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Zero Fatalities
Freight Scans
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U.S. Department of Transportation

Federal Highway Administration

Public Roads

—featuring developments in Federal highway policies, programs, and research and technology—

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Front cover—Transportation projects on Federal lands often pose construction challenges, such as boring this tunnel road through mountainous terrain in Utah's Zion National Park. The Federal Lands Highway Program (FLHP) helps agencies that oversee Federal lands deploy innovative technologies in roads, bridges, and other infrastructure that provide access to these lands, fit seamlessly with the natural environment, and meet rigorous standards for safety and performance. For more on the FLHP, see "Deploying Technology in Challenging Terrain" on page 24 in this issue of PUBLIC ROADS. *Photo: Shutterstock.*

Back cover—Local and tribal agencies maintain more than 4.8 million kilometers (3 million miles) of roadway in the United States. Local and Tribal Technical Assistance Program (LTAP/TTAP) centers across the country provide timely and relevant training, technical assistance, and resources to help these agencies safely and cost effectively maintain roads like this one near Los Angeles. For more about LTAP/TTAP centers, see "LTAP/TTAP: 25 Years of Service" on page 8 of this issue of PUBLIC ROADS.

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Guest Editorial

New Era for Highways Demands New Financing

For nearly a year, Americans have been driving less and, as a result, buying less gasoline and diesel. Although this shift benefits the environment and U.S. energy security, it raises challenges for meeting the investment requirements of the Nation's transportation system. The Federal Highway Trust Fund, a primary source of funding for the U.S. transportation industry, is supported primarily by motor fuel taxes. The trust fund's financial health, therefore, depends on increasing fuel consumption. As Americans purchase less fuel, the fund's revenues are declining. At the same time, the costs of highway construction materials and labor have spiked, leading to a shortfall in States' abilities to fund highway improvements.

This issue of PUBLIC ROADS features an article about the impacts of reduced fuel consumption on the transportation system in Texas. In "Higher Gas Efficiency Equals Lower Fuel Revenues," the author reports on a recent study by the Texas Department of Transportation that supports the need for new approaches to funding critical infrastructure.

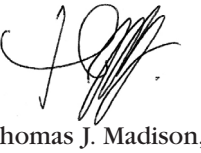
The sustainability of the current funding system has been in question for years; however, little has been done to address the problem. Recently, the U.S. Congress passed a last-minute measure to add general revenues to the Highway Trust Fund so the Federal Highway Administration could continue to reimburse States for Federal-aid construction costs. This solution will work for the short term, but a viable long-term funding solution is needed.

The path away from motor fuel taxes includes numerous options. One option being explored by several States is public-private partnerships (PPPs), an innovative strategy to finance new transportation corridors by allocating responsibilities to the parties—public or private—best positioned to produce the desired results. PPPs tap new sources of private capital and can result in transportation projects being completed faster, with greater savings and improved system performance.

Another option is high occupancy toll (HOT) lanes, which address the need for transportation funding *and* congestion reduction. HOT lanes are a proven way to generate revenue needed to build and maintain roads, while easing congestion by providing motorists with more travel choices. Studies show that many drivers during rush hour are not going to or from work and could drive at a different time. HOT lanes encourage these drivers to use the road during offpeak times to reduce congestion.

These are only two of the many funding solutions available. Although the transportation community does not know which of them will play the greatest role in the future of highway finance, the current means of financing highways is not sustainable. But one factor is a given: traffic congestion will continue to grow and become increasingly unmanageable unless new approaches are taken.

As the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users expires in 2009, it heralds the beginning of the end of conventional highway financing. The next surface transportation authorization must provide greater flexibility to States to utilize sustainable revenue sources that will increase mobility and enhance economic productivity.



Thomas J. Madison, Jr.
Administrator
Federal Highway Administration

The Quest For Zero Fatalities

by Summer Clarke

A comprehensive program aims to eliminate deaths on Utah's roadways.

According to the World Health Organization, globally motor vehicle crashes kill 1.2 million people every year and injure or disable as many as 50 million more. Crashes are the second leading cause of death among people ages 5 to 29 years old and the third leading cause of death among people 30 to 44 years old.

For decades, countries around the world have taken steps to improve traffic safety, but only recently have they begun to act on the idea that traffic fatalities can be eliminated altogether. Vision Zero, developed in 1997 by public health researchers in Sweden, was the first program based on the principle that, theoretically at least, traffic fatalities can be reduced to zero. According to Vision Zero, safety should be based on refusing

(Below) Utah's Zero Fatalities program uses the wrecked car shown here and other outreach methods to drive home the point that traffic fatalities are not acceptable. *All photos courtesy of Zero Fatalities.*

to accept human deaths or lifelong suffering as a result of traffic crashes.

Other European countries, including Estonia, France, Germany, Italy, Luxembourg, Malta, the Netherlands, and Portugal, have since implemented Vision Zero. These countries saw a decrease in all road fatalities by 14 percent for 2001–2004, according to the report *Vision Zero: Adopting a Target of Zero for Road Traffic Fatalities and Serious Injuries*, released in 2006 by the Stockholm Environment Institute.

In the United States, 24 percent of all highway fatalities are 16- to 25-year-olds—that is more than 10,000 deaths annually. The California Office of Traffic Safety has found that a 16-year-old is 20 times more likely to be killed in a vehicle crash than an adult, due largely to inexperience.

The Utah Department of Transportation (UDOT) believes that the loss of even one life on the State's highways is too many and that deaths on the Nation's roadways often are preventable. In 2006, to reduce the number of deaths on Utah's roadways, UDOT established a program that calls on partnerships with public agencies and private sector organizations to help the agency educate the public, especially young drivers, on road safety. Envisioning a future when there are *no* traffic-related deaths, UDOT calls the new program Zero Fatalities™.

UDOT Deputy Director Carlos Braceras (at the podium) introduced the Zero Fatalities program at a kickoff event in 2006. He told the assembled crowd that reaching the goal of zero fatalities will require a united effort from individuals, families, communities, the Federal Government, State organizations, and businesses, targeting the top five behaviors that cause fatalities on Utah roads.

Zero Fatalities Program Adopted in Utah

Between 2000 and 2005, Utah saw a 24 percent reduction in overall roadway fatalities. The declining trend can be attributed to Utah's efforts in engineering improvements in roads, educational programs for new and experienced drivers, and enforcement initiatives to ensure proper driving behavior. To reduce this number even more, UDOT created the Zero Fatalities program in 2006. Zero Fatalities adds the dictum that every person behind the wheel of a vehicle should take responsibility for themselves and other motorists to drive safely. The program aspires to alter misconceptions about traffic fatalities being inevitable and acceptable. Eliminating fatalities is "A Goal We Can All Live With"™, says the program's tagline, and the Zero Fatalities program aims to generate intolerance in society for any traffic deaths.

Zero Fatalities specifies five driving behaviors that contribute significantly to the number of fatalities in roadway crashes: drowsy driving, distracted driving, aggressive driving, impaired driving, and lack of seatbelt use. To help ensure that the multifaceted program will have maximum effect, UDOT aligned the program's goals with those of the Utah Comprehensive Safety Plan (UCSP), which focuses on engineering, education, emergency response, and enforcement.

The ultimate goal of the UCSP is also zero fatalities. "Everything we do from an engineering standpoint to make our roads safer supports the Zero Fatalities philosophy," says Robert Hull, director of traffic and safety for UDOT.

"We want to improve safety regardless of the discipline," adds Hull. "State departments of transportation often think of engineering their way out of problems. Zero Fatalities looks at all angles, especially the behavior side of things."

In this regard, Zero Fatalities is a program, not just a campaign. "Typically, a campaign consists of ads and marketing tactics that are often short-lived," says Hull. "They inform and educate the public on a given topic, and eventually fizzle out or lose funding. Zero Fatalities, however, is a program. It determines our funding prioritization and helps establish our annual performance measures to reduce fatalities. Zero Fatalities is the roadmap and compass that guide our direction."

UDOT acknowledges that supporting behavior-based programs is a new approach to traffic safety from a DOT standpoint. However, to accomplish its goal, the department partners with the Utah Highway Safety Office and other organizations in addressing critical roadway issues. Zero Fatalities is the umbrella program to all the other traffic safety programs in the State.

Partnership Is Key To Success

Partnerships are at the core of coordinating the Zero Fatalities message. The program maximizes its reach throughout Utah by working with a variety of agencies and organizations involved in improving safety. "Having partnerships opens many doors," says Stacy Johnson, a Zero Fatalities partner and educator with the Salt Lake Valley Health Department (SLVHD). "As a team, you achieve the goals you need to achieve."

Johnson notes that the more people involved in the program, the more credible it becomes. Agencies and groups from many levels participate in Zero Fatalities, including the Federal Highway Administration (FHWA); Federal Motor Carrier Safety Administration; UDOT; State of Utah Office of Education; Utah Department of Public Safety, including the

The Zero Fatalities headstone display, shown here at The University of Utah right before spring break in 2008, represented the traffic fatalities for 2007. No students died in crashes over spring break following this installation.

Highway Patrol, Driver License, and Highway Safety divisions; and Utah Department of Health, including the Violence and Injury Prevention and Emergency Medical Services divisions. Local participants include the Primary Children's Medical Center, municipalities, health departments, school districts, companies such as 3M, and organizations such as the American Traffic Safety Services Association.

"The more awareness there is in the community about Zero Fatalities, the more people want to become involved and help," says Kristy Rigby, program manager at the Utah Highway Safety Office. "Unified outreach efforts, media events, and educational programs will catch the attention of government organizations, public entities, and businesses, and will encourage them to unify their focus to changing the top five contributing factors of traffic crashes."

Outreach

Modification of the public's driving behavior starts internally within the partner organizations through maintenance of consistent communication, coordination, and cooperation among State, regional, and local agencies; safety organizations; and advocates.

Hull encouraged strong communication by supporting several partnership projects. In 2006, Zero Fatalities cosponsored the Safe Kids Utah initiative to distribute car seats and booster seats to local health departments to redistribute to low-income families.

"They [Safe Kids staff] were able to provide car seats and booster seats to low-income families, and we could offer funds to supplement the ongoing success of their projects," Hull says. "When partners benefit from working with UDOT, it strengthens those partnerships and improves our relationships."

Zero Fatalities' other outreach efforts involving partnerships include roles in the Utah Safety Council's Alive at 25 initiative, Utah Highway Patrol's Adopt-a-High School program, and Utah Department of Public Safety's Click It Or Ticket events. Program staff members also participate in health and safety conferences, expos, and events across the State.

Zero Fatalities' outreach resources—material intended to turn heads, get attention, and deliver the message—include a headstone display, banners, and Zero Fatalities-branded giveaways. The headstones

(Right) "The Zero Fatalities crashed car has been a hit at the high schools," says Jennifer Riches, student body adviser at a Salt Lake City high school. "Watching the kids walk by the car and look in, you can see their minds going, 'How did anyone survive this?'" Here the car is parked in front of Franklin Covey Field, the city's minor league baseball stadium.

Don't Drive Stupid

Utah teens are a small percentage of all licensed drivers, but they cause more than three times as many crashes as adult drivers. To address this public safety concern, Zero Fatalities devised a program targeting teens called "Don't Drive Stupid."

"While the 'Don't Drive Stupid' catchphrase may not sit well with adults, it's a message that certainly registers with teens," says Hollie Davis, information specialist for the Utah Safety Council.

To maximize the program reach, Utah formed a Don't Drive Stupid Teen Driving Task Force involving nearly a dozen State, local, and private organizations. "The teen task force has a common goal, and that goal can only be achieved when we all work together," explains Stacy Johnson of the Salt Lake Valley Health Department (SLVHD). "In our meetings we bounce ideas off one another and learn from others' experiences. We get a different perspective of why some ideas may work and why other ideas won't work. I believe this kind of teamwork makes any program successful."

In a 6-week SLVHD program, Salt Lake City high schools play Zero Fatalities commercials during morning announcements; hang Don't Drive Stupid banners; and pass out T-shirts, lip balm, posters, and backpacks, such as the one shown here. SLVHD also developed interactive activities such as "Death Day," when students cannot speak during the day in recognition of the voices silenced through traffic fatalities.

The following Don't Drive Stupid resources are available to teens and teachers:

- Buckle Up and Don't Drive Stupid hand stamps for sports events and stomps (school dances)
- Entertainment at halftime or assemblies sponsored by Zero Fatalities
- Zero Fatalities, Buckle Up, and Don't Drive Stupid banners
- A 6-week teen driving program conducted by student body officers
- Promotional items distributed by local health departments and Zero Fatalities
- Guest speakers and interactive games to educate students on injury prevention, driving choices/consequences, and driver/passenger lessons
- The Zero Fatalities crashed car
- The headstone display representing every fatality on Utah's roads

The Teen Task Force created a brochure to educate teenagers on driving laws, teen crash statistics, and graduated driver's licensing. Another creation, the print and Web ad, "Driving Stupid Can Really Make You Look Bad," shown here, connects well with young people.

represent all the roadway fatalities from the prior year. As just one example of outreach, program staff set up the headstone display at The University of Utah a day before spring break in March 2008. There were zero fatalities from The University of Utah that weekend.

In other examples, program staff members manned the Zero Fatalities booth at several sporting events, such as Real Salt Lake soccer games and Salt Lake Bees baseball games. At expos and conferences, the staff passed out brochures and promotional items, such as highlighters, pens, and stopwatches. Also, "Don't Drive Stupid" promotional items such as T-shirts, hats, lip balm, and tote bags have proved popular at high school events. Seatbelt surveys went out before and after the high school events, and the percentage of seatbelt users increased as a result of these outreach activities.

A Zero Fatalities newsletter, *Zero News*, aims to improve communication between program partners and the public. A Web site, www.zerofatalities.com, is another creative tool used for communications purposes. Web site visitors such as partner agencies and educators can download award-winning TV commercials, radio ads, posters, brochures, and other resources to use in their own outreach activities. Utah's Teen Driving Task Force also created lists of safety contacts and Web sites, available at www.dontdrivestupid.com, to facilitate quick access to community programs and partner resources.

Zero Fatalities gains exposure through television and radio commercials, strategically placed print ads, and press releases. Numerous individuals and organizations have endorsed the award-winning outreach materials, including politicians, planning organizations, law enforcement officials, driver's education instructors, high school counselors and students, private businesses, city administrators, and community leaders.

Outcomes

The headstone display and other innovative aspects of Zero Fatalities already are proving effective. Awareness of the program among drivers between the ages of 18 and 54 in 2007 grew from 35 percent in 2006 to 49 percent in late 2007, according to an independent study by a Utah market research firm. The percentages are extraordinary considering

Each headstone in the Zero Fatalities display, such as the ones shown here, represents one highway death.

Programs in Other States

Washington. In 2000, the Washington State Department of Transportation (WSDOT) teamed with sister agencies associated with the Washington Traffic Safety Commission and Governor to create the Governor's Quality Initiative of Target Zero. A steering committee also included the Washington State Patrol, Washington State Department of Licensing, and Washington State Department of Health, along with State and local agencies and private organizations. The partners designed a plan to support the goal of achieving zero traffic deaths and injuries within 30 years.

In 2005, a State-developed Strategic Highway Safety Plan became a Federal requirement. Washington State met the challenge with Target Zero. With Target Zero, Washington State became one of the first States in the United States to follow Vision Zero's idea to use zero as a goal for reducing roadway deaths.

Like Utah's Zero Fatalities program, WSDOT's Target Zero has formed partnerships to accomplish the program's goals. Stakeholder groups include combinations of Washington State agencies, local organizations, tribal nations, and Federal agencies.

"We really think zero is the right goal," says WSDOT State Traffic Engineer Ted Trepanier. "You can argue, 'Can we actually get to zero?' but at the end of the day, the only acceptable target is zero. Everybody recognizes this is a difficult goal. However, the target needs to be pointed at zero to aggressively drive the trend down."

Target Zero's primary focus is impaired drivers, seatbelts, and speed. Secondary emphases include younger and older drivers and aggressive driving.

Minnesota. Minnesota adopted Toward Zero Deaths (TZD) in 2004. The program is based on and integrated with the State's Strategic Highway Safety Plan. TZD is an interagency partnership led by the Minnesota Department of Public Safety and Department of Transportation (Mn/DOT), and it cooperates with the State Patrol, FHWA, Minnesota county engineers, the University of Minnesota's Center for Transportation Studies, and other State and local agencies.

"Toward Zero Deaths is the recognition that one fatality is too many," says Bernard J. Arseneau, director of Mn/DOT's Office of Traffic, Safety, and Operations. "We recognize that we are not going to get there tomorrow. Someday, though, I think it can be a reality. We need to demand and strive for zero deaths."

Minnesota's safety strategies focus on unbelted drivers, drunk driving, intersection crashes, single vehicles running off the road, speeding, drivers under the age of 21, head-on crashes, and sideswipes. Minnesota also places additional emphasis on addressing crashes that occur on local roads.

"If we are really trying to reduce fatalities, we need to eliminate the knock on the door [a police officer reporting to a family that a loved one was killed in a crash]," says Arseneau.

Early on, TZD set an interim goal of fewer than 500 fatalities by 2008. The program achieved that goal in 2006. By September 2008, the State was down more than 50 fatalities than in the same month the previous year.

TZD also holds an annual conference for traffic safety stakeholders, and more than 500 people attended in 2007. "The synergy developed through these partnerships has been great," says Arseneau. "If you have a good vision, people want to be a part of that and want to help on the journey—success breeds interest."

Others. The international Organization for Economic Cooperation and Development recently released a summary of its report *Towards Zero: Ambitious Road Safety Targets and the Safe System Approach* (www.internationaltransportforum.org/jtrc/safety/targets/08TargetsSummary.pdf), which reviews the state of the art in improving road safety performance and examines the role of targets in raising the level of ambition and achieving effective implementation of road safety policies. Based on this growing international experience and the U.S. precedents established by Minnesota, Utah, and Washington, many other States are considering moves to establish and implement zero fatalities programs.

the program had been running for a little more than 2 years, the firm said. Most important, Zero Fatalities is helping save lives, as evidenced by the continued downward trend in fatality rates. After the program's first year, traffic fatality statistics showed significant reductions in unsafe driving behaviors compared to the previous year. By August 2007, there were 178 traffic fatalities; however, in August 2008, there were only 147, a 17 percent decrease.

The program brings engineering, education, emergency response, and enforcement efforts to bear on achieving the goal. Zero Fatalities is achieving this goal by educating young people and working through its partnerships. For example, Utah Highway Patrol's Adopt-A-High School program was able to increase the number of teens wearing seatbelts in several high schools. Other successful partnerships include the following: Alive at 25, the Primary Children's Medical Center's booster seat education, driver license laws, new online driver tools, engineering of barrier cables, and high-speed curve electronic signs—all of which operate in partnership with Zero Fatalities and have helped reduce Utah's highway deaths.

Spreading the Word

Zero Fatalities has captured national attention, and other States are considering implementing the program. Fortunately, States can easily adapt the outreach elements to suit their needs with only slight modifications, such as identifying the top contributors to their fatalities and adding their partners' logos to advertising materials. By using the same materials and messaging, the program will maintain a consistent, well-recognized brand identity for all Zero Fatalities partner States, the next goal for UDOT's Hull and other program participants.

"It would be great to have a national movement on the ultimate goal," says Hull. "No matter what it is called, zero should be the main component, integrating efforts not only locally but also around the country."

Summer Clarke is coordinator of the Zero Fatalities program for public relations firm Penna Powers Brian Haynes (PPBH), which is a contractor for UDOT. She assists with various public relations and public involvement aspects of the program. Prior to joining PPBH, she worked in journalism, photography, and public relations for 10 years. She has written for the weekly *Davis County Clipper* and Utah's largest daily newspaper, *The Salt Lake Tribune*.

For more information, contact Summer Clarke at 801-487-4800 or sclarke@ppbh.com.

LTAP/TTAP: 25 Years of Service

Local and Tribal Technical Assistance Programs rise to the challenge of meeting transportation needs at the local level.

(Above) At a Construction Career Day event in Rhode Island, high school students had the opportunity to man the controls of this backhoe. Growing the pipeline of students interested in transportation careers is one goal of the LTAP and TTAP centers. *Photo: University of Rhode Island Transportation Center.*

by Denise Saunders and Donna Shea

Building and maintaining the Nation's roadways is no small feat. Across the country, 38,000 local and tribal agencies are responsible for maintaining 4.8 million kilometers (3.0 million miles) of roads and more than 300,000 bridges—75 percent of the Nation's streets and highways. These cities and towns, rural and urban counties, and tribal governments juggle a multitude of increasingly complex challenges, including enhancing roadway and work zone safety, managing congestion without building more roads, providing safe and convenient paths for pedestrians and bicyclists, complying with new Federal and State regulations, and training the grassroots transportation workforce—all with limited funds.

In 1982, the Federal Highway Administration (FHWA) answered

the call for training and technical assistance at the local level by creating the Local Technical Assistance Program (LTAP). Nine years later, FHWA launched the Tribal Technical Assistance Program (TTAP) to meet the needs of tribal transportation agencies. Together, these programs help local and tribal governments build, maintain, and operate U.S. roadways by delivering targeted training, technical assistance, materials, and resources.

Today, the LTAP/TTAP network consists of 58 centers—one LTAP center in each State and Puerto Rico, and seven regional TTAP centers that serve tribal governments. The LTAP/TTAP mission: To foster a safe, efficient, and environmentally sound surface transportation system by improving the skills and increasing the knowledge of the local and tribal transportation workforce. That means providing hands-on methods for moving innovative transportation technologies and practices into the hands of the men and women charged with maintaining the Nation's local roads and bridges.

The LTAP and TTAP centers serve a diverse and geographically dispersed audience of professionals that includes public works directors and staff; city, town, and county engineers; transportation planners; and street and road maintenance superintendents and staff. The programs also reach officials at State departments of transportation (DOTs), municipal planning organizations, regional planning agencies, and private consultants.

The centers meet the training needs of this varied audience through workshops, technology demonstrations, computer training, distance learning, conference seminars, and courses in the field and classroom. The ability to be flexible and tailor training and technical assistance to an individual State or local agency is paramount to the programs' success.

"It would be hard to find a program in the Federal Government that touches as many people and fosters such success as LTAP and TTAP," says Joseph Toole, associate administrator of FHWA's Office of Professional and Corporate Development. "Part of this is clearly due to the partnerships these centers have created, but even more so it is a measure of the commitment and passion of the people that make them work."

As LTAP celebrates 25 years of service, both programs continue to innovate and evolve to meet tomorrow's transportation challenges, including a retiring workforce, declining transportation budgets, and aging infrastructure. Mirroring national transportation policies, LTAP and TTAP are focusing on four key areas: safety, infrastructure management, workforce development, and organizational excellence. A newly revamped Web site, an online clearinghouse for materials and training, a collection of educational programs designed to meet local needs, and a national voice—through a national LTAP association—combine to make the LTAP/TTAP network stronger than ever.

Workforce Development

One of the most pressing challenges facing the transportation industry is that nearly half the workforce is eligible to retire by 2010. With 950,000 people directly employed in the transportation industry at the State, local, tribal, and contractor levels, the next decade will bring increased need for training, education, and technology transfer.

The industry as a whole faces the challenge of an aging and retiring workforce, leaving fewer people with institutional knowledge and field-tested experience. Offering training and career development opportunities can help motivate and retain the next generation of transportation workers.

"Our LTAP center helps transportation practitioners in the field stay current on best practices—which is absolutely vital in this time of aging infrastructure and shrinking budgets," says Laura Melendy, director of the University of California, Berkeley's Technology Transfer Program, the California LTAP. For example, when Vickie Smith-Becker, an analyst at the Calaveras County Department of Public Works, needed information to prepare a grant application, she contacted the California LTAP. "I needed information about adding passing lanes on rural, two-lane roads in order to apply for a grant and to help explain to the public why this was important," she says. "The [LTAP] librarian not only sent me some electronic files on the subject but copied print resources that weren't available online and mailed them to me. We're a rural county, and we're far away. [The LTAP center] saved us the time and

North Carolina LTAP

These transportation workers are engaged in a tabletop exercise on work zone safety, hosted by the North Carolina LTAP.

LTAP/TTAP: By the Numbers

Over the past 10 years alone, the LTAP and TTAP centers have achieved the following results:

- They conducted more than 60,000 training events.
- More than 1.5 million local transportation professionals attended LTAP and TTAP training.
- Participants logged more than 9 million hours of training.
- Nearly half of all LTAP and TTAP training included content related to highway and worker safety.
- Centers distributed more than 2 million technical publications and resources in response to requests from local and tribal agencies.
- Local transportation agencies saved an estimated $8 for every $1 LTAP spent on information and training.

"The return on the investment of Federal, State, and local funds into LTAP and TTAP has been incalculable," says Anthony Giancola, executive director of the National Association of County Engineers. "These programs have provided critical training for county and local highway professionals and, in particular, are improving the safety and preservation of our local roads. The end result has been the implementation of state-of-the-art best practices in highway operations and maintenance, and ultimately improved service to our citizens."

expense of me driving down and hunting for the information myself."

At the local and tribal levels, a number of barriers can limit the availability and feasibility of delivering and attending training. Whether driven by budget constraints or lack of awareness of available training and the value it could bring to their organizations, local agency officials sometimes are hesitant to invest in workforce development.

LTAP/TTAP centers overcome these challenges by forming partnerships with agencies and organizations that can influence decisionmakers. These partners include the National Association of County Engineers (NACE), American Public Works Association (APWA), Transportation Curriculum Coordination Council (TCCC), State agencies, and regional planning agencies. In addition, many LTAP centers have integrated their services with those at colleges and universities, offering programs such as summer transportation institutes and engineering and construction career days.

Even when funding and training opportunities are available, personnel are sometimes hesitant to commit to training if they have reservations about how comfortable the learning environment will be or how relevant the training will be to their day-to-day jobs. To overcome these barriers, the centers work hard to provide environments that are welcoming and conducive to learning by tailoring class presentations to the needs of participants as much as possible, says David Page, workforce development coordinator at the Florida LTAP. "When an agency asks us for training, our instructors often call the agency ahead of time to discuss their goals and any specific skills training they would like included or emphasized in the class," Page says. "For example, our heavy equipment instructor determined before buying his plane tickets that an upcoming class of students did not need his hands-on course. He found out that everyone had 20–30 years' experience. He recommended a refresher course on safety and equipment inspections and a different instructor who was local to the agency. We reduced the cost to the agency by over half and still met its training needs."

Adds Tiffany Wise, codirector of the Florida LTAP, "The most positive feedback is obtained when the instructor tailors the class to the individuals and spends one-on-one time with them, making sure they master the skills they are being taught. This is especially true in the hands-on courses, such as heavy equipment operation and safety." Wise describes one instance in which a local agency was grateful to the LTAP center for the skills imparted during a course on chainsaw safety. During the hands-on training, the instructor explained that before clearing a tree on the ground, it is critical to look up to ascertain whether any broken branches or limbs might fall from above. The agency reported that shortly after the training, its workers were called out at night to clear a downed tree. Remembering what they learned in training, the workers spotted a broken treetop above the one they were about to clear and took steps to control the fall of the overhead treetop, avoiding potential injury or death during the clearing operation.

The reach of the training is considerable: LTAP and TTAP centers provide 5,300 training events to more than 145,000 participants every year. The LTAP/TTAP centers also deliver key transportation information—technical information, research updates, and legislative and regulatory news—to local agencies through technical assistance requests, newsletters, and other publications.

