance of hydrogen fuel. The 2005 Pyke Johnson Award paper, included in this volume, describes the development of speed–acceleration matrices in transit bus emissions modeling.

*2005; 190 pp.; TRB affiliates, $41.25; nonaffiliates, $55. Subscriber category: energy and environment (IB).*

***Security 2006***
**Transportation Research Record 1942**
This selection of papers covers transportation security-related topics, including emergency evacuation of densely-populated, urban areas and the response of transportation systems; the impact of security perception on intercity mode choice; trade-offs between security and inspection capacity at land border ports of entry; activity-based approaches for homeland security applications; air cargo security regulations; and a survey of employee security awareness and alertness training programs at state departments of transportation.

*2006; 51 pp.; TRB affiliates, $30.75; nonaffiliates, $41. Subscriber category: security (X).*

***Railways***
**Transportation Research Record 1943**
Authors assess diverse railway topics, including marginal cost pricing of railway infrastructure, operation, maintenance, and renewal in Sweden; the probability of exposure of various soil types to hazardous material spills from trains; the effects of high-speed rail service on shares of intercity passenger ridership in South Korea; earthquake early warning systems for railways; performance-based regulations for the development and use of microprocessor-based signal and train control systems; improvements in ballasted track design for high-speed rail; nondestructive testing methods for condition assessment of railway bridges; and more.

*2006; 73 pp.; TRB affiliates, $33; nonaffiliates, $44. Subscriber category: rail (VII).*

***Intelligent Transportation Systems and Vehicle–Highway Automation, 2006***
**Transportation Research Record 1944**
Studies presented in this volume include an evaluation of collision warning–collision avoidance systems; the effects of information delay on the performance of intelligent vehicle control systems; an advanced traveler information system for users of metropolitan expressways in Shanghai, China; a mobile commerce system to pay for on-and-off street parking via cell phone; a mode-based approach for extracting roadway background images from traffic video streams; and use of archived traffic data compiled via probe-equipped vehicles to determine path choice, travel time, and compliance.

*2006; 114 pp.; TRB affiliates, $36; nonaffiliates, $48. Subscriber category: highway operations, capacity, and traffic control (IVA).*

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

## INFORMATION FOR CONTRIBUTORS TO

# TR NEWS

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

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

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

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

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

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

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

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

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

- All manuscripts should be supplied in 12-point type, double-spaced, in Microsoft Word 6.0 or WordPerfect 6.1 or higher versions, on a diskette or as an e-mail attachment.
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# Commuting in America III

## *The Third National Report on Commuting Patterns and Trends*

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The report explores

- Population and worker trends,
- The demographics of a changing population and households,
- Vehicle availability,
- Modal use,
- Travel times,
- Congestion, and
- Work locations.

*Commuting in America III* identifies important trends associated with single-occupant vehicle use, carpooling and transit use, automobile ownership among African-Americans, the role of immigrants, mode changes, the length of commutes, travel flow, the impact of working from home, early commutes, multicounty commutes, and more.

*Commuting in America III* is a must-have reference for the transportation community—for academics, practitioners, and decision makers—for all who need to understand how public policies and commuter behavior have affected or may affect commuting patterns.

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