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of Transportation Federal Highway Administration A Shoulder to Drive On Freight in Focus State-Driven Research



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

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Front cover—Undertaking a transformational change of approach, USDOT and FHWA are encouraging a multimodal perspective for analyzing freight movements throughout the United States and across its borders. The goal is to improve the efficiency of the U.S. transportation system, support global connectivity, and strengthen the Nation's economic competitiveness. For more information, see "The Times They Are Definitely Changing" on page 11 in this issue of PUBLIC ROADS. *Photo:* ©*Doug Berry/ Getty Images.* **Back cover**—One tool that States are using to help save time and money on locally administered Federal-aid projects is stakeholder partnering. The stakeholder committees can produce innovative ideas. For example, Arizona's Stakeholder Council shares knowledge and best practices that can benefit local projects statewide, including multiuse paths such as this one built by the city of Tempe along a former gas line for use by bicyclists and pedestrians. For more information, see "Working Smarter, Together" on page 34 in this issue of PUBLIC ROADS. *Photo: City of Tempe, AZ.*



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Guest Editorial

Overhauling Policies and Programs For Freight Transportation

new era is underway for freight transportation in the United States. The movement of freight is changing, and the Nation's transportation system needs to keep up with those changes to assure the continuing economic growth of the United States.

The U.S. Department of Transportation anticipates that by 2045, the volume of freight transported in the United States will increase by 45 percent. Preparing for this unprecedented growth is one of the major challenges facing USDOT, the Federal Highway Administration, and State and local transportation departments and authorities.

The role of USDOT is to ensure safe, efficient, and effective use of the Nation's entire transportation network road, rail, water, and air. Developing new approaches to cope with the growing impacts of freight transportation, including traffic congestion, is essential to ensuring the network's ability to support the U.S. economy.

To address the challenge of this new reality, the transportation community is shifting away from looking at freight movement in terms of separate modes. Instead of stove-piping individual highway, rail, air, and water systems, the new multimodal approach involves strategic solutions aimed at developing a seamless network with all modes interacting efficiently.

Under this perspective, USDOT is fostering multimodal strategic planning and Federal investments, plus improving efficiency through a seamless system. The national freight network includes not only highways, railways, and waterways, but also airports, other intermodal facilities, and hundreds of ports of entry from Canada, Mexico, and across the oceans.

Kicking off with this issue of PUBLIC ROADS, a series of five articles will discuss this emerging era. To begin, an article titled "The Times They Are Definitely Changing" (page 11) examines the multimodal approach in detail. Future articles in the series will focus on new initiatives within FHWA, including truck parking, State freight plans, freight performance measures, and reducing the impacts of freight movements on communities.

Truck parking shortages are a national safety concern because weary drivers may continue to use the road whenever they have difficulty finding a place to park. Or they may choose to rest at unsafe locations, such as road shoulders, exit ramps, or vacant lots.



Another article in the series will focus on the requirement under the Fixing America's Surface Transportation (FAST) Act that each State develop a comprehensive 5-year freight plan, which must include a list of priority projects for the investment of matching funds.

In addition, the FAST Act elevates the requirements for freight planning and performance measurement. FHWA has a number of initiatives underway to improve freight data on reliability, truck speeds, and bottlenecks, and to develop performance measures for freight planning.

To complete the series, the final article will focus on the impact of freight movement on communities, especially downtown urban areas. It will examine noteworthy strategies implemented in urban areas and provide available resources for planning urban freight movements.

With the nexus between the societal changes in the way that goods are purchased, delivered, and used, and the multitude of new and emerging technologies to improve the efficiency of freight movement, transportation is entering a whole new era. For example, connected vehicle and information sharing technologies are preparing to help the transportation community meet the huge challenge of the growth expected over the next three decades.

Martin C. Knopp Associate Administrator Office of Operations Federal Highway Administration

HOT TOPIC

by David Harris

Using Advanced Technologies To Tackle Congestion

Drivers in the United States spend, on average, more than 40 hours stuck in traffic each year. The Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD) program, a new program within the Federal Highway Administration, funds cutting-edge technologies that help reduce congestion, improve safety, lower operating costs, and maintain infrastructure.

This program is part of the answer to the concerns outlined in *Beyond Traffic*, the report issued by the U.S. Department of Transportation in 2015 that examines the challenges facing the country's transportation infrastructure over the next three decades. The ATCMTD program was established under the Fixing America's Surface Transportation Act of 2015.

"Technology can help improve the highway system and make it work better for everyone," said former Federal Highway Administrator Gregory G. Nadeau. "The Nation can make more efficient use of the transportation system by maintaining it in good condition and knowing in real time what's happening out on the highways. And the ATCMTD program is designed to do just that."

Available Funding

Each fiscal year from 2016 through 2020, a maximum of \$60 million will be available for awards under the ATCMTD program, through 5 to 10 grants not exceeding \$12 million to each qualifying entity. These grants will make up no more than 50 percent of total proposed project costs, with the remainder coming from non-Federal sources. State departments of transportation, local governments, transit agencies, metropolitan planning organizations, and other eligible entities may apply under the program.

C Technology can help improve the highway system and make it work better for everyone."