Road Scholar and Road Master Programs

One particularly successful means for promoting ongoing skills development at the local and tribal levels is the Road (or Roads) Scholar and Road Master programs, which recognize staff for reaching various competency levels through training and development of transportation expertise. The details of the programs vary from State to State, but the underlying approach is to provide curricula that enable local and tribal transportation workers to study road fundamentals, safety, drainage, snow and ice removal, and other topics with the goal of becoming expert road managers. The courses help participants develop professionalism and advance their careers.

In New Hampshire, anyone who takes an LTAP course is automatically entered into the Road Scholar program. "Right away, course attendees know they are part of the program," says Kathy DesRoches, former director of educational programs at the New Hampshire LTAP center. "Every time they participate in a workshop, they receive a transcript that shows how many hours of training they have taken."

New Hampshire's program has four levels, and each workshop generally runs 5 hours. Level 1 involves completion of any five courses (25 hours of training). Level 2 requires

completion of 10 courses (50 hours), including mandatory workshops on staff supervision, tort liability, and environmental issues. "We purposely keep course requirements flexible so people take training of interest to them, but we require certain core courses to ensure a well-rounded education," DesRoches says. To achieve Level 3 (Senior Road Scholar), participants must complete 15 courses (75 hours). Participants who complete Level 4 (100 hours) earn the designation Master Road Scholar.

Twice a year, the New Hampshire LTAP center hosts a graduation ceremony to honor new Master Road Scholars. The ceremony features a keynote speaker, and graduates are encouraged to bring a supervisor or spouse. The center also recognizes the graduates in its quarterly newsletter and publishes and distributes an annual directory of Road Scholars.

In terms of training content, LTAP centers offer something for everyone. DesRoches says maintenance personnel represent the largest number of training attendees at her center, but course offerings draw people from a variety of professions. For example, some training counts toward continuing education units, which help engineers fulfill their professional licensing requirements.

Nearly half the LTAP centers offer Road Scholar/Road Master programs. Though the cost of training varies by State, centers strive to keep the rates affordable. In New Hampshire, DesRoches says, "You can become a Master Road Scholar for less than $1,500."

Building Organizational Excellence

To reach diverse audiences efficiently, LTAP and TTAP centers rely on their ability to leverage their combined resources. The LTAP/TTAP Clearinghouse, available online at www.ltapt2.org, is a central source of information for the centers and is a one-stop shop for training, resources, and materials for local and tribal transportation agencies.

"We provide support services to help centers accomplish as much as they can," says Alison Premo Black, director of the LTAP/TTAP Clearinghouse. "We make sure LTAP and TTAP staffs are aware of the latest materials available. We have a database of trainers to help center staff locate instructors for various topics. We also have a resource database listing all the courses offered through LTAP and TTAP centers across the country."

Literally thousands of resources are available through the clearinghouse, ranging from reports and training materials to videos, tips from the field, best practices, and Web-based information. "We continuously look for new resources

Wyoming LTAP

George Huntington, with the Wyoming LTAP center, is using a retroreflectometer to test the retroreflectivity of this pedestrian crossing sign.

Technology Transfer Expos, such as the one shown here, are one of the many ways LTAP/TTAP centers highlight the latest in transportation technology and equipment.

to keep on top of the latest materials," Black says. Checklists and factsheets are among the most requested items. Currently, the top products by far deal with new retroreflectivity requirements released by FHWA in the latest update to the *Manual on Uniform Traffic Control Devices* (MUTCD). "We've sent out more than 18,000 of those," Black says. The clearinghouse also offers customizable LTAP/TTAP marketing materials to help centers promote their individual programs.

The clearinghouse has gone through many changes in the nearly 20 years since it was established. In recent years, the Web site has become the primary mechanism by which the clearinghouse works with the centers. "We completely revamped the Web site recently," Black says. "One new feature is that we introduced a password-protected area to give centers a 'virtual' home." Here the centers can update their public profiles, enter information into the resource database, download contact information for other centers, and collect information on their courses.

The Web site helps improve the centers' operating efficiency on a number of fronts. For example, centers previously submitted annual reporting data to FHWA via paper documents, but the password-protected area on the new site enables them to enter the data online, saving time.

The clearinghouse also facilitates using the latest technologies to extend LTAP/TTAP reach and impact. Videos are among the newest additions, and the clearinghouse is considering podcasts for future online applications. Another new feature is a virtual meeting space that centers can use any time to host online meetings. The virtual meeting space takes the traditional conference call to a higher level, enabling participants to talk, send instant messages, and view shared documents.

"Improving efficiency and doing more with less, that's the heart and soul of the clearinghouse and LTAP/TTAP," says Black.

NLTAPA: A National Voice

While individual LTAP and TTAP centers focus their efforts at the local level, the National Local Technical Assistance Program Association (NLTAPA) represents the centers at the national level. NLTAPA fosters awareness of LTAP/TTAP efforts to help FHWA and States understand local transportation issues and build capacity for meeting customer needs at the local and tribal government levels. The association also is an avenue of communication bridging the centers across the country.

"Most centers are small, with fewer than three or four full-time-equivalent employees, and are very independent, but we do need to represent ourselves and speak clearly in a common voice to FHWA and industry at the national level," says Kevin Burke, director of the Illinois LTAP center and NLTAPA president. "NLTAPA gives us a foot in the door to talk with national organizations and help influence how resources are spent at the local level."

NLTAPA's roots lie in the informal peer-to-peer interactions and sharing of lessons learned that germinated with the LTAP program in the early 1980s. The association officially formed and elected officers in 1991 and operates as a "100 percent volunteer organization," says Marie Walsh, director of the Louisiana LTAP center and former NLTAPA president.

Local and tribal centers provide the resources and opportunities for their employees to participate as NLTAPA members. Volunteers from the LTAP and TTAP centers participate as officers, committee chairs, or members of various workgroups who carry out much of NLTAPA's work. The workgroups focus on program strategies, partnerships, internal and external communications, training development, and professional development.

An annual conference affords the opportunity for sharing information about national priorities with the centers. For example, in 2008, NLTAPA scheduled a half-day train-the-trainer session focused on FHWA's sign retroreflectivity requirements. NLTAPA coordinated the session with the association's annual meeting, enabling center staff to interact directly with FHWA experts and provide feedback.

The association also plays a leading role in envisioning the strategic direction for LTAP and TTAP efforts. It solicits stakeholder input on topics to cover in webinars and information to include in the new trainer database available through the clearinghouse Web site. A recent needs assessment conducted in partnership with NACE will help NLTAPA find and fill gaps in the knowledge, skills, and technical capacity at the centers. Performing this activity at the national level avoids the need for the centers to do so individually.

NLTAPA's efforts in developing and maintaining industry partnerships have helped ensure the centers' ongoing success. In 1998, after years of informal collaboration with many State DOTs, local public works chapters, and county associations, NLTAPA established formal agreements with APWA, NACE, and the American Association of State Highway and Transportation Officials (AASHTO). The goal of these relationships is to reduce duplication of services, share training costs and expertise, and provide optimum training and information to their shared customers.

"AASHTO strongly supports the work of the centers in providing valuable training and transferring knowledge to our DOT members as well as county and city government employees," says AASHTO Executive Director John Horsley. "With State DOTs seeing budget constraints and limited resources, the LTAP and TTAP centers not only need to be continued but enhanced and expanded."

NLTAPA officers and members sit on national highway committees to provide local input and perspectives. For example, NLTAPA has representatives on the FHWA LTAP/TTAP strategic planning committee and on the steering committee for the LTAP/TTAP Clearinghouse. Walsh participates on the AASHTO subcommittee on safety management, which focuses on integrating safety efforts at the Federal, State, local, and tribal levels. In this way, NLTAPA provides input on both operational and strategic issues at the Federal level.

Professional development, the subject of one of the association's workgroups, is a key focus area. One recent initiative, conducted with support from FHWA and the clearinghouse, was development of an orientation program for new LTAP and TTAP directors. The orientation helps bring new directors up to speed quickly and expands staff development opportunities. "For a small organization, we stay focused on what centers need and want," Walsh says.

Opportunities abound for participating in NLTAPA initiatives, whether through involvement in a committee or workgroup, attendance at regional meetings or presentations, or simply signing up for the organization's listserv to stay abreast of what is going on, Walsh says. "I have been involved for 4 years. Thanks to the opportunities to interact with peers, I have learned more than I possibly could have anywhere else," she says.

These transportation professionals are participating in a site visit at a suburban intersection and crosswalk. Field exercises are an important part of the RSA trainings for local agencies.

Focus on Safety

Safety is a primary concern of every part of the surface transportation system, with focus from local, tribal, State, and Federal government partners as well as the private and commercial sector. LTAP and TTAP centers take responsibility for delivering hands-on training and technical assistance on safety at the local level. Nearly half of all LTAP and TTAP training is related to highway and worker safety. The LTAP/TTAP focus on safety also is supported through collaboration with the FHWA Office of Safety, National Highway Traffic Safety Administration, and Governors Highway Safety Association.

Two of the flagship safety-focused tools available through LTAP and TTAP centers are road safety audits (RSAs) and road safety audit reviews (RSARs). FHWA defines an RSA as a formal safety performance examination of an existing or future road or intersection by an independent audit team. Some highway agencies define RSAs as assessments of

During training conducted jointly by the Northern Plains Tribal Technical Assistance Program and the Northwest Tribal Technical Assistance Program near Polson, MT, participants consult the MUTCD while in the field conducting an RSAR.

Northern Plains Tribal Technical Assistance Program

Town of Granby, CT, Public Works Department

Worker safety is a focus of many LTAP/TTAP trainings and resources. The town of Granby, CT, is committed to protecting its workers' safety, requiring use of appropriate worker visibility apparel, as shown here.

planned facilities, while RSARs cover reviews of existing roadways. Other terms for these reviews include road safety assessments, road safety evaluations, and safety impact teams. RSAs and RSARs rely on independent assessment and review teams that perform site visits at targeted intersections or segments of roadways and then prepare written reports for the roadway owners, detailing the assessed problems and recommended solutions to improve safety.

"RSARs determine whether the safety needs of road users are being met," says Dennis Trusty, director of the Northern Plains TTAP center in Bismarck, ND. "They can help determine whether the use of a roadway has changed over time, or whether standards or traffic levels have changed since a road was designed and built."

RSARs use crash data as background information but rely on more than history and existing data, Trusty says. "Good RSARs identify what can be improved, not just what has already created problems."

According to Great Falls District Traffic Engineer James Combs of the Montana Department of Transportation (MDT), an RSAR resulted in plans for a more thorough review of warning signs at various locations. "The review is currently in progress by MDT," he says. "Curve warning signage will be updated to meet current State guidelines and the 2003 MUTCD. Unwarranted warning signs will be removed and new curve warning signs installed where needed. Part of the review looked at the school bus route on secondary highway 464 with the local school bus drivers to determine which existing School Bus Stop Ahead signs should be relocated or removed and to determine if new signs are warranted at other stops."

The Northern Plains TTAP leads the audits for tribes in five States, and the tribes help recruit the people and organizations who should be involved in the audits. Audit teams might consist of LTAP/TTAP staff, State DOT personnel, and representatives of other organizations, including FHWA, the Bureau of Indian Affairs (BIA), the transportation industry, law enforcement, and emergency medical services.

"Having more eyes reviewing a new design or an existing transportation system provides the many perspectives that must deal with the end result," Trusty says. "Law enforcement's views might be much different from those of maintenance and engineering personnel or those involved in construction." For example, in the case of an RSAR on the Blackfeet Reservation, law enforcement officials from the Montana Highway Patrol highlighted the challenge of responding to run-off-the-road crashes during severe weather, such as high winds and whiteout driving conditions. "Having the law enforcement perspective helped the RSAR team focus on a very important issue," Trusty says.

RSAs and RSARs are tools that can be used in every State, whether through an LTAP or TTAP center, FHWA, or State DOT. For each location, staff from LTAP or TTAP centers serve as leaders, organize the audits for each location, or help find personnel to lead or staff the teams.

The Northern Plains TTAP already has conducted RSAs with three State DOTs. The results of those audits are helping prioritize maintenance projects and are finding their way into tribal transportation improvement plans and road reconstruction projects directed by the tribes and BIA. A recent RSAR in Montana for the Blackfeet Nation will result in improvements on roads managed by MDT and BIA. Specific improvements include installation of better signs and striping; enhancement of guardrails; installation of bridge ends with newer, safer designs; and removal of trees and rocks in clear zones.

Safety Circuit Rider Program

Another safety initiative carried out through the LTAP and TTAP centers is the Safety Circuit Rider (SCR) program, which presents workshops for local and tribal governments and other organizations. The cornerstone of the program is the SCRs, safety specialists who travel throughout a State, region, or reservation making presentations on topics such as work zone safety, MUTCD requirements, retroreflectivity, roadside and excavation safety, and pavement markings. Many transportation workers cannot attend training events because of the travel time and cost involved. However, through onsite workshops and site visits, SCRs take safety training to local and tribal agencies, making participation convenient and cost effective.

The idea for the SCR program grew out of a 2003 meeting of representatives from FHWA, NACE,

and NLTAPA. While reviewing the latest statistics on roadway fatalities, the assembled safety experts determined that the highest percentage of fatal crashes occurred on local roads. The proposed solution was to establish a program to identify high-crash locations and recommend corrective measures.

In 2004, FHWA funded SCR programs in Florida, Kentucky, and West Virginia, and another involving the Northern Plains TTAP. In 2006, the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) authorized States to use funds from the Highway Safety Improvement Program for engineering improvements and as a resource to address problems identified through SCR programs. Today, 20 States have active SCR programs.

"The number of riders depends on how each LTAP or TTAP center decides it can best meet local interests and needs," says Bruce Drewes, training and research manager with the Idaho Technology Transfer Center. Some States, such as Iowa, Kentucky, and Wyoming, have one person who serves as the SCR. Others have multiple part-time staff. Florida, for example, has three part-time SCRs to call on depending on the location and schedule. Each SCR works closely with Florida Department of Transportation staff to identify high-crash locations and help the local agency determine appropriate measures to improve safety.

Identifying possible hazards is a major focus, Drewes says. "The most common problems are obstructions along the roadway, issues with signing or pavement markings, and sight distances," he says. "Most of these problems can be solved fairly inexpensively." Therefore, many of the corrective measures SCRs recommend are low-cost maintenance improvements, such as clearing vegetation around signs and intersections, correcting roadside drainage, fixing shoulder dropoffs, and removing rockfalls and trees along roadsides.

SCRs also can organize and participate in RSAR teams. "Most of us drive the same route between home and work every day," says Drewes. "We become so familiar with the route and how to drive it safely that we overlook deficiencies that someone new to the road might notice. An SCR and an RSAR team can provide that 'new' perspective."

The SCR can assist in finding funding or otherwise addressing a safety issue, but, Drewes says, "it is up to the local jurisdiction to determine what improvements to make. In essence, the SCR program needs to be a strong partnership between the LTAP/TTAP center, State DOT, and local jurisdiction. It's that partnership and cooperation that will push down the numbers of fatalities on the national roadway system."

Infrastructure Management

Another major priority for local and tribal agencies is maximizing the performance of transportation infrastructure while minimizing impacts on financial and human resources. These agencies occupy the front

These participants from departments of transportation and local agencies are gathered in a conference room to discuss ways to make work zones work better.

Mutual Aid Programs

The Utah and New Hampshire LTAP centers are among several that are spearheading innovative partnering relationships with municipalities, counties, and other States to facilitate faster responses to emergencies. New Hampshire's Public Works Mutual Aid Program, the first voluntary statewide program of its kind in the United States, invites government entities to become part of a mutual aid network of municipalities that assist one another during emergencies through partnering agreements and a protocol for requesting and receiving aid.

Benefits include reduced vulnerability for participating communities, prompt and effective responses to incidents, and rapid rehabilitation of infrastructure. In addition, the program facilitates exchange and sharing of supplies, equipment, and personnel. The network proved integral in helping numerous communities repair and restore damaged infrastructure following major floods in 2005, 2006, and 2007, according to Kathy DesRoches, formerly with the New Hampshire LTAP center.

A partnership between the Utah LTAP center and county emergency managers was instrumental in developing a public works resource inventory. The list will be critical in identifying available resources and their locations, and calculating response times for critical equipment. Due to exhaustive work on the State's new emergency operations plan, Utah is now 1 of 11 States accredited through the voluntary Emergency Management Accreditation Program.

Mutual aid programs represent another means of broadening the support network available to local and tribal governments.

Michigan LTAP

LTAP/TTAP centers offer training on winter operations, covering topics such as snow plow safety, to ensure that drivers know how to operate plowing equipment safely, as shown here in Michigan.

line in overseeing the vast majority of the Nation's transportation infrastructure. LTAP and TTAP centers provide a critical service to those responsible for the longevity of roads and bridges. The centers have trusting relationships with local and tribal agencies throughout the country.

"Local agencies trust the information that centers provide because we don't have the vested interest that a vendor has," says Terry McNinch, director of the Michigan LTAP center. "The centers are in a perfect position to take the lead on local agency implementation of asset management nationwide."

According to FHWA's "Asset Management" Web site, today's transportation system is deteriorating more rapidly than ever. In FHWA's *Asset Management Primer*, the agency defines asset management as "a systematic process of maintaining, upgrading, and operating physical assets cost effectively. It combines engineering principles with sound business practices and economic theory, and it provides tools to facilitate a more organized, logical approach to decisionmaking. Thus, asset management provides a framework for handling both short- and long-range planning."

The Michigan LTAP center condenses the FHWA definition of asset management to "an ongoing process of maintaining, upgrading, and operating physical assets cost effectively, based on a continuous physical inventory and condition assessment." McNinch underscores the importance of the latter part of this definition. "Everyone deals with other types of physical infrastructure—buildings, houses, and cars—and nonstructural things like our physical health using the principles of asset management," he says. "You take care of the asset before it totally falls apart. If your roof leaks, you get it repaired quickly; you don't wait until the walls and floors have been ruined."

According to McNinch, over the past century, physical, social, and administrative factors have led roadway managers down a path from system expansion to system reconstruction, resulting in the majority of current resources being devoted to heavy rehabilitation and reconstruction. This approach, he says, sacrifices preventive maintenance—the activity that keeps good roads good—for more costly reconstruction of the roads deemed in the worst condition.

"This has become the way of doing business," McNinch says. "You never see a ribbon cutting on a crack-seal job, but reconstruction initiated by an elected official makes the news. Dwindling budgets, along with increasing costs of pavement materials, have put road managers in a position where their backs are up against the wall. The revenue stream cannot support this 'worst first' way of doing business."

Changing business as usual involves changing the knowledge and culture of road management agencies, which takes time. Everyone involved—engineers, managers, road crews, elected officials, finance managers, and the public—needs to be

Connecticut Advanced Pavement Laboratory

Pavement preservation is a critical priority for infrastructure management, and LTAP centers can help by providing training and technical information on new materials and technologies. Before beginning this paving project on I–89 near Randolph, VT, the contractor enlisted the Connecticut Advanced Pavement Laboratory to perform thermal imaging to study the effectiveness of a new material transfer unit. Testing revealed that the equipment produced a more uniform pavement.

New York LTAP

Dave Orr (center, red and green striped shirt), of the New York LTAP center, is leading a course on the principles of drainage. Here, he is giving a demonstration on compaction as participants look on.

educated to some degree on pavement deterioration, the benefits of a "mix of fixes," and the pitfalls of the "worst first" approach, McNinch says.

In Michigan, the LTAP center works in partnership with the Michigan Transportation Asset Management Council, conducting a variety of training events on asset management. The council provides substantial funding for 20 half-day sessions of Introduction to Transportation Asset Management for Elected Officials, 4 full-day sessions of the Michigan Transportation Asset Management Workshop, and 10 full-day sessions on using the Pavement Surface Evaluation and Rating condition rating system. The center also is integral in organizing the Michigan Transportation Asset Management Conferences.

In 2007, under a contract with the council, McNinch revamped the *Asset Management Guide for Local Agencies in Michigan*, which serves as the foundation for the Michigan LTAP workshops. The guide is available for download at www.michigan.gov/documents/mdot/AMC_MDOT_Guide_Local_Agencies_180204_7.pdf.

The Michigan LTAP center also has a hand in developing software tools for asset management. For example, the center helped develop and conducts training for "RoadSoft GIS [geographic information system]," an infrastructure management system now being used by more than 260 counties and cities in Michigan, as well as other State agencies.

Agencies applying the principles of asset management are seeing big payoffs, McNinch says. In 2004, the Emmet County Road Commission invited the Michigan LTAP center to give a presentation on asset management to county road commissioners and township board members. In the months following the presentation, the center worked with the Emmet County highway engineer to upload the county's road condition data into RoadSoft GIS for analysis. The county engineer then developed 5-year road maintenance plans for all 16 townships in the county. After numerous meetings, the engineer succeeded in having tax millage proposals placed on the ballot in every township. All the proposals passed. By its fourth year, that special millage had generated $8 million intended specifically for local road maintenance.

A Successful Recipe

Through innovative partnerships with State DOTs, municipal planning organizations, universities, associations, and others, each LTAP center matches with local funds every Federal dollar it receives. BIA in partnership with FHWA's Office of Federal Lands Highway provides matching funds to TTAP centers. The LTAP and TTAP centers collaborate with other organizations to share resources and expertise, increase efficiency, and reduce duplication of services, making the LTAP/TTAP model as sustainable as it is successful.

"You have to plant the seed if you expect anything to grow," McNinch says. "Something as simple as an article in a newsletter or distributing a manual qualifies as a seed. But an LTAP/TTAP center's real mission is to cultivate those seeds, through training and technical assistance, to help them grow into something worthwhile, something that makes a difference—like changing the way roads are managed in this country."

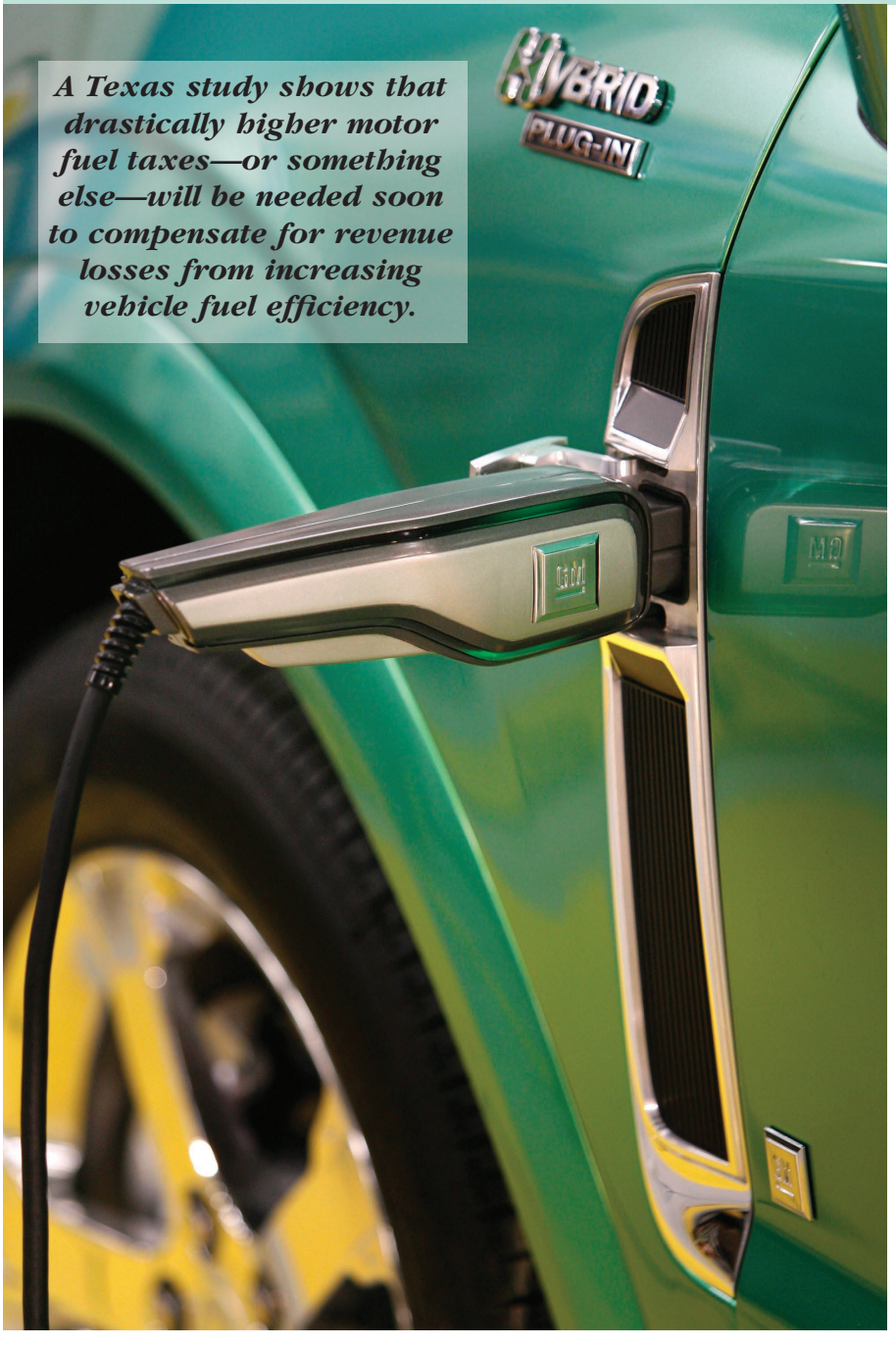
Denise Saunders has served as the LTAP/TTAP program manager since July 2007. She has more than 20 years of experience with FHWA, working at headquarters and division offices. She brings experience in quality management principles, performance measurement, and program evaluation. Prior to this position, Saunders worked on FHWA's National Review Program as a member of the reviews on administration of local projects and procurement and selection of consultant services. Before moving to the Washington, DC, area in 2004, she was the quality coordinator in the FHWA Connecticut Division Office.

Donna Shea is director of the Connecticut LTAP center at the University of Connecticut, where she has worked for 9 years. Previously, she was with the Tuck Executive Education program at Dartmouth College. Shea's expertise is adult learning. She also serves as president-elect of NLTAPA.

For more information, visit www.ltapt2.org or www.ltap.org, or contact Denise Saunders at 703-235-0532, denise.saunders@dot.gov, or Donna Shea at 860-486-0377, shea@engr.uconn.edu. To locate a center, visit www.ltapt2.org/centers.

Higher Gas Efficiency *Equals* Lower Fuel Revenues

by Ron Hagquist



A Texas study shows that drastically higher motor fuel taxes—or something else—will be needed soon to compensate for revenue losses from increasing vehicle fuel efficiency.

It would be difficult to miss all the recent articles surrounding the current status of the Federal Highway Trust Fund. A main source of financial support for the transportation community, the fund is based on an old model of high gas consumption. Today, automobiles are more efficient, and consumers are cutting back.

But fuel tax rates have not been adjusted to meet growing needs for highway investment. The last increase in Federal fuel taxes was in 1993. Since then, highway construction costs have risen substantially. Recent spikes in fuel prices have reduced travel and hence fuel tax revenues, and voters have been reluctant to increase fuel tax rates.

Inflation in both construction and maintenance also have contributed to the highway revenue needs gap. At a time when fuel costs are continuing to increase, consumer demand is decreasing, and the institutional environment is staying the same, a long-term solution could take a while. Where does that leave the transportation community?

State departments of transportation (DOTs) are beginning to implement innovative financing strategies such as tolling and public-private partnerships (PPPs), but the bulk of their funding still comes from motor fuel taxes. Using even conservative estimates for market acceptance of technological improvements, such as

(Left) Plug-in vehicles such as this one are slated to enter the marketplace in 2010. *Photo: General Motors Corporation.*

hybrid and plug-in electric vehicles, the prognosis indicates a dramatic increase in motor fleet efficiency (cars and trucks) in the United States over the coming quarter century.

For State DOTs, which rely on motor fuel taxes for most of their funding, the years ahead pose a major financial challenge as motor vehicles become increasingly fuel efficient, motorists purchase less fuel, and fuel tax revenues decline. The Federal and State governments need to plan for this significant change when estimating future funds from the motor fuels tax.

As a basis for long-range strategic planning and policy evaluation, the Texas Department of Transportation (TxDOT) recently engaged a transportation consulting firm to produce a long-term forecast of the fuel efficiency of motor vehicles in the State. The study found that the fuel tax might have to be increased nearly eightfold to meet the expected mobility needs and to compensate for much wider use of more fuel-efficient motor vehicles. These findings indicate that policymakers need to start looking at expanded use of innovative financing and technological solutions such as a vehicle miles traveled (VMT) tax as alternatives to fuel taxes for transportation-related funding.

Fuel Efficiency on the Rise

In his 2007 State of the Union speech, President George W. Bush laid out a comprehensive plan to improve U.S. energy security by reducing the Nation's gasoline consumption by 20 percent over the next 10 years. Increasing Corporate Average Fuel Economy (CAFE) standards for the new car fleet is a primary means of meeting that goal.

The 2007 CAFE standard for the fuel efficiency of new vehicles is 11.7 kilometers per liter, km/l (27.5 miles per gallon, mi/gal) for cars and 9.4 km/l (22.2 mi/gal) for light trucks. Some commercial hybrid vehicles already on the road attain double those figures.

The second generation of hybrids (plug-in vehicles), coming to market around 2010, will have a fuel efficiency of 42.5 km/l (100.0 mi/gal). The third generation will be lighter and even more fuel-efficient. Already, a Volkswagen prototype car made of high-strength carbon composite material attains 101.6 km/l (239.0 mi/gal).

A perfect storm of political, technological, and market factors are converging to drive this change. Politically, financial incentives (subsidies such as tax credits) for purchasing hybrid vehicles have been used. In addition, more ambitious CAFE standards might become a reality.

Technological and market factors, and actions by automakers and buyers, could outpace government action. According to a 2007 survey of motor industry experts by technology-futures forecasting firm TechCast, the consensus is that 2012 is the most likely year for hybrids to attain 30 percent of the U.S. new car market. By 2025, the hybrid market share could be as high as 75 percent, the firm says.

In addition, automakers are introducing other fuel-saving technologies,

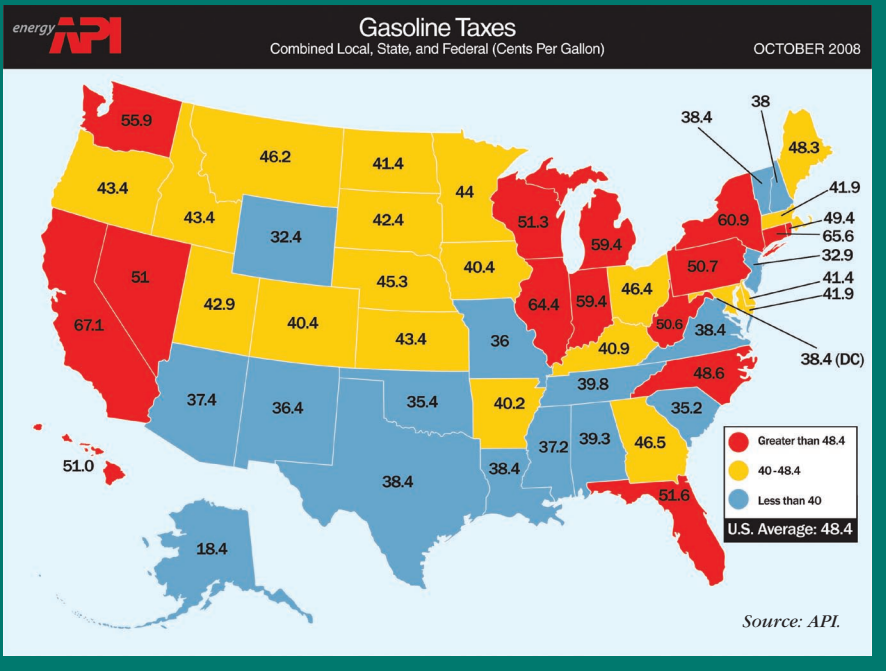
Gas Tax Rates and the Highway Trust Fund

States impose their own gas taxes, in addition to the Federal taxes per gallon of gas. These taxes vary from State to State. Alaska has by far the lowest tax rate at 8 cents per gallon, while Pennsylvania has the highest tax rate at 38.1 cents per gallon. The tax rates for diesel also vary substantially by State.

The largest contributor of revenues to the Highway Trust Fund is the Federal tax of 18.4 cents per gallon on gasoline and gasohol (a fuel consisting of a blend of ethyl alcohol and unleaded gasoline). Under current Federal law, such taxes are scheduled to expire in 2011. The gas and gasohol tax currently produces about two-thirds of the fund's total revenues. Almost 2.9 cents per gallon is dedicated to the mass transit account. The second-largest source is the levy of 24.3 cents per gallon on diesel, which accounts for about one-quarter of the revenues.

Thus, taxes on motor fuels generate about 90 percent of the trust fund's total revenues. The rest come from a 12 percent tax on the first retail sale of a truck or trailer above a certain weight, taxes on truck tires for highway use, and an annual use tax on heavy trucks. The Congressional Budget Office projects all five of those revenue sources separately, along with refunds on amounts paid by certain taxpayers, such as State and local governments, which are exempt from the taxes.

Revenues from taxes on gasoline and diesel fuel are credited to the trust fund, and then the highway and mass transit accounts receive shares. Revenues from the three different taxes on trucks are credited entirely to the Highway Account. Currently, more than 85 percent of the revenues in the Highway Trust Fund go to the Highway Account.



Fuel-Saving Technology

New Technology	Efficiency Increase
Variable valve timing and lift	5.0%
Cylinder inactivation	7.5%
Turbochargers/superchargers	7.5%
Integrated starter/generator systems	8.0%
Direct fuel injection	12.0%
Continuously variable transmissions	6.0%
Automated manual transmissions	7.0%

Source: www.fueleconomy.gov/feg/tech_adv.shtml.

such as state-of-the-art transmissions. The benefits generally are additive. As more new technologies are incorporated into a vehicle, the fuel efficiency increases. Motivated by fuel prices, auto manufacturers could replace standard spark-ignition engines with diesel engines in light trucks, increasing fuel economy by 30 percent.

In addition, according to the U.S. Department of Energy, although hybrid vehicles accounted for just 2.2 percent of all new vehicle registrations for 2007, hybrid vehicle registrations rose 38 percent for a total of 350,289. Of the top 10 States for new hybrid vehicle registrations, California had by far the most, accounting for a quarter of all new hybrid vehicles, while the remaining top 9 States—Florida, Illinois, Massachusetts, New Jersey, New York, Pennsylvania, Texas, Virginia, and Washington—each had about 3 to 5 percent of new hybrid registrations. Although the State of Washington had only 3.7 percent of new hybrid registrations for 2007, it was second only to California on a per capita basis.

Hybrid vehicles have been sold in the United States since the Honda Insight went on the market in 1999. Total hybrid sales were about 350,000 in 2007, which is an increase of about 40 percent over total 2006 sales. Sales of hybrids also have increased at the national level from 1.4 to 2.6 percent. Diesels, however, experienced a slight decline in 2007, bringing their total sales figures closer to that of hybrid vehicles.

The Texas Study

In developing its long-range plans, TxDOT sought to account for these market trends in fuel efficiency. Using a scenario-based approach, the consultant's study, *Accounting for Fuel Efficiency in Texas Fuel Tax Revenue Estimations*, found that the average fleet mileage, currently 7.6 km/l (17.9 mi/gal), will likely increase to 24.7 km/l (58.0 mi/gal) by 2030—and quite possibly as high as 36.6 km/l (86.0 mi/gal).

In other terms, Texas's average total fleet (all cars and trucks on the road in the State) efficiency most likely will triple by 2030 and could increase nearly five times. This rate of increased efficiency greatly outstrips the expected growth in Texas's population, resulting in a large net decrease in fuel tax revenues.

The second part of the analysis used the consultant's efficiency projections to determine how much higher the State motor fuels tax would have to be to cover the estimated $86 billion gap in mobility needs expected to accrue in Texas by 2030—that is, the shortfall that was expected in fuel tax revenues before considering higher vehicle fuel efficiency. Using a set of fleet efficiency scenarios, the consultant determined that the tax, currently 20 cents per 3.8 liters (1.0 gallon), necessary to close the gap is between $1.33 and $1.79, most likely $1.51 per gallon. Thus, the State would need to increase the current tax by a factor of nearly eight to compensate for the greater fuel efficiency anticipated in Texas.

The Texas Scenarios

The next 25 years will look very different than the last 25 in terms of two critical factors affecting fuel consumption: the dawn of high fuel-efficiency technology and the dusk of cheap oil. Even a cursory assessment of these factors finds a wide range of possible outcomes. Since simple extrapolation of historical trends is not appropriate due to likely major changes in these fundamental factors, the consultant used a scenario approach to forecast fuel consumption in Texas. According to the study, the two parameters critical to the future of motor fleet fuel efficiency are technological progress and market acceptance.

The consultant combined scenarios of motor-industry market forecasts with scenarios of technological fuel-efficiency improvements. The

Why Scenarios?

According to an old military adage, "the first casualty of any battle is the battle plan." Recognizing this, major military planning is based on multiple scenarios that explicitly recognize the uncontrollable. Likewise, a long-term forecast usually contains multiple uncertainties that make a single-number prediction of limited value to a decisionmaker. Of greater value is a range of predicted values along with a statement of the likelihood that the actual outcome will be within that range.

Forecasting fuel tax revenues out to 2030 involves compounding two critical but uncertain factors: technological fuel-efficiency progress and rate of adoption in the marketplace (fleet turnover). Therefore, a high technological possibility paired with a high rate of incorporation into the fleet results in high fuel efficiency, whereas the combination of low progress and low market acceptance has a low efficiency outcome.

For this reason, the Texas researchers used a scenario approach to provide a fuller picture in their long-term forecast of motor vehicle fuel efficiency. They used three scenarios of technology and three of market penetration as inputs, resulting in nine combinations of the underlying variables. The researchers went another step by taking a risk analysis approach, assigning likelihoods (probabilities) to the input scenarios and producing joint likelihoods for the nine resulting forecasts. So in 2030, the fleet efficiency will almost certainly be between 13.0 kilometers/liter, km/l (30.5 miles per gallon, mi/gal) and 36.8 km/l (86.5 mi/gal), with about a 60 percent probability of being between 14.9 km/l (35.0 mi/gal) and 24.7 km/l (58.0 mi/gal).

Alternative Scenarios

Scenario	Probability	Cumulative Probability
Low market penetration and low km/l (mi/gal)	6.25%	6.25%
Low market penetration and high km/l (mi/gal)	6.25%	12.50%
Low market penetration and average km/l (mi/gal)	12.50%	25.00%
Average market penetration and low km/l (mi/gal)	12.50%	37.50%
Average market penetration and high km/l (mi/gal)	12.50%	50.00%
Average market penetration and average km/l (mi/gal)	25.00%	75.00%
High market penetration and low km/l (mi/gal)	6.25%	81.25%
High market penetration and high km/l (mi/gal)	6.25%	87.50%
High market penetration and average km/l (mi/gal)	12.50%	100.00%

Source: TxDOT.

consultant also estimated the associated probabilities for these individual scenarios, allowing calculation of the likelihoods of the final combined scenarios. Since wider adoption of hybrids is only one of the expected fleet changes that will increase fuel efficiency over the coming decades, the analysis factored in other changes, including greater use of diesel engines and technologies such as continuously variable transmissions and cylinder idling.

Low, medium, and high scenarios for both market and technology resulted in nine scenarios of fleet fuel efficiency, each with an estimated probability, in turn allowing determination of confidence intervals for future fuel efficiency.

The consultant's study found that the overall fleet fuel efficiency in Texas will likely range between 10.4 km/l (24.5 mi/gal) and 17.0 km/l (40.0 mi/gal) in 2020 (averaging out at 13.7 km/l, 32.2 mi/gal), and range between 13.0 km/l (30.5 mi/gal) and 36.8 km/l (86.5 mi/gal) in 2030 (averaging out at 24.7 km/l, 58.0 mi/gal).

"Rather than simply come up with a point estimate of the revenue shortfall due to increased vehicle efficiency, the consultant came up with a range of plausible outcomes on two dimensions of uncertainty to give decisionmakers a look at the real future, which is always more complex than our expectations allow," says Peter Bishop, coordinator of the Future Studies program at the University of Houston.

Financial Ramifications

The second part of the analysis consisted of determining the necessary tax increase that would be required to meet an $86 billion gap in mobility needs through 2030. This analysis goes to the issue of the feasibility of funding mobility needs in Texas entirely from increasing fuel taxes as opposed to tolling roads or using other forms of revenue generation. This computation involved adding to the fuel efficiency scenarios two additional low and high scenarios for annual traffic growth over the 25-year timeframe (1.7 percent and 3.2 percent, respectively).

The "average tax value" is the average annual Texas State tax that would have to be imposed over the entire 25 years to close the entire $86 billion gap over that period. The range of scenario results shows that the "expected value" (the probability-weighted average) is $1.51, with a 75 percent probability that the tax will have to be within a range of $1.33 to $1.79.

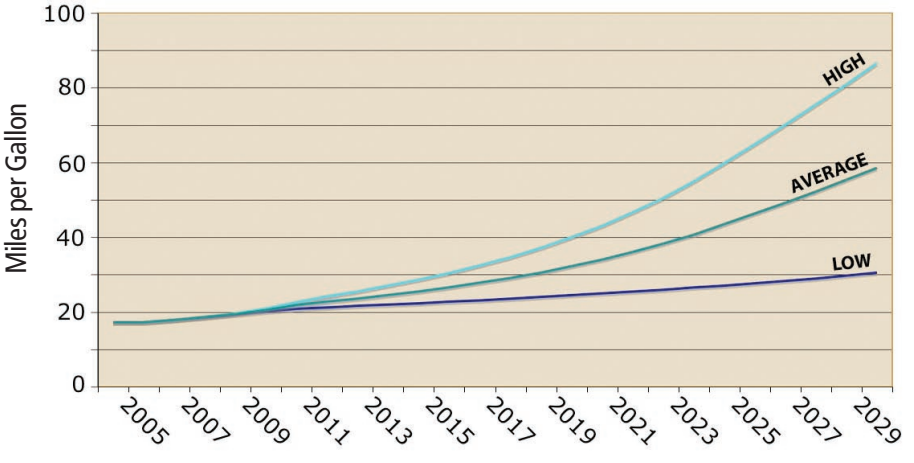
Trends and Solutions

Even in growth States such as Texas, the outlook for fuel tax revenues over the coming decades is for dramatic declines. Increases in fuel efficiency can easily exceed long-term growth in driving, resulting in lower fuel use and therefore lower tax revenues.

Many factors will continue to drive the popularity of hybrids and other fuel-saving technology: the rising price of oil, the push to reduce foreign imports of oil, and the desire to reduce greenhouse gas emissions and smog-causing pollutants from tailpipes. The common-denominator solution is reducing fuel use, and the technology is already doing just that.

The study findings—that a considerable increase in funding would be required to meet mobility needs

Scenarios of Texas Fleet Efficiency



This graph depicts the projected future of vehicle fuel efficiency in Texas, with low, high, and average scenarios. Cumulative effects of high-efficiency vehicles on fuel consumption will likely become significant within the next 10 years and have an even greater impact in the subsequent decade. *Source: TxDOT.*

Alternative Scenarios Results

Market Penetration Of Alternative Technologies	Km/l (mi/gal) Improvement For All Technologies	Average Tax Value	Probability	Cumulative Probability
Low	Low	$1.26	6.25%	6.25%
Medium	Low	$1.32	12.50%	18.75%
Low	Medium	$1.33	12.50%	31.25%
High	Low	$1.38	6.25%	37.50%
Low	High	$1.44	6.25%	43.75%
Medium	Medium	$1.51	25.00%	68.75%
High	Medium	$1.68	12.50%	81.25%
Medium	High	$1.79	12.50%	93.75%
High	High	$2.14	6.25%	100.00%

Source: TxDOT.

over the next quarter century—argue forcefully for the need for policymakers to consider innovative and road user-based financing. "Future vehicle design and fuel efficiencies are going to profoundly change the financial landscape for highways," says Robert Harrison, deputy director of the Center for Transportation Research at The University of Texas at Austin.

Next Steps

Departments of transportation across the Nation face a similar situation: changing fuel efficiency, aging infrastructure, and the demand-dampening impact of higher fuel prices. In Texas and elsewhere, increasing mobility needs due to continuing

Spurring Innovation

With encouragement from Federal agencies, the X PRIZE Foundation and Progressive® insurance company are offering $10 million in prizes to teams who can design vehicles that achieve the energy equivalent of 42.5 kilometers per liter (100.0 miles per gallon) and are safe, environmentally friendly, and appealing to car buyers.

"This competition will result in more choices of more fuel-efficient vehicles for drivers and will be a catalyst for moving this technology forward, faster," said Progressive CEO Glenn Renwick at the prize's announcement at the New York International Auto Show in March 2008.

The X PRIZE Foundation achieved a primary goal in 2004, when its $10 million Ansari X PRIZE spurred pilot Burt Rutan to take the world's first private vehicle into suborbital space flight. The Progressive Automotive X PRIZE has received support and encouragement from Government agencies that will help the privately funded organization conduct the competition and test vehicle compliance. These agencies include the following: the U.S. Department of Energy (DOE), Argonne National Laboratory, the U.S. Department of Transportation's Federal Highway Administration and National Highway Traffic Safety Administration, the U.S. Environmental Protection Agency, and the California Air Resources Board.

Progressive Automotive X PRIZE

The New York International Auto Show saw the kickoff of the Progressive Automotive X PRIZE competition. Here, John Mizroch, principal deputy assistant secretary for DOE's Office of Energy Efficiency and Renewable Energy, offers the agency's support during remarks made via video monitor placed behind two next-generation cars.

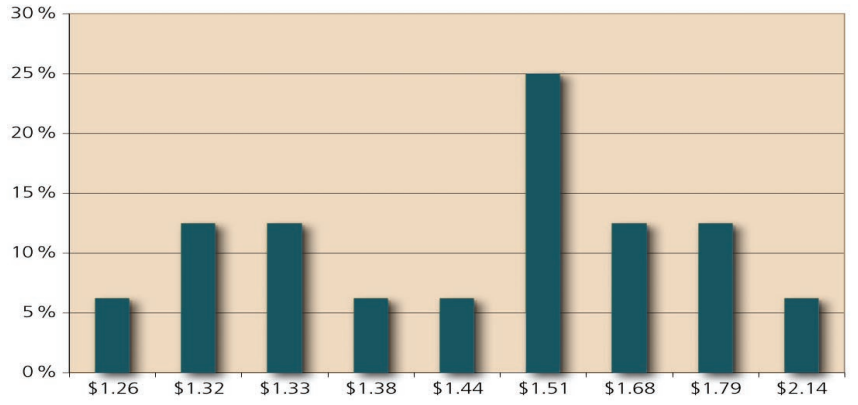
As of July 2008, 90 teams from 12 countries said they plan to enter the competition. The goal is "to inspire a new generation of viable, super fuel-efficient vehicles that offer more consumer choices," with emphasis placed on affordability, safety, and the environment. "It is about developing real, production-capable cars that consumers want to buy, not science projects or concept cars," according to the competition's press release.

Teams compete in one of two vehicle classes: mainstream and alternative. Mainstream vehicles must be able to carry four or more passengers, have four or more wheels, and have a 322-kilometer (200-mile) range. Alternative vehicles must be able to carry two or more passengers and have a 161-kilometer (100-mile) range; there are no constraints on the number of wheels. All vehicles must meet current pollution and safety standards.

The competition culminates in two long-distance stage races in 2009–2010. The race courses will reflect typical consumer driving patterns in varied terrain, communities, and weather conditions. To win, vehicles must complete both races with the lowest overall time averaged over all scoring stages. The $10 million purse will be divided 3:1 between the winners of the alternative and mainstream classes.

For more information, visit www.xprize.org.

Scenarios and Probabilities



This graph depicts the likelihood, in percentages, that a given level of motor fuels tax would have to be implemented to compensate for the $86 billion anticipated shortfall in transportation funding. The probabilities for the various fuel tax amounts take into account technological advances and market acceptance of high-efficiency vehicles. *Source: TxDOT.*

population and economic growth add to the challenge.

In response, TxDOT established a high-level 2030 Committee composed of transportation officials, stakeholders, and researchers with the mission to direct a major assessment of the State's transportation needs through 2030. Two university transportation research organizations will complete the study in time for the convening of the Texas Legislature in January 2009.

That study, together with the revenue scenarios based on fuel efficiency, will provide elected officials with the most extensive and up-to-date information possible for considering policy options for addressing the funding gap.

For example, one long-term strategy might be to levy a fee on vehicle miles traveled rather than a per gallon fuel tax. Some new investment-raising strategies that several States are using or testing for building and maintaining the transportation system include tolling, pricing, bond issuance, and PPPs. In the financial arena, diversification is viewed as a prudent strategy to balance risk. Likewise, a mix of revenue sources to fund future surface transportation improvement programs also could benefit States. Industry experts agree that the financing issue is serious and complex. Most likely, the solution also will be complex.

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For more information, contact Ron Hagquist at 512–936–9512 or rhagquis@dot.state.tx.us. To view a copy of the Texas report, visit www.camsys.com/pubs/TXDOT_GBE.pdf.

Editor's note: On September 18, 2008, the U.S. Secretary of Transportation Mary E. Peters remarked on President George W. Bush's action regarding the Highway Trust Fund: "Following the President's signature of legislation to prevent a funding shortfall in the Highway Trust Fund, $8.017 billion of general funds has now been transferred to the Highway Account of the Highway Trust Fund. Yesterday, we paid all current State payment requests, and today, we will resume daily payments. While the Highway Account has been temporarily replenished, we should not delude ourselves into thinking the fundamental problems of transportation funding are somehow resolved. It is imperative that the debate begin now as to the most effective means to finance and improve highways and transit infrastructure in the United States. Clearly, the current tax and spend model is both unsustainable and unresponsive to the country's needs."

Funding Mechanisms Available to States

The following funding mechanisms are among those available to States.

- Bond and other instrument debt financing, such as Private Activity Bonds, (www.fhwa.dot.gov/PPP/tools_pabs.htm), Transportation Infrastructure Finance and Innovation Act (tifia.fhwa.dot.gov), and Grant Anticipation Revenue Vehicles (GARVEE) bonds (www.fhwa.dot.gov/innovativeFinance/garguid1.htm)
- Public-Private Partnerships (www.fhwa.dot.gov/PPP)
- Tolling (www.fhwa.dot.gov/ppp/toll_survey.htm)
- Third Party Donations of Funds, Materials, or Services for Federally Assisted Projects (www.fhwa.dot.gov/innovativeFinance/sc322510.htm)
- Congestion pricing (www.fhwa.dot.gov/policy/vppp.htm)
- Express Lanes Demonstration Program (http://ops.fhwa.dot.gov/tolling_pricing/express_lanes.htm)
- Interstate System Reconstruction & Rehabilitation Pilot Program (http://ops.fhwa.dot.gov/tolling_pricing/interstate_rr.htm)
- Interstate System Construction Toll Pilot Program (http://ops.fhwa.dot.gov/tolling_pricing/interstate_constr.htm)
- Title 23 United States Code Section 129 Toll Agreements (http://ops.fhwa.dot.gov/tolling_pricing/toll_agreements.htm)
- Toll Credit for Non-Federal Share, Section 1905 of SAFETEA-LU (www.fhwa.dot.gov/specialfunding/020807.cfm)
- Sales taxes

For more information on revenue sources, see the 2007 report *Revenue Sources to Fund Transportation Needs* by the American Association of State Highway and Transportation Officials, available at www.transportation1.org/tif4report/intro.html.

Deploying Technology in Challenging Terrain

by H. Gabriella Armstrong, Amit Armstrong, Gary L. Brown, and Roger W. Surdahl

Now 25 years old, the Federal Lands Highway Program is still making out-of-the-way places safely accessible.

Sinuous, exhilarating, emotive—the roads that provide access to the majestic peaks, magnificent vistas, and awe-inspiring terrain on the Nation's public lands are feats of engineering that safely guide visitors through what is known as some of the most spectacular scenery in the world. The topography of these rugged, remote, and environmentally sensitive areas poses engineering challenges for the Federal land management agencies (FLMAs) responsible for building and maintaining the roads and bridges that provide access to Federal and tribal lands.

The primary challenge of providing access to these lands is ensuring that roads, guardrails, and other infrastructure fit seamlessly with the natural environment while simultaneously meeting rigorous standards for safety and performance. For FLMAs, the goal is for visitors to experience safe and pleasant journeys when driving in national parks, forests, wildlife refuges, and Indian reservations. Over the past 25 years, FLMAs have relied on the Federal Lands Highway Program (FLHP) to construct these public

roads, oftentimes deploying innovative technologies in the process.

The FLHP Approach

In 1982, the Surface Transportation Assistance Act created the FLHP to provide financial resources and technical assistance for a coordinated program of public roads that serve the transportation needs of Federal and Indian lands. The Federal Highway Administration's (FHWA) Office of Federal Lands Highway (FLH) is charged with overseeing the FLHP and providing stewardship and engineering services for planning, designing, constructing, and rehabilitating the highways and bridges on federally owned lands. The focus of the program is to define the challenges involved in its projects and then propose solutions using new, innovative, emerging, and underused technologies. (For more information on the history of the FLHP, see "Accessing America's Treasures" in the July/August 2008 issue of PUBLIC ROADS, or visit www.fhwa.dot.gov/FLH.)

To streamline technology deployment for transportation projects on Federal lands, FHWA established the Coordinated Federal Lands Highway Technology Implementation Program (CTIP) in 1984 in cooperation with the National Park Service (NPS), U.S. Forest Service, and Bureau of Indian Affairs (BIA). In 1998 the program expanded by coordinating with the U.S. Fish and Wildlife Service (USFWS). Also in 1998, FHWA supplemented CTIP with the Technology Deployment Initiatives and Partnership Program (TDIPP), which was discontinued in 2005 with passage of the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU).

Through CTIP and other such initiatives and programs, FLH champions innovative technologies and approaches in numerous areas to design and build NPS roads and parkways, Forest Service roads, BIA reservation roads, and USFWS roads. Although the FLHP's focus is to deploy technology on low-volume, low-speed roads in difficult environments, many Federal lands are adjacent to urban or suburban areas that pose additional challenges, such as traffic congestion.

"Innovation is an important part of the Federal Lands Highway mission, and programs such as CTIP help us advance new products and tools for our partners," says FLH Associate Administrator John R. Baxter. "Any celebration of successes on U.S. highways in the last 25 years must include the innovations and solutions of CTIP."

CTIP innovations comprise four broad categories: safety enhancements, context sensitive solutions (CSS), acceleration of project delivery and construction, and nondestructive evaluation (including field-based testing and evaluations). CTIP empowers FLH designers and engineers to use advanced technologies in current projects and plan for deploying emerging technologies in future projects. One avenue used by FLH to identify innovations is its partnership with the FHWA Turner-Fairbank Highway Research Center (TFHRC). (See "Innovations and Deployment: FLH and TFHRC" on page 26 for more details.)

The following discussion of technology deployments on Federal lands over the last quarter century highlights the value the FLHP delivers to its partners and, ultimately, the motoring public.

Safety Enhancements

"One of the primary objectives of FLH designers and engineers for each new construction or rehabilitation project is to include safety enhancements to bring the roadway to current safety standards," says Greg Schertz, FLH safety functional discipline leader. "However, meeting these safety requirements while also fulfilling the historic, cultural, aesthetic, and environmental requirements specific to the project poses a special challenge and requires innovative solutions. We have conceived, designed, and constructed aesthetically pleasing barriers and other safety devices to meet all these requirements for our partners."

Aesthetic Barriers for NPS. Due to safety concerns in the 1980s, FHWA

(Left) The recently constructed east entrance road to Yellowstone National Park, WY, shown here, incorporates simulated stone-faced concrete retaining walls with guardrails. In rugged, environmentally sensitive areas such as this, FLH helps Federal land management agencies address engineering challenges on Federal lands.

Timeline of FLH Technology Deployment Program

1984:	The Office of Federal Lands Highway (FLH) started its first technology deployment program, the Coordinated Federal Lands Highway Technology Implementation Program (CTIP), in cooperation with the National Park Service, U.S. Forest Service, and Bureau of Indian Affairs. Each partner agency contributed 0.5 percent of its highway funds for the program.
1985–1996:	CTIP provided funding for the FLH technology deployment program. CTIP was implemented at the FLH headquarters level.
1998:	The Technology Deployment Initiatives and Partnership Program (TDIPP) was established under the Transportation Equity Act for the 21st Century. Technology deployment positions were created at the three FLH divisions: the Western Federal Lands Highway Division in Vancouver, WA; Central Federal Lands Highway Division in Lakewood, CO; and Eastern Federal Lands Highway Division in Sterling, VA.
1998:	The U.S. Fish and Wildlife Service joined CTIP. The CTIP council was established with membership from each partner agency. The council formalized the proposal review and funding process.
1997–2005:	Technology deployment by all three divisions increased, helped by sufficient funding and involvement of partner agencies.
2005:	TDIPP was discontinued under the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users.
2008:	The FLH technology deployment program is cooperating successfully with partner agencies, State departments of transportation, local entities, and university transportation centers.

Innovations and Deployment: FLH and TFHRC

The relationship between FLH and TFHRC is mutually beneficial. The TFHRC facility provides research services and a means to study the effects of innovations in the field, and FLH deploys innovations that solve problems on Federal lands. "Applying research developments and innovations in the real world in addition to the lab setting provides TFHRC with information, which contributes to development of better innovations and increased likelihood of technology and innovation deployment," says Michael Trentacoste, acting associate administrator of the FHWA Office of Research, Development, and Technology and acting director of TFHRC. FLH and TFHRC have collaborated on several innovations for deployment on Federal lands—a sampling follows.

- The Pavement Surface Analysis Laboratory at TFHRC developed a series of noncontact devices to measure pavement surface texture, collectively known as the Road Surface Analyzer (ROSAN). ROSAN quickly became one of FLH's standard devices for measuring pavement smoothness, roughness, and texture. This innovation improves the safety and productivity of field staff because no traffic control is needed, and results are available almost in real time. Further, ROSAN increases objectivity, accuracy, repeatability, and speed of data processing by multiple orders of magnitude.
- FLH volunteered to beta test TFHRC's Interactive Highway Safety Design Model (IHSDM), a computer-based system that enables roadway designers to assess the potential safety effects of alternative highway designs. IHSDM consists of several analytical modules: a crash prediction module, a design consistency module, a driver/vehicle module, an intersection diagnostic review module, a policy review module, and a traffic analysis module. "The benefits of using IHSDM for FLH are the same as for any organization," says Ray Krammes, technical director of the FHWA Office of Safety Research and Development. "The evaluation capabilities of IHSDM assist planners and designers to maximize the safety benefits of highway projects within the constraints of cost, environment, and other considerations. The benefit to us is that FLH will test the model and provide input and insights that will help us refine the product so we can provide the most useful software."
- In another cooperative roadway safety project, TFHRC researchers analyzed existing bridge-related crash data to assist FLH in setting policy about the installation of bridge rails on low-volume Federal roads.
- FLH and the FHWA Office of Research, Development, and Technology share a mutual interest in hydraulic analysis studies and software. For example, TFHRC and contractors enhanced the software program BRIdge Stream Tube model for Alluvial River Simulation (BRI-STARS), a generalized semi-two-dimensional water- and sediment-routing computer model that includes an integrated graphical interface. BRI-STARS can help solve complicated river engineering problems with limited data and resources and is particularly useful for evaluating sites where contraction scour and/or the effects of in-stream mining are concerns. The Western Federal Lands Highway Division has used the model in hydraulic analyses of several of its bridge locations.
- When NPS experienced a problem with pavement rutting at the intersection of 15th Street and Constitution Avenue in Washington, DC, the agency contacted FLH for help. The standard asphalt mix for the District of Columbia was failing at the intersection, and the pavement was rutting prematurely. FLH in turn requested assistance from TFHRC, which evaluated the DC mix design using accelerated performance tests. Using the data from the evaluation, the District and FLH tried a modified asphalt mix for the first time.
- Over the years, TFHRC has supported efforts to develop roadside hardware for FLH, including managing or conducting crash testing of proposed designs. Most recently, the Federal Outdoor Impact Laboratory at TFHRC conducted proof-of-concept testing for a new end treatment for steel-backed timber guardrail.

TFHRC supports FLH in developing and crash-testing proposed designs for roadside hardware. A recent collaboration involved steel-backed timber guardrail, shown here installed along a roadway in Yellowstone National Park in Wyoming. Inset: A closeup of the steel-backed timber guardrail.

mandated that roadside barrier systems must meet safety and crash test requirements. But the steel and concrete systems typically used by departments of transportation (DOTs) did not meet the cultural, historical preservation, and aesthetic requirements of the FLMAs. New barriers using stone and wood had failed crash tests conducted at the Texas Transportation Institute. The FLMAs tried a number of systems without identifying an acceptable design.

To solve the problem, FLH worked with the FLMAs to develop roadside barrier systems that would meet both aesthetic requirements and FHWA's safety requirements. FLH designed barriers using wood and stone but incorporated steel and concrete to enable the systems to pass the safety tests. Engineers designed timber and log barriers with steel backings placed behind the rails.

Construction crews in Glacier National Park, MT, built stone guardwalls with steel-reinforced concrete cores and stone facing. In Mount Rainier National Park, WA, FLH designed artificial stone guardwalls with steel-reinforced concrete cores and simulated stone facing. The FLH engineers raised barrier heights to match typical roadside barriers. The barrier system design also included bridge transitions and buried terminals used for anchoring the guardrails. The new barriers improved the safety and performance of roads on public lands and maintained the aesthetic standards the FLMAs desired.

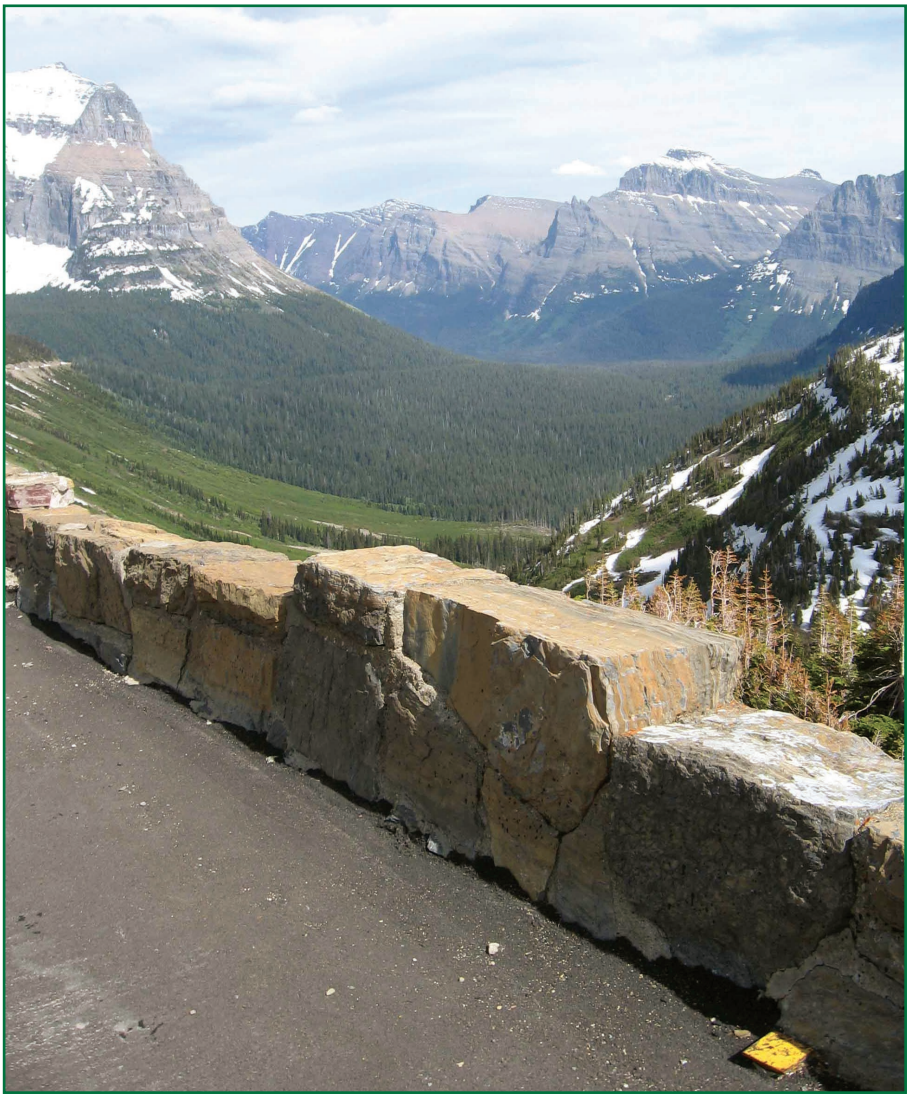
CSS: Lying Lightly On the Land

Because FLHP projects are located in some of the most ecologically sensitive areas, program engineers learn to tread lightly on the land. The engineers strive not only to minimize construction footprints but also to blend projects with the natural environments. The construction approaches and resulting projects, while aesthetically pleasing and minimally intrusive, enhance safety and provide access.

FLH works with its partners in implementing CSS to ensure that roadway facilities balance local, regional, and national concerns with the scenic, aesthetic, historic, and natural environments, and that they add value to their communities. FLH now has expertise and a reputation for planning, designing, and constructing transportation facilities in some of the most environmentally, historically, culturally, and scenically sensitive areas of the country. FLH engineers and designers led development of a course titled Introduction to Context Sensitive Solutions (FHWA-NHI-142050), now offered by the National Highway Institute to Federal, State, and local transportation professionals.

Rustic Pavements. A "rustic pavement" is one that matches the historic character of a location while meeting current safety and traffic requirements. NPS asked FLH to design rustic pavements that would satisfy the criteria for long-term durability and aesthetics and could be placed using conventional hot mix asphalt paving techniques. NPS wanted a number of designs that could be used in different park environments in future years.

FLH utilized a transparent, amber-colored, synthetic binder that, when mixed with select aggregates, would achieve a rustic (that is, dirt- or gravel-colored) appearance. Engineers on the project used no pigments, so the aggregate's color and texture are visible. FLH investigated various aggregate sources, pavement types such as Superpave and stone matrix



FLH installed a crenulated stone-faced guardwall (shown here) with a concrete core at Logan Pass in Glacier National Park, MT.

A paver is placing this rustic pavement at Richmond National Battlefield Park in Virginia.

asphalt, and job mix formula combinations until it obtained the aesthetic and quality requirements. To assess the performance of the rustic pavement concept, researchers at TFHRC conducted a series of laboratory tests to study properties such as durability, weathering, moisture susceptibility, and resistance to rutting.

FLH first used this innovative pavement at Virginia's Richmond National Battlefield Park in 2003, and the next year placed it at the Pennsylvania Avenue pedestrian plaza in front of the White House in Washington, DC. (For more information, see "Rustic Pavements" in the September/October 2004 issue of PUBLIC ROADS.)

Roadside Revegetation. In another CSS project, FLH worked with the FHWA Office of Planning, Environment, and Realty and the Forest Service to develop an integrated approach to use native plants for roadside revegetation. The approach provides a common framework for biologists and engineers to work together to minimize the disturbance within construction areas. The framework includes roadside revegetation within the timeline of roadway design and construction, making it an integral part of the project. WFLHD used this approach on a number of forest highway projects in eastern Oregon. (For more information, see "The Greening of Public Roadsides" in the November/December 2007 issue of PUBLIC ROADS.)

Stabilized Grass Pulloffs. Grass shoulders are the standard design for NPS roads and parkways for aesthetics and to minimize the impact of roadway footprints on the environment. The Gatlinburg Spur Road of the Foothills Parkway in Great Smoky Mountains National Park, TN, is an atypical park road because of the large volume of high-speed traffic generated by the tourist towns at either end. The combination of high traffic volumes, high speeds, and changes in geometric configuration contributes to many crashes. The lack of paved shoulders creates additional safety hazards for park rangers and stranded motorists.

To enhance safety, FLH designed and constructed eight soil-stabilized pulloffs in areas prone to recurrent crashes, typically at the beginning or end of a horizontal curve or near roadside features that restrict the safety zone (that is, the shoulder and unpaved section). At all eight sites, workers placed woven geotextile fabric on the subgrade; used a combination of geocells, geoblocks, polyethylene ring and grid, and/or fiberglass grid for stabilization; and backfilled with an aggregate-topsoil mixture. FLH then seeded the pulloffs to form turf, helping them blend into the environment. The seeded pulloffs deter long-term parking as people are not used to parking on roadside vegetation.

Accelerating Project Delivery and Construction

Timely completion of projects is a priority for FLH. But any number of variables can hamper this goal: weather, changed site conditions, out-of-specification material or work, shutdowns, and contract disputes. For example, in September 2006 strong winds toppled a high-line crane at the Hoover Dam Bypass bridge project in Nevada, resulting in a 6-month delay. Other causes of construction delays are less spectacular but no less important: Variables might range from a snowstorm in June on an asphalt paving project to a rejected concrete drilled shaft for a bridge abutment. FLHP offers numerous solutions to address or circumvent these types of problems.

Design Visualization. FLH engineers used three-dimensional (3-D) design visualization technology to increase stakeholder interaction during planning, design, and construction of the Going-to-the-Sun Road project in Glacier National Park during 2006 and 2007. The technology helped accelerate project delivery by performing "what-if" analyses to assess stakeholder input in near real time. FLH now is using this approach for a number of phases of the Going-to-the-Sun Road project. This technology also will be used to simulate the new transit systems at Glacier National Park. (For more on design visualization, see "Virtual Highways—A Vision of the Future" in the May/June 2007 issue of PUBLIC ROADS.)

Prefabricated Bridge Elements. Prefabricated bridge elements provide significant advantages in terms of construction time, safety, environmental impact, constructability, and cost. FLH uses prefabricated elements in many of its new and rehabilitation bridge projects.

In the early 1990s, FLH employed precast segmental bridge construction on the new Natchez Trace Parkway Bridge in Tennessee. The precast elements accelerated construction and enabled crews to do the fabrication offsite in a controlled environment. The practice also facilitated maintaining traffic on the State

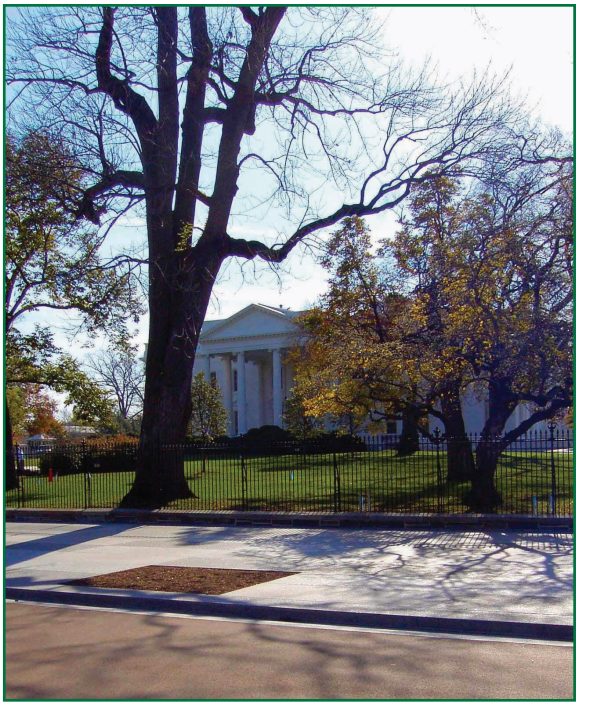
highway beneath the new bridge and otherwise reduced the construction footprint.

In 1998, FLH used precast bridge deck panels to rehabilitate three bridges on the George Washington Memorial Parkway in Virginia. The technique minimized disruption of weekday commuter traffic, and the bridge was closed for construction only during the weekend. During closures, the construction crew removed the old deck and railing, placed new panels, and installed longitudinal tendons to connect the panels so they would perform as a monolithic deck. Workers placed and post-tensioned a total of 142 panels in 10 weekends.

More recently, FLH employed prefabricated bridge elements for the substructure and superstructure of a small three-span bridge in the Parker River National Wildlife Refuge in Massachusetts. The construction project used prefabricated support piles for piers and abutments, pier caps, abutments and wingwalls (cast monolithically), and bridge beams. The prefabricated elements expedited work so the bridge could be constructed during the short time allowed. The prefabrication approach also reduced interruptions from adverse weather and enhanced quality control.

FRP Composite Bridges. FLH's partners—the Forest Service, NPS, and USFWS—support an extensive system of trails. These trails often cross streams and rivers and require lightweight, low-maintenance, easily constructed bridges. To fulfill these needs, FLH engineers developed a lightweight bridge using fiber-reinforced polymer (FRP) composites that can be transported to remote locations and erected without construction equipment.

The engineers used Falls Creek Trail in Gifford Pinchot National Forest, WA, as a case study for an FRP bridge. In 1998, they designed and constructed a 14-meter (46-foot) pedestrian bridge using a Pratt truss. Both top chords of the truss also worked as pedestrian handrails. Because the FRP composite sections are much stronger along their longitudinal axes than their transverse axes, they are ideally suited for narrow, long-span bridges. Also, they are easier to assemble because they are readily available in structural shapes. Based on the performance of this pedestrian bridge, FLH will deploy more FRP composite bridges on other trails in the future.



FLH placed rustic pavement in front of the White House on Pennsylvania Avenue, as shown here completed.

GRS Bridge Foundation. Low-lying wetlands with deep deposits of soft soil and frequent flooding, typical of many wildlife refuges, pose challenges for designing bridge foundations. In 2005, FLH bridge engineers used geosynthetic-reinforced soil (GRS) technology to construct cost-effective shallow foundations for three single-span bridges in the Upper Ouachita National Wildlife Refuge in Louisiana. Staff from the TFHRC geotechnical laboratory worked with FLH to design and monitor the three bridges.

GRS technology consists of alternating layers of geosynthetic fabrics and compacted granular soil that form an internally reinforced structure. At the wildlife refuge, FLH built a reinforced soil foundation in combination with a spread footing for load distribution. The approach reduced the applied bearing pressure on the subgrade soils, essentially "floating" the structure over soft and wet soil deposits. This treatment also reduced settlement while making it more uniform. The GRS technology significantly decreased construction time, used locally available material, and minimized impacts on wetlands. For more information, see the report *Design and Construction Guidelines for Geosynthetic-Reinforced*

Workers install geoblocks for construction of a stabilized grass pulloff on Foothills Parkway in Great Smoky Mountains National Park, TN.

This stabilized grass pulloff on Tennessee's Foothills Parkway blends into the surrounding environment.

Soil Bridge Abutments with a Flexible Facing at http://onlinepubs.trb.org/Onlinepubs/nchrp/nchrp_rpt_556.pdf.

Quantifying Construction Delays Due to Weather. Engineers can reduce weather delays by applying statistical techniques to assess the type and severity of rainfalls and other events expected over the course of a construction job. The planners then can modify the project construction schedule so that weather-dependent activities are scheduled properly to avoid delays.

FLH's weather prediction methods use information from one or more of the National Weather Service stations or other stations kept by NPS or USFS near a construction project to predict potential delays within set statistical limits. Weather prediction using location-specific data is more representative than weather charts developed from local or regional historical conditions.

The weather prediction methods included in the FHWA publication *Quantifying Construction Delays Due to Weather* (FHWA-CFL/TD-08-003) are based on historical weather data. The report includes weather-impact case studies for three recent FLH construction projects on five public lands: Humboldt-Toiyabe and Eldorado National Forests, CA; Six Rivers and Shasta-Trinity National Forests, CA; and Brazoria National Wildlife Refuge, TX.

Characterizing Defects in Drilled Shaft Foundations. Engineers increasingly are using drilled shaft foundations for bridge piers and abutments. The structural stability of the foundation depends on minimizing construction defects, such as voids, honeycombs, segregation, and soil contamination, during concrete placement in drilled shafts.

FLH engineers are using Crosshole Sonic Logging (CSL) to assess the integrity of concrete in drilled shafts. They analyze the defects and compare the shafts with lab samples of similar design mixes. The CSL results, provided in 3-D color-coded graphs, enable the engineers to make informed decisions about repairing or replacing shafts before disrupting construction schedules.

The FHWA technical report *Drilled Shaft Foundation Defects: Identification, Imaging, and Characterization* (FHWA-CFL/TD-05-007) offers methods to identify the nature, severity, and location of measured defects. The report analyzes actual field results for concrete drilled shafts on FLH projects in Hagerman National Wildlife Refuge, TX; Petrified Forest National Park, AZ; and Fishlake National Forest, UT.

MSE Wall System Design Guidelines. Many FLH projects use mechanically stabilized earth (MSE) walls for road widening and new road construction. Typical MSE wall construction in steep terrain requires a level working space, or flat bench. The width of the bench should be at least 70 percent of the wall height; however, this is not always practical and can be expensive, especially in rugged areas.

In one innovative application, FLH used shoring methods to stabilize the back slope while building an MSE wall in front. *Shored Mechanically Stabilized Earth (SMSE) Wall System Design Guidelines* (FHWA-CFL/TD-06-001) documents these methods and illustrates how MSE walls can be constructed on a bench width that is only 30 percent of the wall height. In challenging environments, shoring significantly reduces excavation, providing cost savings and accelerated construction. In 2008, FLH used this shoring process to build an MSE wall in Yosemite National Park, CA, that saved more than $200,000 when

Transportation designers created this rendering using 3-D interactive modeling to assess the location of a transit station and new comfort station at Logan Pass in Glacier National Park, MT.

compared to historical costs for conventional MSE walls.

Peering Into the Unknown: Nondestructive Evaluation

Road design and construction require significant engineering judgment. Construction plans reflect the best available knowledge of a project site, often derived from surveying, geologic mapping, hydraulic analysis, and geotechnical investigation. Engineers and designers typically need to perform such investigations without the benefit of in-person visual observations. Instead, they rely on innovative tools and techniques to "see" behind the rock, under the road, in the culvert, and deep into the water.

FLHP engineers use nondestructive evaluation methods to provide insight into what previously might only be assumed. Engineers now can investigate under water using a small submarine with an onboard video camera, look into confined spaces and pipes using a self-propelled crawler and camera, and determine the thermal signature of pavements and structures using an infrared digital camera. In addition, they can use electromagnetic induction, geophysical surveys, and step-frequency radar to look under pavement or underground.

Bridge Inspection. Safe, economical bridge inspection is an ongoing challenge for FLH and its partners. Engineers use several nondestructive techniques to evaluate a bridge's condition.

To determine the extent of concrete delamination, FLH, in cooperation with TFHRC, used an infrared camera to create thermal images of high-profile bridges along the George Washington Memorial Parkway and Baltimore-Washington Parkway in 2007. FLH performed ultrasonic testing on a large, steel cantilever bridge in Rocky Mountain National Park, CO, in 2000 to test for any flaws in the critical pin and hanger assemblies. FLH used eddy current technology developed by TFHRC to test fatigue-prone connection details of a high steel bridge on the George Washington Memorial Parkway in 2004. FLH also performed load tests using wire-deflectometer technology on bridges at Delaware Water Gap National Recreation Area, PA, in 2006 and 2007, and at Natchez Trace Parkway, AL, in 2005. All these approaches evaluated structural components of the bridges so engineers could determine safe loading capacities accurately.

Clay Seam Mapping. During geotechnical investigations of a project, engineers take samples approximately every 152 meters (500 feet). Engineers usually assume that the soil properties measured at these discrete locations are representative of the surrounding area; however, field sampling techniques are not perfect and do not provide a complete picture of a site. During construction, engineers can encounter deep and extensive pockets of clay not identified in sampling. Subexcavating and replacing these pockets (or seams) of clay (also called clay lenses) increases project costs and can delay the schedule.

A new process using electromagnetic induction (EMI) developed by FLH provides continuous mapping of subgrade material up to 3.7 meters (12.0 feet) deep and clearly identifies clay lenses. These clay pockets may originate from lesser quality construction methods, or be undisturbed layers that the original road was built upon. The EMI equipment and antennas are portable and easily towed behind an all-terrain vehicle while soil conductivity data is collected. Plan and profile sheets can illustrate these results as color-coded plots where areas of high conductance indicate clay-rich areas.

Engineers then can use the information to design more effective sampling plans for geotechnical investigations. Clay seam mapping also provides the planners with an estimate of the volume of material that needs to be subexcavated and replaced. The mapping provides

Precasting this segmental arch bridge helped speed construction of the Natchez Trace Parkway in Tennessee.

Prefabricated decking enabled repair work on the George Washington Memorial Parkway to be completed on the weekends, when traffic was relatively light.

information that can be used during both project design and construction.

Clay Seam Mapping With Electromagnetic Induction (FHWA-CFLTD 05-010) details FLH's new method. The report includes results for FLH projects in the Jicarilla Apache Reservation, NM, and on the Natchez Trace Parkway.

Application of Geophysical Methods. FHWA published *Application of Geophysical Methods to Highway Related Problems* (FHWA-IF-04-021) to present the technological concepts and practical applications of geophysics and geotechnology to road design and construction. The report identifies the geophysical tools available to engineers and provides detailed solutions for specific geotechnical problems.

FLH used the methods described in the publication on various projects, including a seismic reflection survey using 3-D tomography on the Zion-Mt. Carmel Tunnel in Zion National Park, UT, in 2002, and 3-D tomography imaging to study compaction grouting in Rocky Mountain National Park in 2004. FLH recently used the step-frequency ground penetrating radar developed by TFHRC to survey the Cumberland Gap Tunnel on the Kentucky-Tennessee border.

Current and Future Projects

"From the beginning, the [FLHP] technology deployment has been driven by users—planners, designers, and engineers—and is now integrated into every aspect of road design and construction," says Keith Wong, FLH project manager. "I have been involved with the program since 1997—I have witnessed the growth of the program and have also seen the immense benefit in delivery of our projects."

However, some challenges remain. The speed of technological innovation is ever increasing and, as a steward of public funds, FLH needs to find the safest and most cost-effective solution for every project. In recent years, FLHP's task has been to concentrate resources on a small number of technical areas. The program now has a long-term roadmap for deploying new and innovative technologies. Current FLH projects include use of high-performance materials, implementation of management systems, and data visualization and analysis.

"Our partners have a wealth of information that cannot be harnessed unless the data are analyzed to provide meaningful answers," says James Amenta, FLH asset management coordinator. "The FLH Asset Management Strategic Implementation Plan helps our partners develop strategic roadmaps to organize and analyze their data. We are helping them optimize the operation, preservation, maintenance, monitoring, and timely replacement of highway assets through cost-effective management, programming, and resource allocation decisions using the asset management tools."

FLH collects data for the Road Inventory Program (RIP) and Bridge Inspection Program (BIP) for FLMA partners, who then use the data to plan highway transportation projects. FLMAs now are using the data to develop management systems for pavements, bridges, safety, and congestion.

"A transportation-related geographic information system [GIS] is used to bring together all the data from the FLMA management systems—RIP, BIP, pavement, congestion, and safety [data]—and the FLMA internal maintenance systems and put them into a system that is easy to use and is related to actual geographic locations," says Dan Van Gilder, GIS specialist for FLH. The transportation GIS provides improved communications between stakeholders and better decisionmaking.

"One of the components of a transportation-related GIS is that it facilitates the viewing of data and information," Van Gilder says. "By linking the transportation data geographically, the collected data are related to the roadway both horizontally and vertically. Interrelationships of pavement character, horizontal alignment, vertical alignment, location of roadway features, bridge condition, traffic use, and safety can then be explored and queried."

In 2005, FLH and NPS agreed to develop an inventory program for

This bridge foundation in Louisiana's Upper Ouachita National Wildlife Refuge employs GRS technology, a solution for soft and frequently wet soils.

retaining walls, similar in scope to the ongoing RIP and BIP inventories, according to Matt DeMarco, geotechnical engineer for FLH. "The program mission is to define and quantify wall assets associated with park roadways in terms of their location, geometry, construction attributes, condition, failure consequence, cultural concerns, apparent design criteria, and cost of structure maintenance, repair, or replacement," says DeMarco.

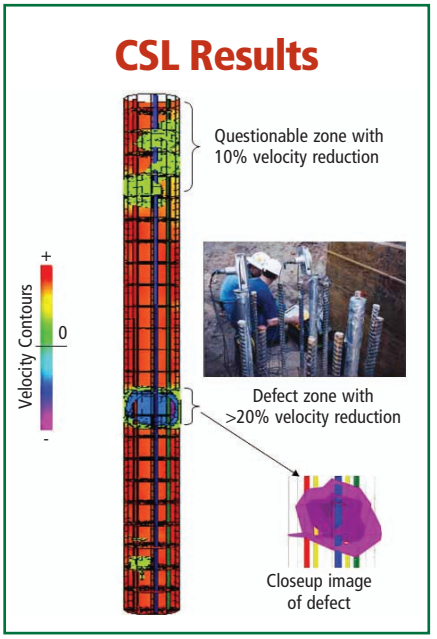
The wall inventory program provides asset and wall information to RIP to update equipment assets associated with the parent roadway asset. It also provides bridge and traffic barrier data. "Similar to RIP, it is the intent of the retaining wall inventory program to periodically reassess retaining wall resources at parks to ensure timely, accurate information is available to support NPS asset management initiatives," says DeMarco.

Satisfied Stakeholders

FLHP remains instrumental in delivering projects by working with other agencies and FHWA offices to find engineering solutions to the challenges posed by nature. Innovative use of technology, after successful testing and deployment for the first time, quickly becomes standard practice. The cooperative nature of the FLHP ensures that it delivers mutual benefits to all participating agencies.

"When the engineers and biologists got together in CTIP, we all learned to expand our respective professional cultures and linguistic understandings," says Sean Furniss, national coordinator for USFWS's Refuge Roads Program and a CTIP council member. "Working with the Forest Service's San Dimas Technology and Development Center and FLH has provided us numerous opportunities to combine highway engineering and road maintenance with biological and environmental concerns. I think we have all learned a great deal from each other in this program and added a certain amount of richness to our experiences."

Alan Yamada is a CTIP council member and engineering program leader at the San Dimas center. "The value derived from multiagency cooperation is multiplied both in terms of sharing the information and cost," he says. "Cooperation creates a win-win situation for all agencies. The Forest Service benefited tremendously, through participation in CTIP, by developing FishXing [a software program to design passages for aquatic organisms through roadway culverts] and a series of publications on road maintenance issues. These products, along with other CTIP publications, help Forest Service engineers design, build, and maintain better roads while protecting the surrounding environment."



Shown here is a 3-D image of a drilled shaft with zones of 10 percent velocity reduction in the top and 20 percent velocity reduction near the middle as measured by CSL. A relative velocity scale, a picture of the CSL testing, and a closeup image of the lower defect are also shown.

Setting the Sights

Vision

Creating the best transportation system in balance with the values of Federal and tribal lands.

Mission

To continually improve transportation access to and through Federal and tribal lands through stewardship of FLH programs by providing balanced, safe, and innovative roadways that blend into or enhance the existing environment, and by providing technical services to the transportation community.

Although FLHP's success is reflected in the safe and accessible transportation system on federally owned lands, the reasons for that success are purposely disguised under the roads, morphed into the surrounding environments, or tucked behind the safety barriers. Only a trained or inquisitive eye might detect the innovative technologies at play on and around these roads—a perfect blending of technology and innovation with the surrounding environment.

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Amit Armstrong manages the technology deployment program at WFLHD. He coordinates deployment of new, innovative, emerging, and underused technologies for design and construction of roads on Federal lands. He has more than 15 years of experience in numerical simulation and visualization of natural systems. He received a doctorate in civil engineering from Texas Tech University.

Gary L. Brown is the technology engineer at EFLHD. He is responsible for coordinating deployment of new, innovative, emerging, and underused technologies for design and construction of roads on Federal lands. He is a 33-year veteran of FHWA. He holds a bachelor's degree in civil engineering from The Pennsylvania State University.

Roger W. Surdahl joined FHWA in 1987 with a master's degree in civil engineering from Montana State University. As the technology delivery engineer for CFLHD, he has a wide range of technical experience in highway materials, contract administration, and innovative solutions to transportation problems.

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Bringing Freight Lessons Home

by Tony Furst

Lessons from other nations on improving freight transportation indicate the need to set a clear national vision and coordinate public and private action effectively.

In a globalized economy, the transportation system of every country is part of a worldwide network. In the United States and elsewhere, increasing volumes of import and export goods move through key gateway ports to and from the rest of the internal transportation systems. International freight flows and rising volumes of domestic freight vie for space on mixed-use systems, overloading capacity at most of the gateways and at many of the increasingly crowded urban cores. Capacity constraints impact the speed and reliability of our transportation system and directly affect the cost of freight transportation. These challenges are not unique to the United States; countries all over the globe face them as well.

Sharing strategies to address these challenges helps solve them. To better understand how other nations are addressing their transportation challenges, the Federal Highway Administration (FHWA) and the American Association of State Highway and Transportation Officials (AASHTO) fund and conduct the International Technology Scanning Program. This program seeks out and evaluates innovative technologies and practices that could improve the performance of the U.S. highway system. The scanning approach enables the U.S. transportation community to adopt advanced technology much more efficiently without spending scarce research funds to re-create improvements already developed by other countries.

To understand how other nations are addressing the increased freight flows on their transportation systems, the International Technology Scanning Program conducted three international scans on freight movement. The report from the first scan in 2001, *Freight Transportation: The European Market* (FHWA-PL-02-009), focused on the European Union (EU) and investigated the issues, constraints, opportunities, and challenges faced by the EU in developing a policy of open boundaries and the strategies it uses to implement that policy.

(Above) Traffic congestion worldwide, such as the congestion shown on this interstate in Florida, wastes fuel and time, adversely affecting freight transportation. *Photo: Florida Department of Transportation.*

The second scan in 2002 investigated the characteristics of trade flows between the United States and Latin American countries. The team studied how the scan countries handle trade-related transportation infrastructure, border crossings, and freight security, and issued a report titled *Freight Transportation: The Latin American Market* (FHWA-PL-03-013). The third scan in 2007 investigated how China provides intermodal access to its new ports and employs investment strategies to foster freight mobility and intermodal connectivity. The report is *Freight Mobility and Intermodal Connectivity in China* (FHWA-PL-08-020).

Although the countries visited in these three scans have obvious differences in history and governmental structure, they face similar transportation challenges: how to best target infrastructure investment; how to coordinate public and private sector action; and how to fund transportation improvements, whether operational enhancements or new capacity. Common issues emerged from the three scans; each of the following sections identifies those issues, briefly discusses each scan's experience, and then poses a question for the reader on how that issue could apply to the U.S. transportation system. Instead of providing solutions or answers, this article aims to challenge readers to think about the issues and formulate their own ideas.

A Common National Vision

Issue: The extent to which an overarching vision or transportation policy provides a framework within which investment and competition can take place.

EU. The EU serves as the institutional framework for establishing consensus on strategies to facilitate an open and competitive market in Europe. The founding EU members saw transportation policy as one of the key policy areas where substantial benefits could occur through EU-level action, and the expanded membership repeatedly reinforced this stance. The EU developed a common transport policy in which public investment in transportation is designed to act as a catalyst for private investment in services and facilities that could provide important public benefits. An example of this action is the creation and funding of the multimodal Trans-European Transport Network (TEN-T), which spans the EU.

Latin America. At the time of the scan, 2002, none of the countries visited (Argentina, Bahamas, Brazil, Chile, Mexico, Panama, and Uruguay) had a comprehensive, systems-oriented national transportation policy, nor did they have one that transcended the individual nations from a regional perspective. Little integration or coordination was evident among investment programs for the various modal systems. Since that time, however, Mexico has focused on freight movement with the development of its National Infrastructure Program 2007–2012.

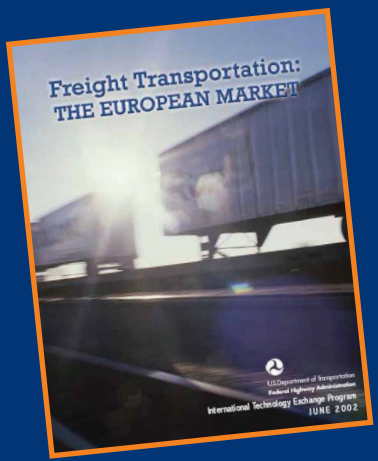
China. China competes as a nation; its national, provincial and metropolitan transportation policy is closely coordinated among the three levels of government and is clearly spelled out in China's 5-year plans. Governmental entities below the national level are provided the leeway to decide how to best meet the established national goals while also addressing local goals, but the national goals must be met. This framework is evident in the investment by ProLogis, an owner and developer of distribution facilities, in the Lingang logistics hub, a 300-square-kilometer (116-square-mile) industrial park on the mainland that will serve Yangshan port, a new container terminal in Shanghai. The national plan goals that targeted the development of the Yangshan port were key drivers in this investment decision.

Q: There have been repeated calls from many sectors for a national transportation policy in the United States. How would a national policy be implemented in the current framework of private sector assets (port terminals, railroads), State-managed transportation assets, and locally established planning priorities? How forceful should the Federal role be?

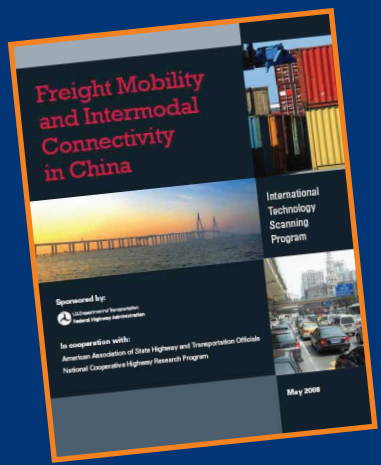
Linking Transportation, Trade, and Economic Policies

Issue: The extent to which a nation's trade or economic policies are directly supported by its transportation policy so that the transportation system is developed alongside a desire for increased trade.

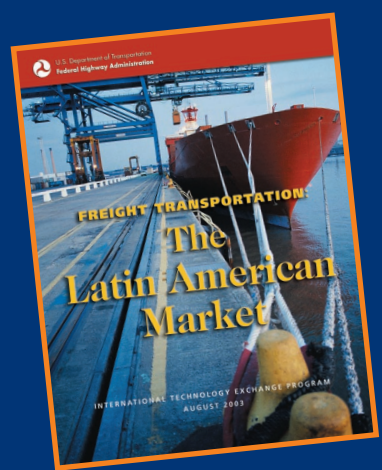
EU. Making the internal European market more transparent led to



Freight Transportation: The European Market



Freight Mobility and Intermodal Connectivity in China



Freight Transportation: The Latin American Market

This new bridge connects the port of Yangshan to mainland China.

greater demand for transportation. This increased demand resulted in significant transportation challenges facing the EU and its member nations. These challenges include high levels of congestion on line-haul facilities and at transshipment points, and the sharing of facilities by freight and passenger movement. Again, the creation, development, and funding support for the multimodal TEN-T seeks to provide a sustainable and interoperable transportation network to support the opening of economic trade within the EU.

Latin America. National strategic policies that link transportation investment to economic or trade policies are not apparent. Some of the countries focus on international trade (Brazil, Mexico, Panama, Uruguay), while others (Argentina) are more focused on regional trade. Because Argentina does not target global trade in its national economic policy, it does not invest in the transportation infrastructure necessary to support such trade, whereas Uruguay clearly links transportation investments to national economic goals and has the most developed road system of the countries visited.

The Latin American countries have no comprehensive agreement comparable to the Common Market of the EU, but instead a number of key trade relationships, each of which treats transportation issues differently. The trade relationships include the Andean Community, Caribbean Common Market, North American Free Trade Agreement (NAFTA), Plan-Puebla Panamá, and Mercosur—a 1991 regional trade agreement.

Mercado Común del Sur/Southern Common Market, or Mercosur, promotes free trade and the fluid movement of goods, people, and currency. Argentina, Brazil, Paraguay, and Uruguay are full members; Bolivia, Chile, Colombia, Ecuador, and Peru currently have associate member status, while Venezuela's status is still pending. The Mercosur countries focus much of their attention internally, with an emphasis on protecting production and commodity groups, rather than growing trade through an open boundaries strategy as found in the EU.

China. The Chinese central government links its national transportation investment policy closely to its trade and economic policy. Recognizing the vital role that transportation plays in pursuing its goal of continued economic growth, China is investing heavily in infrastructure—almost 9 percent of its gross domestic product—to directly support that growth.

Q: How should the United States link its trade policies with its transportation policy? Should U.S. Customs duties, a proxy for trade levels, augment public transportation expenditures?

What Drives Transportation Policy?

EU. Transportation policy at the EU level is linked integrally to national and EU policies on environmental issues and emphasizes sustainable mobility. However, the importance of economic competition, especially in a global market, is raising economic development, productivity, and accessibility to a comparable level of importance. This pressure is also felt at the local level with some local governments seeking to balance economic development with sustainability. Demonstrating that these are not mutually exclusive goals, local authorities were instrumental in the development of the port of Gioia Tauro in Italy. This port was originally developed as a Mediterranean transshipment hub but is now being looked at to provide an intermodal gateway to Europe. The gateway connections would be by rail and would relieve pressure on the northern European ports of Rotterdam and Hamburg. This new intermodal gateway could balance freight flows and modal usage across the EU.

Latin America. There was no clear consensus on the drivers of transportation policy in many of the countries visited with the exception of Uruguay, which clearly linked transportation investments to national economic goals. Uruguay is not on a major trade line, yet has adopted a liberal approach to free trade zones and private concessions to position the port of Montevideo as a gateway to southeastern South America. Its position as a gateway is supported by the highest density of paved roads in any Latin American country and an effort to expand that capacity by issuing a concession to construct and maintain an additional 1,272 kilometers (763 miles) of tolled roads.

China. Up to now, China's economic development clearly has driven its transportation policy, which is focused heavily on international trade. It appears that economic development will be the dominant driver in the near future. As the populations of urban centers along the coast have exploded, however, passenger movement often receives priority to meet the basic needs of these large populations and to maintain social harmony. In addition, the Chinese leaders have added environmental quality and energy conservation to the national agenda as performance measures.

Q: Transportation directly supports economic activity and yet there are increasing environmental (greenhouse gas) and energy conservation concerns that directly impact transportation. How should these concerns be balanced?

Multimodal System Management and Planning

Issue: The extent to which the transportation system is planned, developed, or managed as a multimodal system, and the extent to which all modes are included in determining where transportation investments should take place.

EU. Development of an integrated and interoperable continental transport network has been a goal of the EU since its inception. The multimodal TEN-T consists of transportation infrastructure, traffic management systems, and navigation systems. The EU has established priorities for selecting projects that include the optimum combination and integration of various transportation modes, interconnections to eliminate bottlenecks, optimization of the capacity and efficiency of existing infrastructure, and improvement in intermodal platforms.

Latin America. The governments of many countries (for example, Brazil, Mexico, and Uruguay) are designing and implementing efficient logistics and integrated intermodal transportation corridors, although these projects are inconsistent in their level of development and, as noted, are not part of an overall national objective. (As noted earlier, since the 2002 scan, Mexico has embarked on its National Infrastructure Program 2007–2012.) Internal to Central America, the transportation component of the Plan-Puebla Panamá is to better connect the region's (southern Mexico and Central America) major urban and rural areas through improved highways, and, by connecting to corridors throughout the rest of Mexico, to North America. Argentina, Brazil, and Uruguay also have undertaken corridor studies to determine the feasibility of toll roads for the Santiago de Chile—Belo Horizonte Corridor.

China. Intermodal connection is an important consideration in network design in China. In most of the central, provincial, and local governmental agencies visited during the scan, staff members responsible for each mode were located in one agency, which encourages the adoption of a multimodal systems perspective when looking at investments in regional transportation. The national expressway system and the national rail network will be the major means of connection between the political and economic centers of the country, reinforcing their importance in China's economic future. Yet, as noted in other sections of this article, the Chinese are not routinely integrating intermodal rail into their port development.

Q: How does the United States best integrate all modes into U.S. transportation management, planning, and investment decisions?

Modal Split

Issue: The extent to which each nation puts in place incentives or disincentives to achieve a balance in the modal split of freight movement.

The Chinese central government has constructed the road infrastructure shown here for China's new Lingang industrial park.

The Hutchinson Terminal (shown here) in Freeport, Bahamas, has become a major transshipment port in the Caribbean.

EU. The EU and its individual national governments put significant emphasis on shifting freight mode shares from road transport to rail and inland water. All the government officials interviewed by the scan team discussed the importance of rail and inland water freight services, and the use of road pricing as a lever for influencing mode choice. The approach is to establish target market shares of the various modal systems. For example, the Netherlands established mode split goals for 2010. With the transport policy in place, road volumes would grow by 38 percent versus 50 percent (without the policy in place), railroads by 40 percent versus 13 percent, inland water by 40 percent versus 25 percent, and short sea by 40 percent versus 34 percent. At this time it is unknown how successful the Netherlands has been in achieving these goals.

Latin America. None of the nations visited have taken direct action to encourage one mode over another. In Chile, which is a long, narrow country that could be a textbook example of coastal shipping, 95 percent of the freight moves by truck. Although the Chilean government is giving some attention to increasing coastal shipping, substantial institutional disincentives (such as cabotage) work against the use of more efficient coastal shipping. Freeport in the Bahamas has leveraged U.S. cabotage laws to its advantage and has become a thriving transshipment hub for trade with the United States.

China. China appreciates the need to balance mode split but has challenges achieving that balance. Although China uses its river systems extensively (see section on natural advantages), its intermodal rail service faces significant challenges, and rail access to maritime port facilities is not being consistently built into new port design. The most significant challenge is the low priority received by container movement on China's rail network; it follows military, passenger, energy (that is, coal), and food movements. Intermodal rail movement is unreliable, often with no scheduled departures. The current 5-year plan (2006–2010) has a goal of moving 10 million 20-foot equivalent units (TEUs) by intermodal rail by 2010. Achieving this goal would represent a three-fold increase from the current 3 million containers moved by rail, but even at 10 million would comprise only 3 percent of the intermodal freight moved in China. This will present a growing challenge as China implements its "Go West" policy, which refers to the next set of provinces west of the coastal provinces.

Q: Should the United States do more to encourage or incentivize increased rail and water shares of freight movement? How should this be accomplished?

Performance Measures

Issue: The extent to which performance measures are developed, evaluated, and used to manage the transportation system, and drive future investments.

EU. Keeping in mind that the scan was conducted in 2001, the scan team found no indication that the EU had developed performance measures or used them to manage the transportation system or drive investment. The team did identify one of the most important concerns of freight transport users—the reliability of service—which is thus a focal point for transport officials identifying needed improvements to the transportation system. According to the EU scan report, "Speed of travel is important . . . but system reliability is even more important." The team concluded that this need should be weighed heavily when determining performance measures used in system monitoring and in project prioritization.

Latin America. Again, this scan was conducted in 2002, but the U.S. team did not find performance measures used by any of the nations visited during the scan.

China. The Chinese government measures the performance of officials by the results they achieve, and officials therefore pay attention to measures of progress. Most measures currently revolve around meeting economic performance objectives. To the extent that transportation system improvements enhance economic performance, they are pursued. This was noted in the earlier discussion on "Linking Transportation, Trade, and Economic Policies." The scan substantiated no performance measures specifically for the transportation system, but the culture is in place should they be established.

Q: Should the United States begin using performance measures to manage the transportation network and drive investment? Who should establish these performance measures and what should they be?

Private Funding Of Infrastructure Improvements

Issue: The extent to which private funds are utilized effectively to expand or improve the performance of the transportation system.

EU. The EU transportation funding is contained in the total EU budget,

which is supplied by customs revenues and value-added taxes. The buy-in on EU priority freight projects from member governments and from the private sector has been slower than expected. Causes include an overestimation of interest by private investors, plus environmental concerns with some of the projects.

Latin America. The scan team did not find public financing mechanisms for funding freight projects in most of the countries visited (Argentina, Brazil, Chile, Mexico, Panama, and Uruguay.) Latin American countries rely on concessions to private companies for providing the necessary port access and terminal infrastructure. Private concessions for port terminal operations have proved successful for the most part, but the necessary funding and maintenance of other infrastructure (such as roads) is not occurring. Reasons include the economic challenges the region faces and the reliance on investment returns for privately funded infrastructure. In many cases, declining revenues have hurt maintenance of existing infrastructure. That said, the corridors planned for key trade routes throughout Latin America are being evaluated for their economic feasibility. Under consideration, for example, are connections to the Uruguayan port of Montevideo as an emerging logistics center and regional container transshipment hub, and the Atlantic and Pacific corridors identified in Mexico's Plan-Puebla Panamá.

China. The Chinese central government actively seeks private sector capital to expand the country's infrastructure. Much of the national public investment in transportation is intended to attract private capital. The private sector has responded positively with many investors being patient and anticipating longer term returns on investment. An example is the massive investment in terminal operations in Yangshan, which when fully built out in 2020 will be able to handle 25 million TEU per year. In 2007, Yangshan handled just over 5 million TEU annually. These investors are building for the future. This strategy does not always work in China's favor, however, as the government has not been successful in generating interest in its new rail and intermodal connector program. In addition, the tolls charged on many toll roads are meeting public resistance as being too high. In some cases, government agencies are trying to renegotiate concession agreements to allow lower toll rates compensated with longer concession periods from 30 to 50 years.

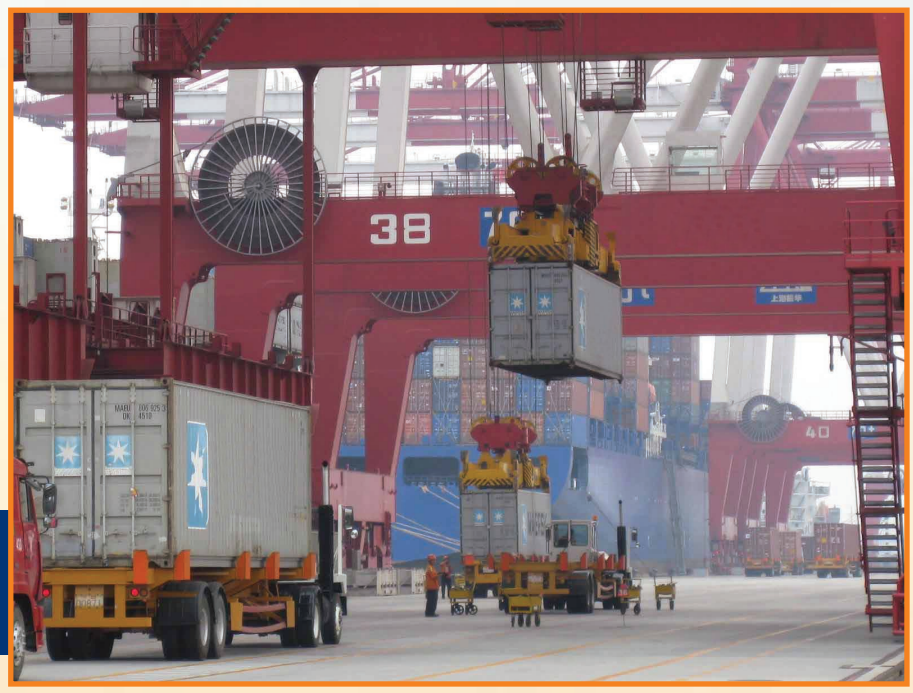
Q: The engagement of private sector capital in transportation infrastructure in these three scans is uneven. What is the best framework that will enable the United States to best utilize and integrate private and public funds to generate the infrastructure improvements necessary to maintain system performance and reliability?

Harmonized Operational Issues

Issue: The extent to which border nations harmonize transportation assets and border operations to affect efficient cross border transportation.

EU. The level of effectiveness of EU policies depends on the willingness of member countries to adopt the recommendations. In some cases, the EU has gone beyond policy to binding rules and regulations to guarantee universal implementation of a policy; the EU monitors these binding requirements. Examples include vehicle emissions standards, allowable vehicle weights, and trucker hours-of-service regulations. In addition to harmonizing standards, the EU has been very successful in its efforts to improve cross-border operations. On January 31, 1993, the EU abolished all national border checks for customs clearance for member nations, although spot checks still occur for drugs and immigration enforcement. The creation of free cross-border transport was identified by almost all those interviewed as one of the most important EU actions for creating a better market environment for freight transport. According to a 1999 report by The European Commission quoted in the EU scan report, "Without transport, it [the Single Market of the Union] would exist only in name. Without efficient, compatible, sustainable transport systems and operation, it obviously will not flourish."

Latin America. Mercosur established size, weight, and safety standards for intra-Mercosur transport. To harmonize land transportation rules and regulations, Argentina, Brazil, and Uruguay signed an Agreement on Land Transport in 1966 that emphasizes consistent standards for granting permits, insurance requirements, and compatible customs procedures. Some major achievements include the harmonization of driving



Moving crates at Qingdao, one of the most efficient and modern ports in China.

This map from the EU scan shows the natural barriers—geographic challenges such as mountains and seas—that impede freight traffic in Europe.

licenses, medical standards for drivers, safety rules, rail safety, and road control devices such as highway signs and traffic lights. However, Mercosur has not been as successful in obtaining agreement among member countries to develop consistent procedures to foster more efficient cross-border movements. The scan report quoted an unidentified Panamanian businessman as saying, "The future success of a free trade agreement for the Americas is tied closely to the existence of an integrated hemispheric transportation system. From a logistics perspective, the transportation system of one country must be closely linked to the transportation system of its trading partners."

China. The China scan did not address this issue.

Q: The EU and Mercosur considered harmonizing transportation assets (for example, vehicles, driver standards) and border operations (clearance procedures) as key issues. The EU accomplished both and Mercosur one. The EU is a more involved, integrated agreement than Mercosur. What lesson does that have for NAFTA?

Landside Access

Issue: The extent to which freight can be moved efficiently to and from major intermodal hubs, particularly maritime ports.

EU. The issue of landside access [access to a port by land] is a challenge for all EU ports. For the port of Rotterdam, one of the busiest in the EU, the Dutch government has developed the Betuwe Corridor, a 160-kilometer (99-mile) rail connection from the port of Rotterdam to the German national railway system. With no at-grade crossings, this electrified double-track corridor dedicated to freight movement pursues the Dutch and EU objectives of shifting freight from the road to rail or waterways, while easing congestion on the roadways.

Latin America. Port terminals in Latin America operate 24 hours a day, 7 days a week (24/7), due to rising congestion levels and customer-oriented service. An operational shift to scheduling deliveries and pickups to nonpeak hours would expand the use of existing capacity. Most of the countries visited have limited investment resources available, however, and have had limited success in using concessions for access projects, as mentioned earlier in the investment section. The port of São Paulo, Brazil, actively pursued rail access to the port and, as of 2002, handled 20 percent of its container traffic (20,000 TEU per month) by rail. At the time of the scan, Santos and the port of San Antonio, Chile, were considering truck-only roads to improve port operations and traffic impacts on the surrounding community.

China. Although the Chinese ports operate 24/7 and are some of the most productive in the world, intermodal connectivity and landside access to the new Chinese ports evolved in the same way that they did in the EU and Latin America. Many new port facilities are located in large urban areas, and accessing these ports involves traversing mixed-use roadways that will, given the growth in Chinese international trade, soon be facing the same congestion issues as the ports noted in the EU and Latin American scans. The port of Yantian, one of the first to evolve after China opened its economic reforms, recently established a truck-only access to alleviate congestion issues. The Chinese government is not consistently incorporating rail access to maritime ports into new port designs.

Q: Effective and efficient freight movement into and out of large intermodal hubs are key to efficient freight movement. What are the best solutions, both operational and physical capacity, for improving the landside access to these assets, and how can they be implemented?

Utilization of Existing Capacity

Issue: The extent to which nations are improving capacity with operations or technology before they pursue new physical capacity.

EU: A focus of EU policy is to make the best use of existing transportation options before developing new transport networks, and one of the key targets for providing enhanced freight transport mobility is to use the existing multimodal transport infrastructure more effectively, possibly by driving mode shift. As one Dutch official stated, transportation system management strategies come first, followed by pricing strategies, and finally actions that construct new infrastructure.

Latin America: Most of the Latin American nations were still in the process of developing their infrastructure. It was not clear that operational measures were being pursued or used by any of the nations visited on the scan. However, as noted earlier in the discussion of landside access, most of the ports in the nations that were visited ran 24/7 port operations to make the most use of port and surface transportation infrastructure.

China: As noted before, China is in 'build' mode for most of its infrastructure, but is facing a serious issue with oversize and overweight trucks on the system they have put in place, and these trucks are an emerging and important concern for transportation officials. China has not progressed to the point of systematically managing its highway infrastructure, nor does it appear that the government is putting into the new capacity the technological capacity to actively manage it at a future date. Like the Latin American nations, the maritime ports operate 24/7 to maximize capacity utilization.

Q: New physical capacity is very expensive to build and then must be maintained. Many State and local governmental transportation

Many container transshipments in China's Pearl River basin take place in midstream, as shown here. The reason is primarily to avoid fees for land terminal use.

agencies are actively pursuing operational means of improving system performance. How can this be accelerated? And what can the private sector do to utilize existing capacity more efficiently?

Natural Geography Advantages and Challenges

Issue: The extent to which a nation takes advantage of its natural geography to improve freight movement or addresses the natural geography that encumbers freight movement.

EU. Congestion is most severe at strategic geographic barriers that hinder continental travel because of the funneling effect they have on traffic flow—the Alps, Pyrenees, and the English Channel. Conquering these barriers continues to be a challenge.

Latin America. The Darien Gap challenges completion of the Pan-American Highway linking North and South America. The gap, which separates Panama and Columbia, is not only one of the most difficult terrains in the world with dense rainforest and swamps, it is also one of the most environmentally important. Biologists consider the Darien Gap a biological defense against organisms that thrive in South American environments and would intrude on North American ecosystems if they could bypass the barrier created by the gap. Many of the countries that have river systems (such as the Amazon, Orinoco, and Rio de la Plata) are looking to take advantage of the Pan-American Highway, particularly to and from their gateway ports.

China. The Chinese central government is leveraging the country's natural geography to facilitate the movement of goods. River and coastal shipping continues to be a significant component of China's intermodal transportation system. Forty percent of the containers shipped through Shanghai's new Yangshan port, which is 32 kilometers (20 miles) off the mainland, arrive by barge. China's land geography was not part of the scan.

Q: How can the United States take the best advantage of its natural geography to improve freight movement? Are there any challenges that need to be overcome? What are they and how can and should they be accomplished?

Next Steps

Any one of these issues is a challenge. Taken collectively, it is clear that no one entity, public or private, is going to be able to solve them. The issues are too interrelated, and solution sets will need to be coordinated across a broad spectrum of national, State, local, and private interests. Solutions need to be a collaborative effort.

As the United States approaches the next surface transportation bill, many of these issues will be open for discussion. A number of new ideas are contained in *Transportation for Tomorrow, Report of the National Surface Transportation Policy and Revenue Study Commission* and in the U.S. Department of Transportation's (USDOT) Reform Plan. For example, both of these documents call for a refocused Federal role and a targeting of Federal funds on those parts of the transportation system that serve a national or regional objective. They also call for the use of performance measures and greater analytic rigor in determining the transportation projects that should be advanced, and a shift toward greater involvement of private funds to improve the performance of the U.S. transportation network. Additionally, proposals offered by private organizations such as the American Trucking Associations, AASHTO, and the American Road & Transportation Builders Association call for an increased focus on freight movement in U.S. transportation investment strategies.

All readers are encouraged to think about these issues, read the reports, and engage on this issue. You can add your thoughts to the dialogue at the Web site for the Framework for a National Freight Policy: www.freight.dot.gov/freight_framework/index.cfm. Together, we can meet these challenges.

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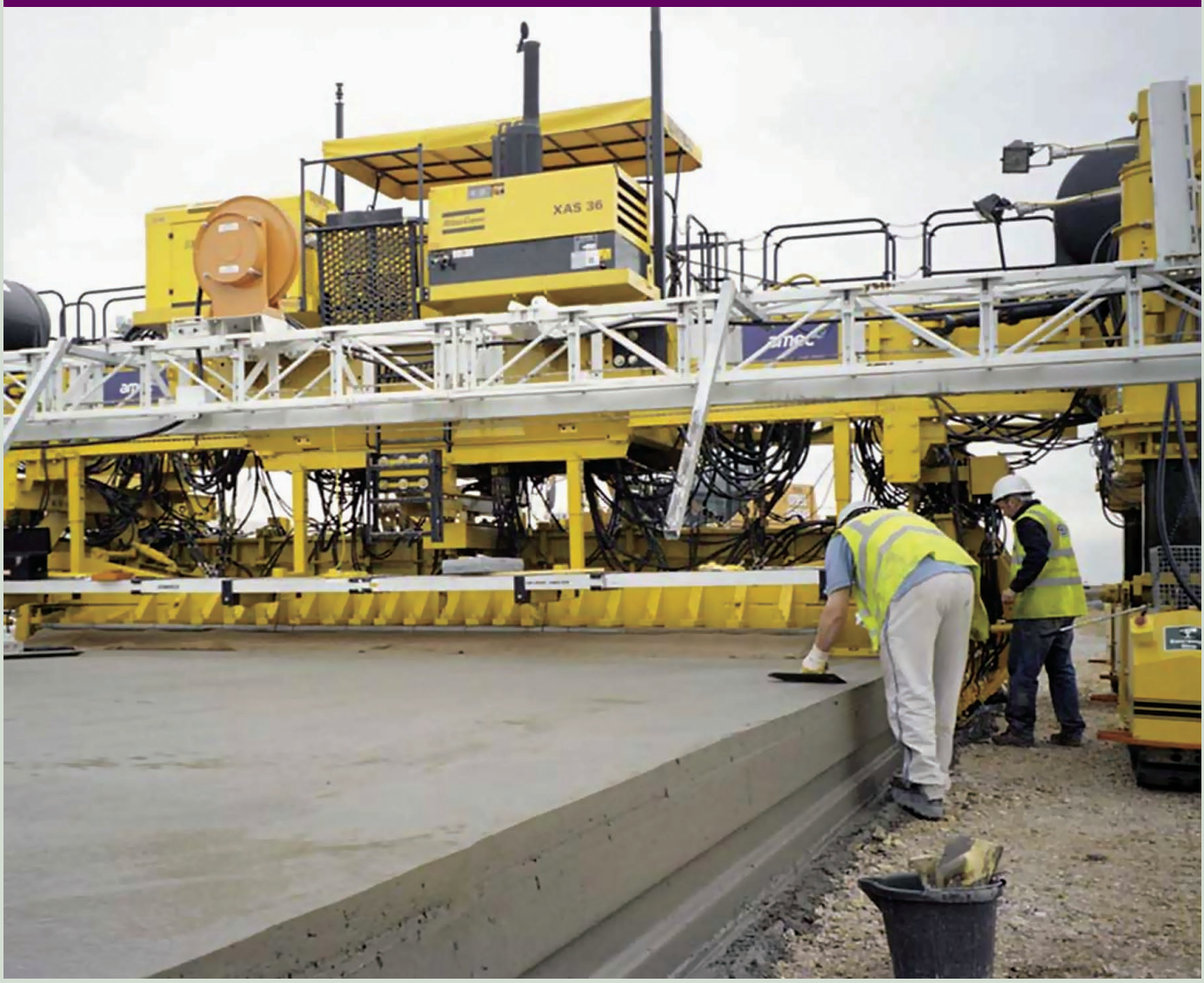
NEWS ON Nanotechnology

by Surendra P. Shah, Paramita Mondal, Raissa P. Ferron, Nathan Tregger, and Zhihui Sun



Recent nanoscience research improves understanding of cement and concrete properties and looks to the next generation of highway pavements.

(Above) These workers are constructing a portland cement concrete road pavement using the slipform paving process. *Photo: GOMACO Corporation, Ida Grove, IA, USA.*

Even as traffic on the Nation's highways has increased from 65 million cars and trucks in 1955 to almost 246 million today, the condition of U.S. highways and bridges has deteriorated. According to estimates by the U.S. Department of Transportation, the current backlog of unfunded but needed repairs and improvements totals $495 billion.

The increased traffic volume has generated an escalating need for high-performance, durable construction materials for roadway pavements. This need, in turn, is driving research to develop the next generation of materials.

In a research project supported by the Federal Highway Administration (FHWA), rather than designing a concrete mix by trial and error, researchers at the Center for Advanced Cement-Based Materials (ACBM) took a back-to-basics approach. That is, they chose to pursue a systematic study of concrete at the micro- and nanoscales to understand the properties of how materials in concrete interact with one another. This study at the smaller scale could enable them to develop more effective solutions that achieve the desired performance.

At all scales, concrete is a heterogeneous material. Concrete's strength and durability depend on structural elements and phenomena at micro- and nanoscales. (A nanometer is one billionth of a meter.) To understand concrete properly, to better control its properties, and to design new materials with specific properties, starting at the smallest scale is necessary—that is, understanding the micro- and nanostructure is the first step. Nanotechnology research today provides the necessary tools for establishing the relationships between the processing, properties, and performance of concrete.

The research project, which started in September 2004 and ended in August 2006, was funded by FHWA and involved a number of research themes. The outcomes of this project led to further research focused on additional themes that are supported by multiple organizations. In the recent research, the first theme involved understanding the micro- and nanostructures of concrete using advanced experimental tools such as atomic force microscopy, which uses a high-resolution probe to measure properties, and nanoindentation, which consists of a set of tests for investigating hardness and other mechanical properties of materials in small dimensions.

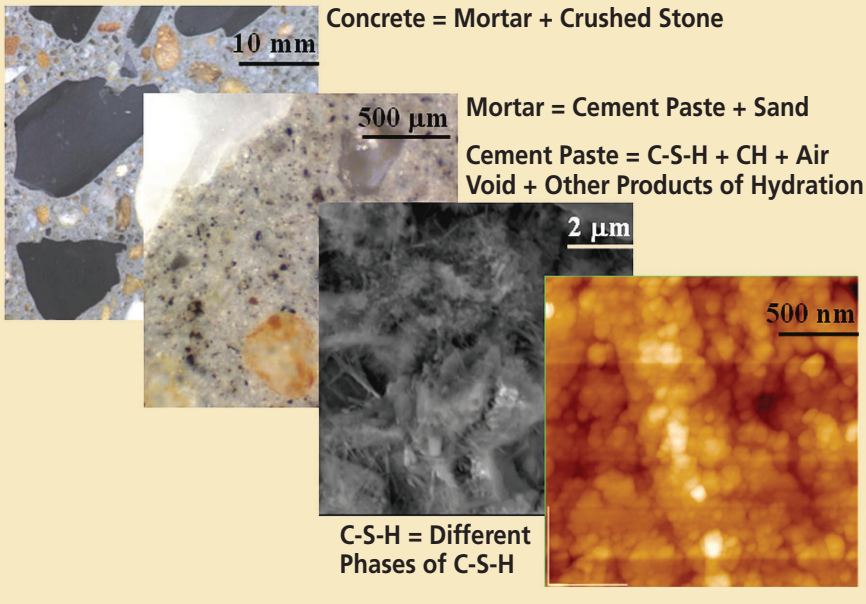
The second theme is development of a new type of self-consolidating concrete (SCC) for slipform (SF) paving processes by adding materials such as nanoclays (very small, plate-like, water-absorbent minerals) and fly ash to the composition. In *Self-Consolidating Concrete* (ACI 237R-07 Emerging Technology Series), the American Concrete Institute (ACI) defines SCC as "highly flowable, nonsegregating concrete that can spread into place, fill the formwork, and encapsulate the reinforcement without any mechanical consolidation [or vibration]." ACI continues, "SCC has also been described as self-compacting concrete, self-placing concrete, and self-leveling concrete." For SF applications, the placed concrete mixture also must become firm enough to hold the vertical pavement edge as the paving machine moves forward. Therefore, the new materials used to make SF-SCC (that is, slipform self-consolidating concrete) require cutting-edge technological and scientific developments for studying the fresh-state properties of SF-SCC. Fundamental research on particle packing and flocculation (particles aggregated to form a structure) mechanisms provided insight on how to eliminate internal vibration and durability issues associated with longitudinal cracking along the vibration trail.

Third, the researchers are using nanofiber (fibers with diameters less than 100 nanometers)-reinforced concrete to develop the next generation of highway pavements.

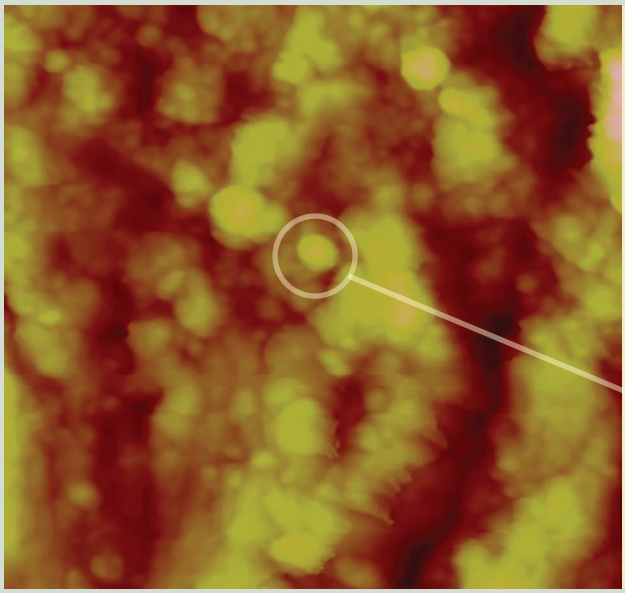
Fourth, nanotechnology shows promise in the development of smart sensors. Because concrete develops its properties (such as strength) with time and chemical reactions (called hydration), it is critical to monitor concrete at early ages. In this effort, the researchers developed a new method to monitor the properties of concrete pavement at its early ages just after it is placed. This new method relies on measuring the amount of ultrasonic sound wave returned after striking the surface of concrete pavement.

Characterization of Cement And Concrete at the Nanoscale

Hydration of cement produces a rigid, heterogeneous microstructure. As water is introduced to cement to make a paste, which hardens over time, the main microstructural phases in the hydrated cement paste are: (1) calcium silicate hydrate gel, C-S-H; (2) calcium hydroxide, CH; (3) ettringite (a sulfoaluminate hydrate); (4) monosulfate; (5) unhydrated cement particles; and (6) air voids. These microstructural phases govern the macroscopic properties



These four photos show concrete at various length scales: 10 millimeters, mm (0.3937 inch), 500 micrometers, µm (0.01969 inch); 2 µm (0.00007874 inch); and 500 nanometers, nm (0.00001969 inch). Note: C-S-H = calcium silicate hydrate; CH = calcium hydroxide. *Source: ACBM.*



ACBM

This 1.5 µm × 1.5 µm image captured using atomic force microscopy shows C-S-H as spherical particles about 40 nm in size.

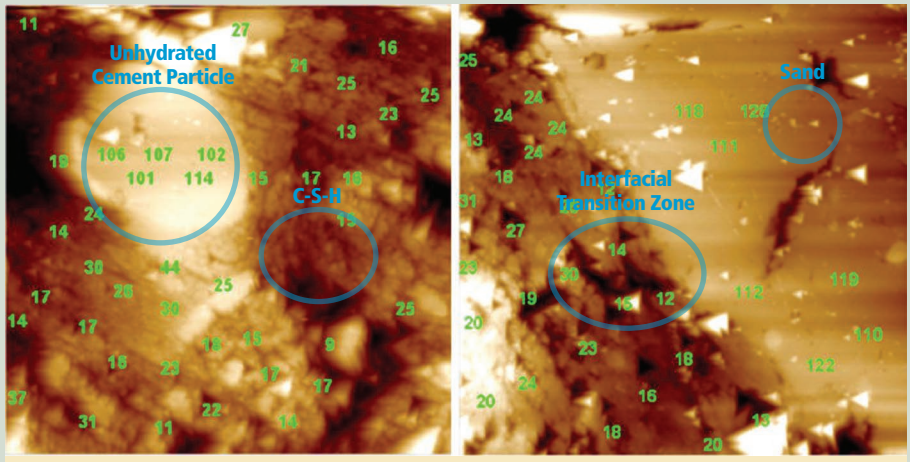
of cementitious materials, such as strength, ductility (pliability), early-age rheology (flow), and durability. Controlling the macroscopic properties demands a detailed knowledge of the structure of these phases at the smallest size level. Among the various phases, the first one—C-S-H—is the most important product of hydration and accounts for 50 to 70 percent of the total paste volume. This main binding phase governs the macroscopic properties of the cement paste, but the micro- and nanoscale structure of C-S-H is not well established.

In the study, the research team used an atomic force microscope (AFM) to image the surface of 6-month-old cement paste samples. The samples were from type I portland cement with a water-to-cement ratio of 0.5. The AFM images show C-S-H as nearly spherical particles of different sizes in different areas.

The research team also combined nanomechanical testing with imaging at the nanoscale. The team did this pioneering research using a special type of nanoindenter. In any indentation technique, one material of known properties is pushed inside the material of unknown mechanical properties. This technique originated from the Mohs scale of mineral hardness developed in 1812, in which one material is considered to be harder if it can leave a permanent scratch on another material. In nanoindentation, a researcher pushes a small probe into a hardened concrete sample and then plots the load applied by the probe versus its displacement in the sample. Next, the researcher analyzes the data obtained from the plots to estimate the elastic modulus (slope of stress versus strain curve) and hardness of the sample. At the normal scale, this is similar to a strength test and modulus of elasticity run on concrete pavement cores or molded cylinders made with the mixture.

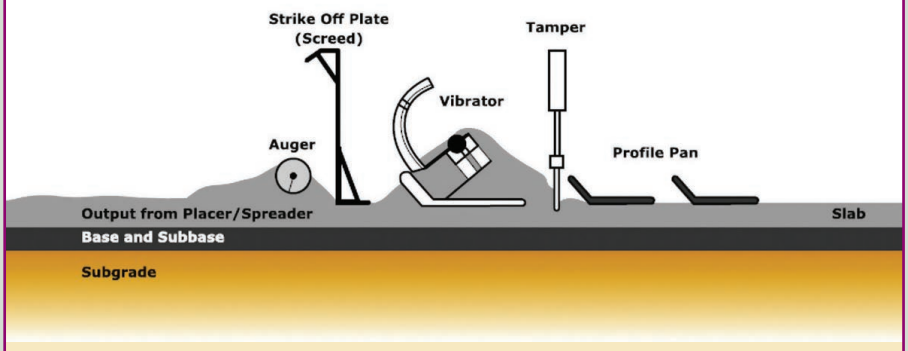
Results from the study showed that the elastic modulus of the C-S-H gel in different areas varied within a wide range (~10–35 GPa, where 1 GPa equals approximately 145.038 kips per square inch, and a kip stands for a thousand pound-force). The team found the unhydrated cement particles to be almost 10 times harder than the C-S-H, with modulus in the range of 100–130 GPa. This finding is significant because the unhydrated cement particles act at this small scale as hard aggregates within a more yielding matrix, which may adapt to stress without brittle fractures.

In addition, for the first time in any study, the researchers measured experimentally the nanoscale mechanical properties of the interfacial transition zone in mortar and concrete. In the concrete at the juncture of the cement paste and aggregate particle surfaces, there is a zone with a high porosity and a tendency to develop microcracking. This zone is called the interfacial transition zone. "The interfacial transition zone is considered to be the weakest link in normal strength concrete, and it affects concrete's strength and durability," says Suneel Vanikar, team leader for concrete in the FHWA Office of Pavement Technology. "It is widely accepted by researchers that the properties of the interfacial transition zone must be taken into account in modeling the overall mechanical and permeability properties



The photo on the left shows a 60 µm × 60 µm image of cement paste, where the bright area near the center is a residual cement particle. The rest of the area in the image shows predominantly the C-S-H phase. The image also shows the elastic modulus values calculated from the nanoindentation data, with the values written at the respective indent locations on the image. This shows how the stiffness of C-S-H varies in different areas and how it is one order smaller than the stiffness of cement particles. The second photo shows the interfacial transition zone between a sand particle and cement paste in a mortar sample. Elastic modulus values calculated from nanoindentation show that a part of the interfacial transition zone is less stiff than the paste matrix. *Photos: ACBM.*

Slipform Paving Process



This schematic demonstrates how unconsolidated concrete enters from the left of the auger and undergoes preliminary leveling under the screed, consolidation through the vibrators, leveling under the tamper, and extrusion through the profile pan, exiting to the right. *Credit: ©Steve Muench, Pavement Interactive.*

of concrete. But the modulus values used in current models lack theoretical or experimental evidence because of the practical problems in measuring such a small, narrow region of only 10 to 20 micrometers around coarse aggregate particles. The researchers successfully used the imaging feature of a nanoindenter to view this phenomenon."

Findings from this research provide more accurate input for models and serve as the first step in designing improved materials for pavements. Further research is ongoing to understand the effect of the addition of nanosilica on the microstructure. This research is of significant interest because previous research by one of the international collaborators showed that nanosilica is useful in reducing the impact of calcium leaching, which is one of the main durability issues with concretes in general.

Self-Consolidating Concrete For Slipform Paving Processes

In current practice, concrete pavement construction uses dry stiff concrete with slump (subsidence of a mold slip) of less than 5 centimeters (2 inches). The slump test provides a measure of consistency (or flowability of the concrete), where typical slumps for normal concrete range from 7.5 to 10 centimeters (3 to 4 inches). Greater slumps indicate more flowable mixes, while smaller slumps indicate stiffer mixes. The right mixture for the concrete is needed so that the pavement has high quality and the required strength; however, the moldability and placeability of the concrete in the intended application is critical also.

A slipform paving machine processes the fresh concrete, including placement, leveling, casting, consolidation, and finishing. The paving machine moves with a constant speed over the fresh concrete deposited in front of the machine, and at the end of the process, the fresh concrete slab can hold its shape without any edge support after the slipform has moved forward.

Equally spaced vibrators in the paving machine introduce extensive internal vibration to consolidate and compact the fresh concrete (pack the materials and remove larger sized trapped air voids). These internal vibrators may cause overvibration of the stiff concrete if the vibration frequency is set incorrectly or the paving machine moves too slowly. Overvibration leads to segregation of aggregates and significant reduction of smaller sized entrained air in the concrete along the path of the vibrators. (Note that in concrete, some entrained air in the mixture is required for the best performance; therefore, the vibration process must not remove all the air.) When such a pavement is subjected to heavy traffic loading and/or freeze-thaw weather cycles during its service life, so-called vibrator trails (surface defects indicating segregation of aggregates, leaving a cement-rich layer) can occur, or longitudinal cracks can form.

To eliminate the need for internal vibration in the paving process, the researchers collaborated with the Center for Portland Cement Concrete Pavement Technology (now called the National Concrete Pavement Technology Center) at Iowa State University to extend self-consolidating concrete technology to slipform pavement applications. The key to slipform paving is that the material must be workable enough to be consolidated, yet stiff enough to stand without formwork after the paver moves on at the end of the processing. The challenge to develop SF-SCC is that the material must change from very fluid to very stiff during the slipform process.

The development of SF-SCC required changing the microstructure

Mean Particle Size and Mineral Additives in SF-SCC Compositions Compared to Typical Cement and Fly Ash

Typical Cement and Fly Ash Materials	Particle Size Average, µm (µin)	Description
Cement	1.8–146 (70.9–5750)	Type I
Fly Ash	1.8–174 (70.9–6850)	Class C
Clay and Clay-Like Mineral Additives	1.8–174 (70.9–6850)	
Acti-Gel	0.5–30.5 (19.7–1200)	Purified magnesium almino silicate
MetaMax	1.8–294 (70.9–11600)	Kaolinite, illite, quartz
Concresol	1.8–146 (70.9–5750)	Purified calcined kaolinite

ACBM

This model minipaver, developed by the Iowa State University research team, is 900 mm (35 inches) long by 457 mm (18 inches) wide and 104 mm (4 inches) high. Researchers place concrete in the vertical compartment, then it flows into the horizontal compartment when the paver is pulled forward. No internal or external vibration occurs. At the exit, the slight slope of the horizontal compartment's upper plate, and weights placed on the upper plate that apply pressure on the concrete, compact it.

by combining concepts from particle packing (how particles of different sizes are arranged and how that affects compressive strength), admixture technology (the combination of different mineral and chemical admixtures), and rheology (the study of how materials flow). Specifically, the addition of different materials such as nanoclays and fly ash to the composition made it possible to maintain a balance between flowability during compaction and stability after compaction. The researchers used scanning electron microscopy to evaluate the particle microstructure of the clays used for the experiments.

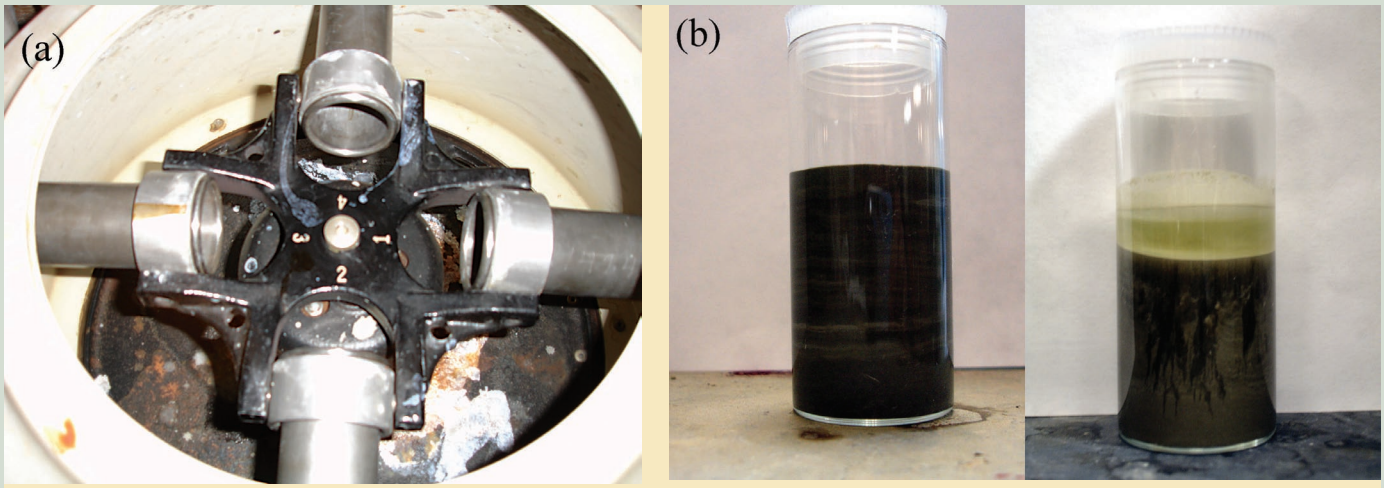
For this research, the Iowa State team developed a model minipaver that simulates the slipform paving process without the application of internal or external vibration. At the end of the process, concrete slabs of modified mix with fly ash or fly ash and clay showed much better shape stability and surface smoothness than the slab with a standard slipform concrete mix.

Study of Flocculation

Flocculation is the grouping or clumping together of suspended particles within a fluid or liquid. The shape stability of any material in suspension depends on the rate at which flocs (groups of particles) form and on the strength of the bonds between particles. The study of flocculation is important in a wide variety of applications, such as nondrip paints, extruded ceramics, and emulsions. In the case of cement-based materials, understanding flocculation and the ability to control it are necessary for developing stable suspensions of self-consolidating concrete with good workability. In the slipform paving process, flocculation is important because the formulation of stable flocs indicates that the concrete mixture will retain its shape better without the need for molds and has more stability because more applied shear stress is required to break apart the bonds. Likewise, if the particles clump or group together in smaller flocs, the pavement mixture will not keep its shape as well. Research efforts include understanding the interactions among particles at the nano and micro levels.

The researchers relied on experimental observation of particle flocculation and deflocculation as they occurred to understand the actual physical processes within the microstructure. To monitor the flocculation process, the research team used focused beam reflectance measurement (FBRM), an experimental technique that provides in situ measurement of the evolution and size distribution of particle flocs. FBRM instruments operate by scanning a highly focused laser beam across particles in a suspension and measuring

(a) The first photo shows consolidation and shape stability of a model pavement slab for a standard slipform mix. The rough pavement exhibits poor consolidation. (b) Consolidation and shape stability of a model pavement slab for an SF-SCC developed with fly ash. The bulging sides indicate poor shape stability, but the smooth surface indicates good consolidation. (c) Consolidation and shape stability of a model pavement slab for an SF-SCC developed with clay and fly ash. The smooth surface and straight sides indicate both acceptable consolidation and shape stability. *Photos: ACBM.*



(a) A swing-bucket centrifuge used to determine the compressive strength of each cement sample. (b) A cement paste sample before and after centrifuging. The solids consolidate, allowing water to bleed to the top. Materials with lower compressive yield stresses will have a lower sediment height. *Photos: ACBM.*

the time duration of back-scattered light from the individual particles. The chord length is determined by the time (pulse width) rather than the intensity (pulse amplitude). Measuring the chord length based on pulse width makes the measurement less sensitive to influences due to color or reflectivity. The researchers also used a centrifuge method to determine the compressive stress on a suspension of settling particles. In this method, the researchers centrifuged cement paste samples derived from SF-SCC concrete mixes at a particular speed until an equilibrium height was achieved. In terms of shape stability, a mix with a high compressive stress requires more energy to break bonds, indicating a greater floc strength and higher shape stability. Similarly, a mix with larger flocs under a given stress indicates a stronger floc strength because more applied shear stress is required to break apart the bonds.

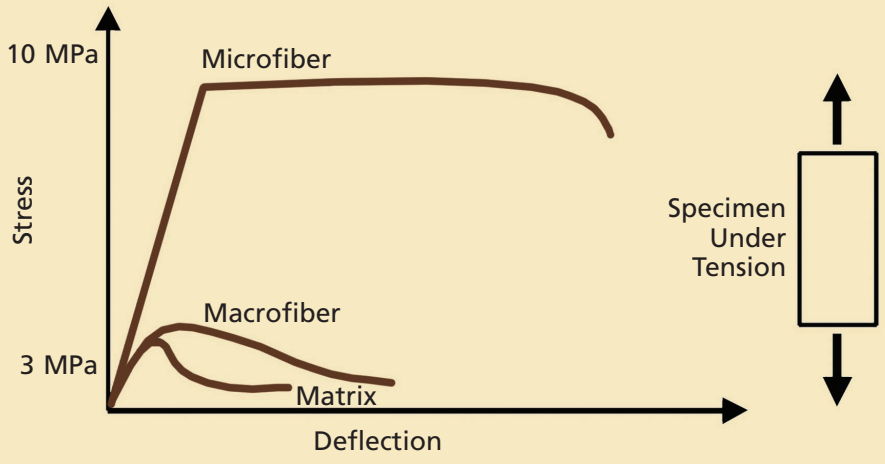
New Generation Of Materials

The researchers are developing new construction materials using microfibers and hybrid fiber systems in cementitious (concrete, extruded materials, and mortar) materials. Currently, the researchers are working on nanofiber-reinforced systems that could lead to the next generation of fiber-reinforced concrete. Engineers use nanofibers when applications require superior mechanical and thermal properties, such as ultralight weight, superior strength, increased toughness, and enhanced electrical and thermal conductivities.

The researchers also are investigating the use of carbon nanotubes in cementitious materials. Carbon nanotubes are cylindrical carbon molecules with very high length-to-diameter ratios and novel properties. Scanning electron microscopy has shown that carbon nanotubes have the ability to bridge cracks in cement systems. This potential might increase the flexural strength significantly and increase the ductility of concrete.

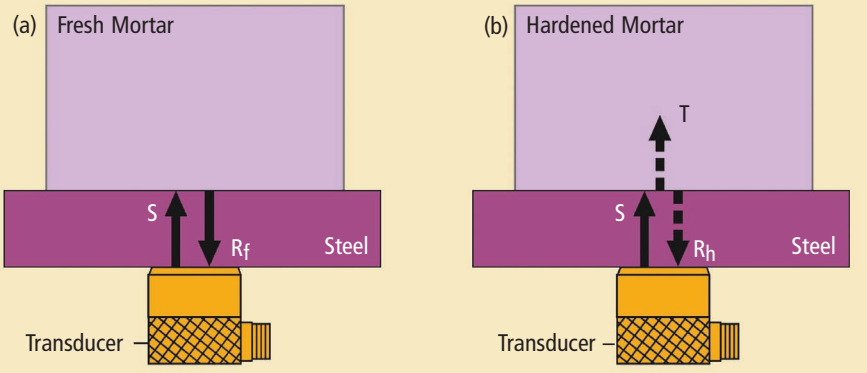
Dispersion of nanotubes in cementitious material, however, is a major issue because they do not disperse easily through the cement paste as it flows into place. To address this problem, current research by the team is exploring alternative processing methods, such as coating fibers with additives, varying the rheological properties of the

Effect of Different Types of Fibers on Hardened Concrete Materials



The plot shows the stress and deflection response of three types of samples: plain matrix and two types of fibers—macrofiber and microfiber under uniaxial tension. The addition of fiber increases ductility, and the concrete then performs better under stress. Matrix with microfiber can withstand much higher stress than matrix with macrofiber. So the addition of a microfiber could provide concrete with both higher strength and higher resistance to destructive cracking. *Source: ACBM.*

Ultrasonic Wave Reflection Method



This diagram illustrates how researchers use ultrasonic waves to monitor the setting of mortar and concrete. As shown in (a), during the very early hydration period of the material, the entire wave energy is reflected from the interface between the buffer (in this case, steel) and tested material because of the nonpropagation characteristic of shear waves in gases and liquids. With proceeding cement hydration (b), part of the incident wave transmits through the material, causing energy loss. Reflection loss can be correlated to the setting behavior and compressive strength gain of mortar and concrete. *Source: ACBM.*

matrix, or changing the mixing procedure. Research efforts also include reducing the number of nanotubes used in the cement mix to make the product cost effective. Future research should include exploring the use of agricultural waste fibers and cellulose nanofibers, both of which have potential as economical alternatives to carbon nanotubes.

Sensors

A reliable testing method is needed to perform in situ monitoring of mortar or concrete properties at early ages to prevent the failure or cracking of pavements during construction or shortly thereafter. Development of new materials also demands improved sensing systems for better quality control during construction, and nanotechnology can play a significant role in developing these smart sensors.

In the past, the researchers developed a nondestructive testing method called ultrasonic wave reflection (UWR). This method measures the shear wave reflection loss at an interface between the hydrating cement paste and a buffer material. The researchers used this measurement to predict the mechanical properties of early-age concrete and to monitor macrostructural parameters, such as setting of the cement paste and its viscosity, dynamic shear modulus, and compressive strength.

The results of the current project show that the UWR method is accurate in determining the viscosity of cement pastes at fresh state and the shear modulus of pastes at the hardened state. The researchers also developed a relationship between the reflection loss and the compressive strength of cement paste, independent of both the curing temperature and the water/cement ratio.

Next Steps

To meet the increasing need for high-performance, durable construction materials for roadways, the researchers took a back-to-basics approach to improve understanding of the properties of cement-based materials at a small scale and to develop new materials. Nanoscale characterization of cement paste samples showed that the mechanical properties of the C-S-H gel—the glue in concrete—vary in a wide range, requiring complex modeling. Furthermore, the researchers observed that the residual cement particles are almost 10 times harder than the glue produced when mixed with water. This finding signifies that engineers might be able to design the material with the minimum glue (C-S-H) necessary to bind the harder particles or phases together.

Research on transferring SCC technology to pavement construction is in progress by the research team. Combining the concepts of particle packing and flocculation, admixture technology, and rheology, the researchers have developed SF-SCC that changes from very fluid to very stiff during the paving process. Experimental observation of particle flocculation and deflocculation as they occur should be included in future research, which could significantly contribute toward increasing the durability of pavements by eliminating segregation and cracking due to overvibration of concrete during construction.

Preliminary research also has shown that nanofibers and nanotubes potentially can make cement itself super ductile, with more ability to accommodate tension without cracking (more tensile strain capacity), which could increase flexural strength significantly. However, dispersion of nanotubes in cementitious material remains a major challenge, and the researchers are exploring various processing methods to optimize the number of nanotubes and their dispersion needed to develop cost-effective concrete for the next generation of highways.

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Along the Road

Along the Road is the place to look for information about current and upcoming activities, developments, trends, and items of general interest to the highway community. This information comes from U.S. Department of Transportation (USDOT) sources unless otherwise indicated. Your suggestions and input are welcome. Let's meet along the road.

Management and Administration

USDOT Awards $133 Million to Fight Traffic in the Twin Cities

Faster commutes, more parking, and improved transit are on the way for the Twin Cities area. In spring 2008, USDOT officials awarded $133.3 million in Federal funds to help reduce congestion along the vital I–35W corridor in the Minneapolis and Saint Paul, MN, area. USDOT will make the funding available through an innovative program called Urban Partnerships, which encourages communities to embrace new approaches to cutting congestion, including increased use of tolling, transit, telecommuting, and technology.

USDOT made the funding commitment because Minnesota State legislators provided transportation officials with the authority to implement an aggressive plan to fight traffic. That plan includes converting existing carpool lanes on I–35W to high-occupancy toll (HOT) lanes, allowing single-occupant vehicles to use the lanes for a fee, and extending the new lanes. Minnesota officials also plan to use the funds to purchase 26 new buses, reduce wait times for buses at stoplights, and construct new park-and-ride facilities along the I–35W corridor. In addition, the plan will finance new dynamic message signs and real-time communications systems to help drivers avoid traffic and know when to choose transit.

The Urban Partnerships program is part of USDOT's comprehensive initiative to address congestion throughout the Nation's transportation system. In addition to the Twin Cities region, USDOT has entered similar partnerships with Chicago, Los Angeles, Miami, San Francisco, and Seattle.

For more information, visit www.upa.dot.gov.

Private Activity Bonds Issued for Congestion Relief in Northern Virginia

In June 2008, USDOT announced that sponsors of the I–495 Capital Beltway HOT Lanes Project in northern Virginia issued $589 million in tax-exempt private activity bonds to move the project forward. According to USDOT officials, the transaction represents a historic turning point in highway financing.

Issued by the nonprofit Capital Beltway Funding Corporation, the private activity bonds are part of an estimated $1.9 billion finance package to fund the 22-kilometer (14-mile) project, which involves adding two variably priced HOT lanes in each direction on the Capital Beltway. Once construction is finished in 2012, there will be two additional lanes on each side of the Beltway. The two existing middle lanes will be converted to HOT lanes with prices that vary depending on traffic volume, thereby ensuring that traffic in these lanes keeps moving at all times.

Two private companies will finance, operate, and maintain the express lanes using facility revenues to repay the bonds. Additional funding in the amount of $589 million comes from a direct loan issued by USDOT through the Transportation Infrastructure Finance and Innovation Act program, which offers flexible repayment terms to encourage private sector participation in financing highway projects. The Commonwealth of Virginia also is providing significant resources to support this historic partnership.

For more information, visit www.fhwa.dot.gov/ppp/private_activity_bonds.htm.

Technical News

Now Available: Interim Guidebooks on Transportation Planning Processes

The Federal Highway Administration's (FHWA) Office of Operations and Office of Planning, Environment, and Realty, and the Federal Transit Administration's (FTA) Office of Planning and Environment recently released two interim companion publications that promote effective approaches to integrating management and operations strategies into transportation planning processes.

An Interim Guidebook on the Congestion Management Process in Metropolitan Transportation Planning (FHWA-HOP-08-008) and *Management & Operations in the Metropolitan Transportation Plan: An Interim Guidebook for Creating an Objectives-Driven, Performance-Based Approach* (FHWA-HOP-08-007) are the latest documents showcasing strategies for enhancing the quality of congestion management practices. The guidebooks build on more than a decade of experience in effective congestion management and emphasize a regional approach to transportation systems management and operations.

The final guidebooks will be published at a later date. To view the interim drafts online, visit www.ops.fhwa.dot.gov/publications/cmpguidebook/cmpguidebook.pdf and www.ops.fhwa.dot.gov/publications/moguidebook/moguidebook.pdf.

FHWA/FTA Update Briefing Book on Transportation Planning

The FHWA and FTA Transportation Planning Capacity Building Program recently published an updated version of *Transportation Planning Process: Key Issues* (FHWA-HEP-07-039), a briefing book for transportation decisionmakers, officials, and staff.

The publication provides an overview of transportation planning and contains a summary of key concepts in statewide and metropolitan transportation planning, along with references for additional information. The briefing book is divided into two parts. The first discusses transportation planning and its relationship to decisionmaking and provides a broad introduction to the planning process. The second part includes more technical information and presents short descriptions

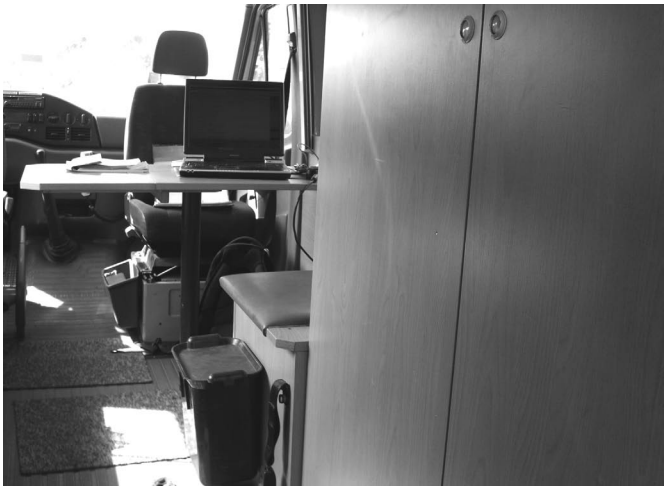
of important policy and planning topics, such as freight movement, land use and transportation, and public involvement.

In addition, the publication features several appendices that cover topics including financing statewide transportation plans, innovative highway financing tools and strategy, and FTA programs.

To request or download a copy of the briefing book, visit www.planning.dot.gov.

FHWA Releases Report on Bridge Evaluations in Europe

FHWA's Office of International Programs released a report summarizing the findings of a 2007 European scan tour that explored quality assurance practices for bridge inspection in Denmark, Finland, France, and Germany. The report, *Bridge Evaluation Quality Assurance in Europe* (FHWA-PL-08-016), was developed by representatives of FHWA, the American Association of State Highway and Transportation Officials, academia, and a private sector professional association.



Shown here is the interior of a German inspection vehicle with conferencing workspace.

The National Bridge Inspection Standards (NBIS) require that transportation agencies use quality control and quality assurance procedures to maintain accuracy and consistency in their bridge inspection programs. The purpose of the scan tour was to evaluate European inspection practices related to quality assurance and identify approaches that might assist U.S. bridge owners and FHWA in refining and improving actions taken to address the NBIS provisions.

The scan team found that European agencies emphasize quality assurance through well-defined inspector qualifications, data collection, and use of appropriate equipment to evaluate structures. Based on this assessment, the scan team offered the following recommendations to U.S. officials:

1. Develop a nationally accepted basis for determining the frequency of bridge inspection that combines different levels of inspection intensity based on factors including safety and the age of the structure.
2. Draft national guidelines for developing quality assurance and quality control procedures.
3. Develop detailed coding guidance that includes illustrations and reference photos.
4. Develop integrated inspection and repair approaches for use by bridge inspectors.
5. Consider the following potential candidates for technology transfer: crack mapping keys and two-dimensional scaled representations, nondestructive evaluation toolbox data sheets from the European Union's Sustainable Bridge project, expanded inventory of access equipment for bridge inspection, and available data from the Sustainable Bridge project.
6. Initiate a demonstration project on the ultrasonic shear wave transducer for use in identifying defects in concrete.

To download a copy of the full report, visit http://international.fhwa.dot.gov/pubs/pl08016/pl08016.pdf.

FHWA Report Covers Lighting Design For Midblock Crosswalks

A new FHWA report presents the results of a series of studies looking at the visibility of pedestrians in nonintersection (midblock) crosswalks. The publication, *Informational Report on Lighting Design for Midblock Crosswalks* (FHWA-HRT-08-053), evaluates lighting designs that might enhance pedestrian visibility to drivers. In addition, the report provides information on lighting parameters and design criteria that transportation agencies should consider when installing fixed roadway lighting for midblock crosswalks.

Virginia Tech Transportation Institute

This photo shows how pedestrians in different colored clothing and positioned in various spots in the crosswalk were presented to drivers during studies of midblock crosswalks.

In compiling the report, researchers looked at driver reaction and performance upon detecting pedestrians in midblock crosswalks under varying experimental conditions, including various types of street lamps, the color of the pedestrians' clothing, the position of the pedestrians in the crosswalk, and the presence of glare.

To download a copy of the report, visit www.tfhrc.gov/safety/pubs/08053/08053.pdf.

Rolling Wheel Deflectometer Helps Improve Asset Management

Engineers traditionally have used visual distress surveys to inform decisionmakers about which roads to schedule for improvement and the types of improvements to make. Although these surveys can provide valuable information about a road's condition, they lack a direct measure of the pavement's structural condition. To solve this problem, FHWA researchers developed the rolling wheel deflectometer (RWD), which can perform structural evaluations by collecting continuous profiles of pavement deflection while traveling at normal highway speeds.

The RWD uses four triangulation lasers mounted on a rigid beam beneath a tractor-trailer to calculate the deflection produced by the trailer's dual-tire single axle. The RWD's data acquisition equipment, located in the truck's cab, collects data in real time. With the RWD, no lane closures are needed, providing instead an innovative and nondestructive method for evaluating pavements.

The RWD is shown here during testing in Vermont.

State departments of transportation can use the RWD to identify problems in pavement sections and then revisit the problem areas using other deflection technology, such as the falling weight deflectometer, to obtain more detailed analyses.

Thirteen States, the Natchez Trace Parkway, and Champaign County, IL, have performed full-scale demonstrations of the RWD. Data collected in Indiana, for example, clearly showed the change in deflection, indicating pavement structural capacity. As the pavement became cracked and weaker, the deflections increased and became more variable. Pavements with good structural capacity and uniformity produce low, uniform deflections. Researchers can use the deflection information to evaluate pavement section candidates for preservation treatments and rehabilitation.

For more information, visit www.tfhrc.gov/focus/may08/02.htm or contact Thomas Van at 202-366-1341 or thomas.van@fhwa.dot.gov.

Public Information and Information Exchange

National Data Show Fewer People Injured in Highway Crashes

In June 2008, USDOT announced that the number of people injured in crashes on the Nation's highways has declined every year since 1995, and that 4.8 percent fewer injuries occurred in 2006 than in 2005. The trend extends to teenage drivers, who were involved in 6 percent fewer highway crashes from 2005 to 2006.

Although many of the latest statistics are positive, the new data also indicate that teen injuries make up more than 16 percent of overall crash-related injuries, even though teens represent only 8 percent of the driving public.

To help improve safety for teens on the road, USDOT officials announced a nationwide competition to develop the next generation of advertising and educational materials, with a focus on encouraging teenagers to drive safely. The winning campaign will receive $5,000, and the National Highway Traffic Safety Administration will help distribute the campaign broadly to where it can do the most good.

USDOT also announced that it will provide $300,000 each to two States to promote seatbelt use in their communities through creative and highly visible law enforcement efforts. In addition, USDOT will award two more States with $100,000 each for efforts to combat drunk driving through use of technologies that disable a vehicle if the driver is legally impaired.

For more information, visit www.nhtsa.gov.

FHWA Receives Recycling Award

In spring 2008, the Office of the Federal Environmental Executive announced that it selected FHWA's Recycling Team as winner of the 2008 White House Closing the Circle Award for Recycling Leadership in the Transportation Sector for successfully promoting recycling as an integral part of road construction. FHWA works across the Nation to educate the highway industry and promote recycling technology to ensure that hundreds of millions of tons of materials are put back into roadways rather than disposed in landfills.

For more than a decade, through research, field studies, experimental projects, and long-term performance testing and analysis, FHWA has educated the road construction community about the engineering properties, environmental benefits, and economic feasibility of using recycled materials. For example, FHWA funds the Recycled Materials Resource Center, and with the highway industry and the U.S. Environmental Protection Agency (EPA), has published two popular factbooks for highway engineers on using coal fly ash and spent foundry sand in highway construction. The fly ash factbook is in its fourth edition, with more than 50,000 copies printed and distributed nationwide.

FHWA outreach activities include an October 2007 forum (cosponsored by EPA) on recycling spent foundry sand into roadways and highway embankments and a

FHWA researchers participate in an asphalt recycling study.

June 2008 workshop on in-place asphalt recycling. FHWA also is planning Green Highway Partnership recycling workshops in Virginia and West Virginia.

Since 1996, the White House has given more than 200 awards for environmental contributions in the Federal sector. In 2008, the White House selected 15 winners and 14 honorable mentions from nearly 200 nominations.

For more information, visit www.ofee.gov/ctc/ctc08prWinners.pdf.

FHWA, U.S. Fire Administration Complete Study On Traffic Incident Management

FHWA and the U.S. Fire Administration (USFA), working in partnership with the International Fire Service Training Association (IFSTA), recently developed a report that provides technical guidance and training programs in traffic incident management for fire and emergency service providers.

The report, *Traffic Incident Management Systems (TIMS)*, features guidance for local fire departments and emergency responders on compliance with USDOT's *Manual on Uniform Traffic Control Devices* and the National Fire Service Incident Management System (IMS) Consortium's *Model Procedures Guide for Highway Incidents*.

The report includes case studies on roadway incidents that have killed firefighters, highlights basic information about safety and survival during highway incidents, and shares examples of effective TIMS programs. In addition, the report provides information on the American National Standards Institute and International Safety Equipment Association (ANSI/ISEA) standard 207-2006, High-Visibility Public Safety Vests.

The report resulted from a study that included research on TIMS implementation by emergency service personnel and application of practices described in the IMS Consortium guide. The study examined technologies and practices for placing roadway warning signs; the ideal amount and type of warning lighting necessary on emergency vehicles; and training, placement, and use of protective equipment by flaggers.

Mike Wieder, IFSTA/Fire Protection Publications

Fire department personnel respond to a traffic incident in Pennsylvania.

To download the report, visit www.usfa.dhs.gov/downloads/pdf/publications/tims_0408.pdf. For more information on USFA roadway safety projects and partnerships, visit www.usfa.dhs.gov/fireservice/research/safety/roadway.shtm.

NIOSH Online Library Promotes Road Safety at Work

The National Institute for Occupational Safety and Health (NIOSH) created an online library hosting information on preventing injuries and deaths resulting from the driving of motor vehicles for work purposes. The online resource features a range of information, from best practices in engineering controls to examples of policies, administrative procedures, and guidance for improving roadway safety. The site targets international organizations, governmental institutes and agencies, academic institutions, corporations, unions, and nongovernmental organizations involved with road safety at work.

For example, clicking on one of the subjects listed in the toolbar on the left-hand side of the screen, such as "Vehicle," takes visitors to a page listing online publications and materials related to vehicle safety, including antilock braking systems. Beneath each publication, the site indicates the type of document (such as modeling tool, public information), target audience (such as employers, workers, policymakers), and language in which the material is provided (such as English, Spanish).

The Web site also enables users to recommend additions to the library. By clicking on "Suggest Materials" on the left-hand toolbar, visitors can suggest materials they would like to see in the library.

For more information, visit www.roadsafetyatwork.org.

NIOSH

NATIONAL HIGHWAY INSTITUTE

Training Update

by Stacy Stottmeister

NHI Promotes In-Place Asphalt Recycling

According to the Asphalt Recycling & Reclaiming Association (ARRA), asphalt is the most recycled product in the world. In fact, more asphalt is recycled annually than all other wastes combined.

ARRA defines in-place recycling as an onsite method of recycling that rehabilitates and preserves deteriorated bituminous pavements and thereby reduces the use of new materials. Jason Harrington, a recycling technology engineer at the Federal Highway Administration (FHWA), compares the in-place recycling process to a farmer tilling the soil every year. In his analogy, a farmer adds nutrients and prepares the soil every spring, and when it comes time to plant, the soil is viable and ready for crops. "Imagine how much more effort would be needed if the farmer had to bring in completely new soil every year at planting time," Harrington says. "Similarly, by using in-place recycling technologies, we reduce the need to bring in new supplies of paving materials and extend the supply of nonrenewable resources."

However, despite asphalt's recyclability, in-place recycling technology is underutilized by departments of transportation (DOTs), perhaps because it is "a newer kid on the block," Harrington says. "But with proper training and technical information provided by FHWA and ARRA, the extent of use could easily double and still have plenty of room for growth."

Benefits of In-Place Recycling

In-place recycling can reuse all the old pavement back into the highway. The hot-mix asphalt (HMA) plant recycling process can reuse 25 to 35 percent of the old, reclaimed asphalt pavement effectively, by blending it back in with new HMA for a highway project. Overall, about 80 percent of all asphalt materials removed are reused in some type of highway application.

In addition to preserving aggregate resources, other benefits of in-place recycling are the lower cost of construction, reduced fuel use, and lower greenhouse gas emissions. Further, Harrington says, reports from States are showing lower costs for long-term maintenance and improved ride quality over the lifetime of the pavement compared with the conventional mill-and-fill process.

"With the rising costs of asphalt and fuel, the dollar savings for in-place recycling, when compared with the cost for various other rehabilitation options, will really surprise a program manager working with a tight budget," Harrington says. In fact, the cost for in-place recycling can be about 30 percent less then milling and hauling off 5 to 10 centimeters (2 to 4 inches) of pavement and then bringing new HMA pavement (containing at least 20 percent reclaimed asphalt pavement) back onsite. The cost of hauling materials to and from the jobsite greatly increases the overall cost.

In-place recycling also can slow roadway deterioration, facilitate preserving and upgrading a higher proportion of pavements, and avoid costly reconstruction. By reusing existing materials, this cost-effective strategy enables public works officials to spread available funds over a much greater area.

NHI's Asphalt Recycling Course

To fill a gap in the traditional education for transportation professionals involved in pavement rehabilitation and preservation, FHWA and the National Highway Institute (NHI) developed the course Asphalt Pavement Recycling Technologies (FHWA-NHI-131050). Created in partnership with ARRA and the National Center for Asphalt Technology, the course provides indepth technical knowledge on several recycling methods. Specifically, the training covers performance of recycled mixes, specification guidance, selection criteria for various types of pavement recycling strategies, economics of recycling, and structural design of recycled pavements.

The course targets State DOTs and local highway officials and administrators. Pavement design engineers and technicians, and construction engineers and inspectors, involved in recycling asphalt pavements also could benefit from the training.

Upon completing the session, participants should be able to describe the various methods of recycling pavements, determine when asphalt recycling is a viable rehabilitation alternative, and select the most appropriate asphalt recycling method or technique. In addition, participants will learn to identify materials and mix designs for recycled pavements; specify equipment, construction methods, and quality control and quality assurance steps involved in asphalt recycling; and demonstrate design methods for hot and cold recycled pavements.

Planned updates to the course include discussion of new technologies and addition of case studies and

Workers demonstrate cold in-place recycling on a highway project in New York State. FHWA engineers visited the jobsite during a national review of the in-place recycling process.

specification guidance that address economic savings and life-cycle cost performance of asphalt recycling.

In-Place Recycling Conference

To help spread the word about the benefits and applications of in-place asphalt recycling, FHWA and ARRA hosted a conference in Salt lake City, UT, in June 2008. The First Western States Regional In-Place Recycling Conference drew pavement professionals from FHWA, State and local DOTs, metropolitan planning organizations, academia, contractors, and suppliers. The event provided a forum to showcase the latest in research, design, specifications, materials, and construction practices, and to promote the cost benefits of in-place recycling.

The conference included a site visit to an in-place recycling project in Nevada, a State with extensive experience with asphalt recycling. The Nevada Department of Transportation recycled more than 1,100 kilometers (700 miles) of pavement from between 1997 and 2005. The site, located on I-80, consists of 32 kilometers (20 miles) of in-place recycling and earned a 2007 Recycling Award from *Roads & Bridges* magazine. The field trip provided the opportunity for attendees to see a cost-effective application of in-place recycling firsthand. More information is available at www.pavementpreservation.org/recyclingworkshop.

To schedule a session of NHI's Asphalt Pavement Recycling Technologies (FHWA-NHI-131050), contact the NHI Scheduler at nhitraining@dot.gov. To learn more about NHI courses, visit www.nhi.fhwa.dot.gov.

Stacy Stottmeister is a contractor for NHI.

Reporting Changes Of Address

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by Keri A. Woodard

Using Podcasts to Listen and Learn

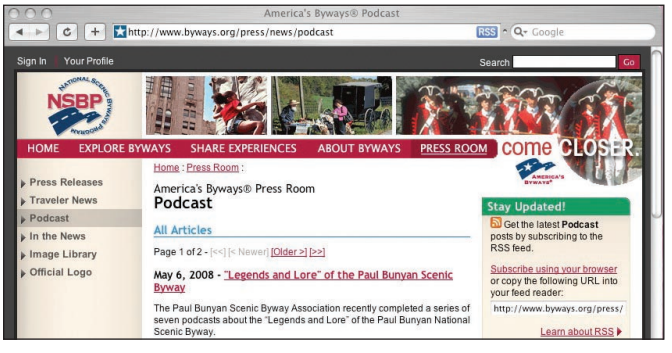
Headphone wearing and rhythmic head bobbing are telltale signs. Whether walking down the street, working out at the gym, or riding the bus, Americans across the country are embracing digital audio devices, including MP3 players, as a means to listen to music and view photos and videos while on the go. These small, easily portable devices enable just about anyone to carry and listen to songs, lectures, and other audio files whenever and wherever. Although some users are listening to their favorite tunes, others are taking advantage of the growing variety of podcasts available for download from many Web sites. Podcasts are recorded broadcasts that listeners can hear on their computers or download to an MP3 player.

Because so many people are listening to podcasts, several transportation agencies and organizations have started posting these types of files on their Web sites to share a variety of information, from training seminars to interviews with highway officials.

At the Federal Level

For the past several years, participants in the Federal Highway Administration's (FHWA) "Talking Freight" seminar series could take part in the lessons only when seated in front of their computers or in a meeting room with Internet access. In spring 2008, however, FHWA began making the seminars available via podcast. Now freight practitioners and others can listen to the seminars whenever and wherever they choose. For example, listeners now can download a podcast of the "Supply Chains and Private Sector Dynamics" seminar held on May 21, 2008. To download this and other "Talking Freight" podcasts free of charge, visit www.fhwa.dot.gov/freightplanning/talking.htm.

FHWA is making other podcasts available online as well. At the Web site for FHWA's America's Byways® program, users can download numerous interviews and discussions about some of the 126 distinct and diverse roads designated by the U.S. Department of Transportation as America's Byways. These podcasts include interviews conducted by humorist, radio personality, and author Tom Bodett with highway officials about the Top of the Rockies byway in Colorado and a discussion about the Native American Scenic Byway in South Dakota. For more information on these podcasts, visit www.byways.org/press/news/podcasts.



Shown here is the Web site that hosts podcasts on America's Byways.

States Talk, People Listen

Several State departments of transportation (DOTs) also have begun posting podcasts on their Web sites. The Texas Department of Transportation's (TxDOT) Keep Texas Moving program offers more then 20 podcasts on its Web site. For example, users can download an interview with TxDOT's emergency management coordinator on mass evacuation procedures or listen to a podcast on public-private partnerships featuring a professor of strategic management at the College of Business Administration at Northeastern University in Boston.

The Missouri Department of Transportation (MoDOT) also is jumping on the podcast bandwagon with its MoDOT Minute program. Every Tuesday, MoDOT officials post 60-second podcasts and videos that update the public on the latest transportation news and events in the State. For example, one podcast featured a MoDOT official discussing 10 work zones to be aware of during the summer travel season. Another podcast highlights the reduction in the number of fatalities in Missouri's highway work zones. These and other podcasts and videos are available at www.modot.org/newsandinfo/ModotMinute.htm.

Connecting With Members

In addition to Federal and State DOT efforts, transportation industry organizations and publications have started using podcasts to connect with their members and readers. The Transportation Research Board (TRB), for example, released a podcast earlier this year through the Sounds of Science series that features a discussion of the TRB 87th Annual Meeting and the role that TRB has played in the transportation industry. To download this podcast and subscribe to others available from the National Academies, visit www.trb.org.

Similarly, magazines, journals, and other publications now offer podcasts as a new way to connect with subscribers and the public. The Web site ENR.com, the online home of a publication featuring engineering news, posts podcasts on a range of topics related to engineering and transportation. For example, one podcast features an interview with Joseph Toole, formerly with the FHWA Office of Professional and Corporate Development (now associate administrator of the Office of Safety), who discussed worker shortages in the transportation industry and FHWA's training programs and global partnerships. Other podcasts have included discussions with the U.S. Secretary of Transportation and officials from the Virginia and Florida DOTs. To download these and other podcasts, visit http://enr.construction.com/people/multimedia/podcasts/default.asp.

Podcasting is just one of the many new technologies that are changing the way members of the transportation industry learn and communicate. Logon, download, and start listening—anytime, anywhere.

Keri A. Woodard is a contributing editor for PUBLIC ROADS.

Communication Product Updates

Compiled by Zachary Ellis of FHWA's Office of Corporate Research, Technology, and Innovation Management

Below are brief descriptions of communications products recently developed by the Federal Highway Administration's (FHWA) Office of Research, Development, and Technology. All of the reports are or will soon be available from the National Technical Information Service (NTIS). In some cases, limited copies of the communications products are available from FHWA's Research and Technology (R&T) Product Distribution Center.

When ordering from NTIS, include the NTIS publication number (PB number) and the publication title. You also may visit the NTIS Web site at www.ntis.gov to order publications online. Call NTIS for current prices. For customers outside the United States, Canada, and Mexico, the cost is usually double the listed price. Address requests to:

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Telephone: 703–605–6000
Toll-free number: 800–553–NTIS (6847)
Web site: www.ntis.gov

Address requests for items available from the R&T Product Distribution Center to:

R&T Product Distribution Center
Federal Highway Administration
9701 Philadelphia Court, Unit Q
Lanham, MD 20706
Telephone: 301–577–0818
Fax: 301–577–1421
E-mail: report.center@fhwa.dot.gov

For more information on R&T communications products available from FHWA, visit FHWA's Web site at www.fhwa.dot.gov, the Turner-Fairbank Highway Research Center's Web site at www.tfhrc.gov, the National Transportation Library's Web site at http://ntl.bts.gov, or the OneDOT information network at http://dotlibrary.dot.gov.

May 2008 *Focus* Newsletter
Publication No. FHWA-HRT-08-013

The May 2008 issue of FHWA's *Focus* newsletter contains features on "National Work Zone Awareness Week 2008: Slow for the Cone Zone," "Rolling Wheel Deflectometer: A High-Speed Deflection Device to Improve Asset Management," "Advancing the Future of Long-Term Bridge Performance," and "New Course Introduces Strategies for Achieving More Effective Pavement Management Programs." This issue also includes an "In Brief" column on products and technologies for accelerating infrastructure innovations and a calendar of infrastructure-related events.

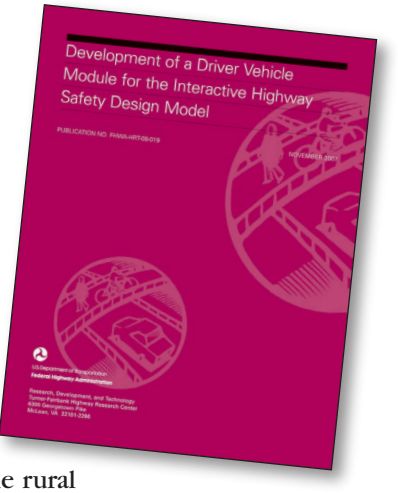
The May issue of *Focus* is available at www.tfhrc.gov/focus/may08/index.htm.

June 2008 *Focus* Newsletter
Publication No. FHWA-HRT-08-014

The June 2008 issue of FHWA's *Focus* newsletter features articles on the following topics: "Extending the Life of Roads and Bridges in Louisiana," "FHWA Offers Soil Nail Showcase," "Meet *The Little Book of Quieter Pavements*," and "FHWA Regional Conferences Showcase Asset Management Around the Country." The newsletter's highway technology calendar lists upcoming events related to products and technologies for accelerating infrastructure innovations.

The June issue of *Focus* is available at www.tfhrc.gov/focus/june08/index.htm.

Development of a Driver Vehicle Module for the Interactive Highway Safety Design Model
Publication No. FHWA-HRT-08-019

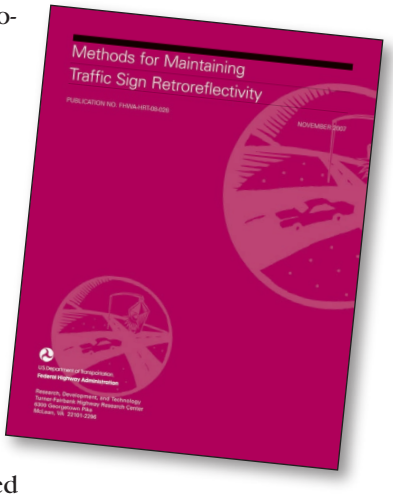


FHWA is developing an integrated set of software tools to improve highway design, known as the Interactive Highway Safety Design Model (IHSDM). IHSDM is a suite of tools to help highway project planners, designers, and reviewers at State and local departments of transportation (DOTs) and engineering consulting firms evaluate the safety and operational effects of geometric design decisions on two-lane rural highways. The latest version released to the public includes the following components: (1) Policy Review Module, (2) Design Consistency Module, (3) Crash Prediction Module, (4) Traffic Analysis Module, and (5) Intersection Review Module. A sixth module, the Driver Vehicle Module (DVM), is a candidate for future release.

This report, *Development of a Driver Vehicle Module for the Interactive Highway Safety Design Model*, provides a complete technical discussion of the DVM. The report includes a description of the specification, verification, and calibration/validation of the DVM for the passenger vehicle and heavy vehicle components, along with additional functionality enhancements.

The report is available online at www.tfhrc.gov/safety/pubs/08019/index.htm and from NTIS under order number PB2008106477.

Methods for Maintaining Traffic Sign Retroreflectivity
Publication No. FHWA-HRT-08-026



In response to a congressional directive, FHWA established minimum retroreflectivity levels for traffic signs and incorporated them into the *Manual on Uniform Traffic Control Devices* (MUTCD). One of the concerns expressed by agency personnel responsible for conformance with required minimums is the potential increase in tort exposure. Therefore, FHWA developed methods for maintaining retroreflectivity that, when implemented as intended, provide agencies with a flexible means of conforming with required minimum retroreflectivity levels and offer protection from potential tort claims. After completing an engineering study, agencies also can use other methods to maintain signs at the required minimum retroreflectivity levels. The information in this report can help DOTs determine which retroreflectivity maintenance method or combination of methods best suits their needs.

The report is available from NTIS under order number PB2008106478.

Long Term Pavement Performance Computed Parameter: Moisture Content
Publication No. FHWA-HRT-08-035

FHWA researchers conducted a study to compute in situ soil parameters based on time domain reflectometry (TDR) traces obtained from Long Term Pavement Performance (LTPP) test sections instrumented for the seasonal monitoring program (SMP). The researchers installed 10 TDR sensors in the base and subgrade layers at each of the 70 SMP test sites monitored as part of the LTPP program.

The report provides a comprehensive description of a new method developed as part of the study to estimate moisture content, dry density, reflectivity, and conductivity of the soil from TDR traces. This new method utilizes transmission line equations and micromechanics models calibrated to site-specific conditions for each site/layer combination. The researchers also documented background information on existing empirical methodologies used to estimate subsurface moisture content from TDR traces. The researchers compared the results to previous methods as well as ground truth data to evaluate the new model's ability to predict soil parameters.

The researchers found that the transmission line equation and micromechanics method provides accurate results and used the method to interpret more than 270,000 TDR records stored in the LTPP database. A computer program, MicroMoist, aided in the computation of soil parameters based on TDR trace data and calibration information. The report provides details on the program, along with descriptions of the tables developed to store the computed values in the LTPP Information Management System database.

The report is available online at www.fhwa.dot.gov/pavement/ltpp/pubs/08035. Printed copies of this report are available from FHWA's R&T Product Distribution Center.

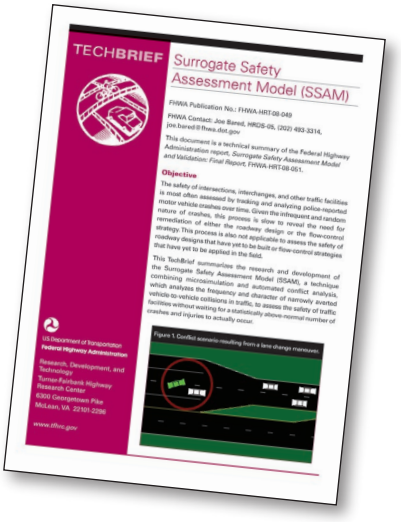
LTPP Year in Review 2007
Publication No. FHWA-HRT-08-039

Improving mobility on the highways is FHWA's mission. During 2007, FHWA's LTPP program worked toward this mission through its efforts to provide answers to how and why pavements perform as they do. To better understand pavement performance, the LTPP program gathers and processes data describing the structure, service conditions, and performance of 2,513 pavement test sections in North America. Highway engineers use these data and data analysis findings to help make decisions that lead to more cost-effective and better performing pavements.

In 1987, when FHWA initiated the LTPP program as a project of the 20-year Strategic Highway Research Program, the agency designed the LTPP program as a partnership. In 2007, the State and Canadian Provincial highway agencies, American Association of State Highway and Transportation Officials, Transportation Research Board, Canadian Strategic Highway Research Program, and FHWA continued to play key roles in helping the program achieve its goals. These partners stay informed about research results and program activities through the LTPP Web site, e-mail newsletter, publications, meetings and workshops, industry trade associations, and professional societies.

FHWA released this report to summarize activities undertaken by the LTPP program during the 2007 calendar year. The report is available at www.fhwa.dot.gov/pavement/ltpp/pubs/08039.

Surrogate Safety Assessment Model (SSAM) (TechBrief)
Publication No. FHWA-HRT-08-049



This TechBrief summarizes the research and development of the SSAM. The model combines microsimulation and automated conflict analysis to analyze the frequency and character of narrowly averted vehicle-to-vehicle collisions in traffic. The goal is to

assess the safety of traffic facilities without waiting for a statistically above normal number of crashes and injuries to actually occur.

The TechBrief is available at www.tfhrc.gov/safety/pubs/08049/index.htm. Printed copies are available from FHWA's R&T Product Distribution Center.

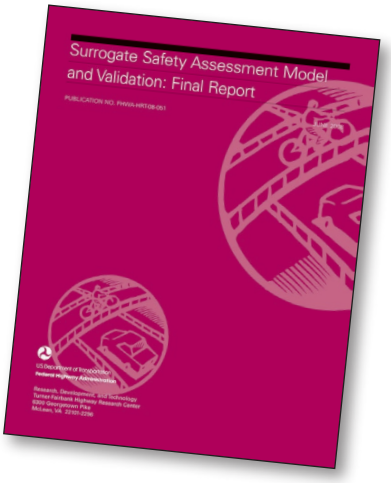
Surrogate Safety Assessment Model (SSAM)—Software User Manual
Publication No. FHWA-HRT-08-050

This document is a user's manual for the SSAM software, providing guidance on installing and using the software to perform surrogate safety analyses of a traffic facility, such as a signalized intersection. The software processes vehicle trajectory data from a given microscopic traffic simulation to identify the frequency of conflicts—where two vehicles are on a collision course and one vehicle must make an evasive maneuver to avoid a collision. Such surrogate measures have been shown to correlate to some degree with the historical frequency of crashes at intersections. This technique may be of use to researchers, transportation engineers, construction and design companies, and safety engineers.

For more information regarding the SSAM application, including discussion of the theoretical background and the results of a series of evaluation tests, see the corresponding FHWA research report titled *Surrogate Safety Assessment Model and Validation: Final Report* (FHWA-HRT-08-051).

The manual is available at www.tfhrc.gov/safety/pubs/08050. Copies also are available from NTIS under order number PB2008111196.

Surrogate Safety Assessment Model and Validation: Final Report
Publication No. FHWA-HRT-08-051



Researchers most often assess the safety of intersections, interchanges, and other traffic facilities by tracking and analyzing police-reported motor vehicle crashes over time. Given the infrequent and random nature of crashes, this process is slow to reveal the need for remediation of either the roadway design or the flow-control strategy. This process also is not applicable to assessing new designs that have yet to be built or assessing flow-control strategies before they are deployed onsite.

This document is a final report on research and development of an alternative safety assessment approach using conflict analysis—analyzing the frequency and character of narrowly averted vehicle-to-vehicle collisions—as a surrogate measure of actual crash data. Researchers developed a software prototype to automate conflict analysis of vehicle trajectory data, which now can be exported from the traffic simulation software of four vendors who collaborated on the project. The majority of the report describes testing conducted to evaluate the efficacy of this approach. The findings may be of interest to transportation engineers, safety engineers, researchers, simulation designers, and firms providing simulation or intersection design services.

The report is available at www.tfhrc.gov/safety/pubs/08051/08051.pdf. Copies also are available from NTIS under order number PB2008111797.

Innovator, Volume 2, Issue 7, June/July 2008
Publication No. FHWA-HIF-08-027

The *Innovator* newsletter, published monthly by FHWA's Highways for LIFE program, advances implementation of innovative technologies and processes in the highway industry. The June/July 2008 issue features the following articles: "Surveys Help DOTs Boost Customer Satisfaction," "Q&A with Kelly Damron: Transforming a DOT," "'Best Solutions' Workshop Resonates in North Carolina," "SPMTs Topic of NHI Seminar," "Virginia Projects Use Rapid Replacement to Slash Construction Time, Congestion," and "Precast Concrete Pavement Systems Speed Construction." *Innovator*'s audience includes transportation professionals in highway agencies, trade and research groups, academia, the private sector, and the driving public.

The June/July 2008 issue of *Innovator* is available at www.fhwa.dot.gov/hfl/innovator/issue07.cfm.

July 2008 *Focus* Newsletter
Publication No. FHWA-HRT-08-015

The June 2008 issue of FHWA's *Focus* newsletter contains features on "Improving Pavement Performance With the Asphalt Mixture Performance Tester," "FHWA to Award Grants to Spur Highway Technology Innovation," "Pavement Recycling Technology Deployment: Meeting Today's Environmental and Economic Challenges," and "Ninth International Conference on Concrete Pavements: Tomorrow's Concrete Pavements Today." It also includes a calendar of infrastructure-related events.

The July issue of *Focus* is available at www.tfhrc.gov/focus/july08/index.htm.

Conferences/Special Events Calendar

Date	Conference	Sponsors	Location	Contact
January 11–15, 2009	TRB 88th Annual Meeting	Transportation Research Board (TRB)	Washington, DC	Linda Karson trbmeetings@nas.edu www.trb.org/meeting
January 18–21, 2009	NAPA's 54th Annual Meeting	National Asphalt Pavement Association (NAPA)	San Diego, CA	Sandy Palacorolla 301-731-4748 sandy@hotmix.org www.hotmix.org
February 3–6, 2009	World of Concrete		Las Vegas, NV	Jackie James 972-536-6379 jjames@hanleywood.com www.worldofconcrete.com
March 15–19, 2009	ACI Spring 2009 Convention: Infrastructure—Concrete Practice & Placement	American Concrete Institute (ACI)	San Antonio, TX	Event Services 248-848-3795 conventions@concrete.org www.concrete.org
March 15–19, 2009	International Foundation Congress & Equipment Expo	Geo-Institute of the American Society of Civil Engineers (ASCE), International Association of Foundation Drilling, and Pile Driving Contractors Association	Orlando, FL	Silas Nichols 202-366-1554 silas.nichols@dot.gov www.fhwa.dot.gov /engineering/geotech /conferences/ifcee09.cfm
March 18–20, 2009	Third International Conference on Urban Transportation Systems	Transportation & Development Institute (T&DI) of ASCE and Transport Technology Exchange Center of the China Academy of Transportation Sciences	Shanghai, China	T&DI Manager 703-295-6420 tanddi@asce.org http://content.tanddi.org /events
March 22–25, 2009	ITE 2009 Technical Conference and Exhibit: Transportation Operations in Action	Institute of Transportation Engineers	Phoenix, AZ	Aliyah N. Horton 202-289-0222, ext. 137 ahorton@ite.org www.cornetser.com/ite
March 24–25, 2009	Midwest Traffic Monitoring Data Workshop	TRB	Columbus, OH	Thomas Palmerlee 202-334-2907 tpalmerlee@nas.edu http://guest.cvent.com /EVENTS/Info/Summary .aspx?e=d6b24d08-d6a7-4e66 -af7f-3fa5969ec47d
March 29–April 1, 2009	Lifesavers Conference, Inc.—National Conference on Highway Safety Priorities		Nashville, TN	Mary Magnini 703-922-7944 mmagnini@cox.net www.lifesaversconference.org
April 5–8, 2009	Geospatial Information Systems for Transportation Symposium	American Association of State Highway and Transportation Officials	Oklahoma City, OK	Jim Ramsey 502-410-1283 jramsey@aashto.org www.gis-t.org

Is Road Safety an Issue In Your Community?

For training, resources, and technical assistance that save money, time, and lives, turn to:

- The Local Technical Assistance Program (LTAP)
- The Tribal Technical Assistance Program (TTAP)

Over the past 10 years, 1.5 million local and tribal road and highway employees attended LTAP/TTAP training courses, nearly half of which focused on safety.

Here are just a few of the practical, cost-effective, and timely solutions available to meet the day-to-day safety needs of transportation professionals:

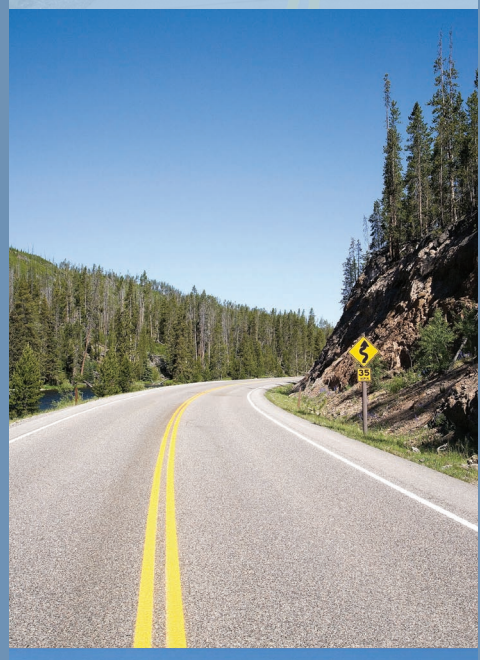
Training

- Roadway Safety Fundamentals
- Low-Cost Safety Improvements
- Work Zone Safety
- Flagger Certification
- Bicycle/Pedestrian Facility Design
- Traffic Sign Retroreflectivity
- Intersection Safety
- Roadside Safety

Technical Assistance

- Road Safety Audits
- Crash Data Analyses
- Safety Circuit Rider Field Visits
- Safety Roundtables

To access the LTAP/TTAP center in your State, visit www.ltapt2.org.



U.S. Department of Transportation

Federal Highway Administration

LTAP/TTAP centers focus on four national transportation priorities:

- Safety
- Infrastructure Management
- Workforce Development
- Organizational Excellence

National LTAP & TTAP Programs

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Federal Highway Administration
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Washington, DC 20590

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Penalty for Private Use $300

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