— Former Federal Highway Administrator Gregory G. Nadeau

First-Round Recipients

FHWA published the first solicitation for proposed projects on March 22, 2016, and announced the award recipients on October 13, 2016. The U.S. Secretary of Transportation selected the following eight projects for a total amount of \$56.6 million.

A Connected Region: Moving Technological Innovations Forward in the Niagara International Transportation Technology Coalition Region. To reduce congestion in the Buffalo-Niagara area, the Niagara Frontier Transportation Authority will use a \$7.8 million grant to deploy connected vehicle technologies to alert commercial vehicle operators of border wait times and available parking.

ConnectSmart: Connecting TSMO [Transportation Systems Management and Operations] and Active Demand Management. The Texas Department of Transportation received more than \$8.9 million to expand person-trip capacity by providing a broad range of innovative mobility options to commuters, such as shared-use bicycles, ridesharing services, and unified payment across transit and other shared-use services.

Denver Smart City Program. In Denver, CO, the city and county received \$6 million to implement three intelligent transportation systems projects. The technologies will include dedicated short-range communications installed in 1,500 city fleet vehicles.

Freight Advanced Traveler Information System. This large-scale deployment in southern California involves automated, optimized dispatching and traffic signal-vehicle speed coordination to reduce truck congestion and fuel usage. The Los Angeles County Metropolitan Transportation Authority received a \$3 million grant for the deployment.

Implementation of Advanced Technologies to Improve Safety and Mobility Within the Promise Zone. The Los Angeles Department of Transportation received \$3 million to implement technology that enables traffic signal systems to detect vehicles that violate red lights and adjust signal timing to hold a longer all-red duration interval. The technology also can use personal wireless devices to prioritize pedestrian travel and safety at intersections.

NW 33 Smart Mobility Corridor Deployment. Marysville, OH, received nearly \$6 million to deploy corridor-focused connected vehicle applications in rural and suburban environments. The NW 33 Innovation Corridor between Dublin and East Liberty, OH, serves one of the largest concentrations of manufacturers in the Columbus region. The project will improve access to large employment sites and enhance economic development.

SmartPGH. Pittsburgh, PA, received nearly \$10.9 million to deploy "Smart Spine" corridors that layer environmental, communications, energy, and transportation infrastructure technologies to improve connections between isolated neighborhoods and major centers of employment, education, and health care.

San Francisco Smart City. In San Francisco, the city and county will use its nearly \$11 million grant to implement connected dynamic tolling for the San Francisco-Oakland Bay Bridge, combined with incentives for high-occupancy vehicle and transit use to reduce congestion.

The timeframe for implementation of these projects is expected to be 2 to 4 years. Project awards are expected in June 2017.

David Harris is the program manager for the deployment of advanced transportation and congestion management technologies in FHWA's Office of Operations.

INNOVATION CORNER

by Robert Ritter

Developing Tomorrow's Transportation Workforce

Highway agencies and their partners in the private sector face a challenge to building, operating, and maintaining the Nation's transportation system: a shrinking workforce.

"The transportation industry and contractors are losing their seasoned workers," says Virginia Tsu, director of the Center for Transportation Workforce Development, one of four centers in the Federal Highway Administration's Office of Innovative Program Delivery. "They have not been able to recruit and retain enough qualified replacements."

The public sector is facing the same hurdle. "It's becoming harder to compete with private sector salaries and benefits," Tsu says, "especially with a smaller pool of qualified workers."

To help, the Center for Transportation Workforce Development works closely with public and private sector partners to coordinate a range of programs to educate and develop the transportation workforce.

"Combining FHWA's workforce-related programs into one center provides a central place where our external partners can come for assistance and support," says Tsu. "This is an opportunity to take a new look at our existing programs and develop new initiatives to enhance transportation workforce development."

Highway Construction Pilot Project

One of the center's new projects, the Highway Construction Workforce Development Initiative, explores how to link qualified applicants more effectively with on-the-job training in highway construction. The 2-year pilot, which began in fall 2016, involves a partnership with the U.S. Department of Labor and transportation organizations to identify, train, and place workers in high-need occupations.

The Department of Labor and FHWA are collaborating on the project with the American Association of State Highway and Transportation Officials, Associated General Contractors of America, American Road & Transportation Builders Association, and State and local workforce investment boards. The partners chose six cities—Atlanta, Dallas, Denver, Los Angeles, Pittsburgh, and St. Louis—and six States—Alabama, Arizona, Connecticut, Idaho, Rhode Island, and South Dakota—where they are working cooperatively to attract qualified people to jobs in highway construction.

Each partner leverages its organizational network to pinpoint skill gaps or identify potential applicants and training programs to fill those gaps. The pilot cities and States tailor their recruitment and training efforts to their resources and labor supply. Measurable results will include the number of workers trained, hired, and retained for at least 6 months.

"We are confident the pilot will enable us to identify techniques and mechanisms that can be replicated across the country to recruit and retain a skilled and diverse workforce,"Tsu says.



(L–R) Former Deputy Secretary of Transportation Victor Mendez, South Dakota Transportation Secretary Darin Bergquist, and then FHWA South Dakota Division Administrator Virginia Tsu meet with local engineering supervisors Greg Aalberg and Mike Heiberger in Sioux Falls, SD. Photo: Kristi Sandal, South Dakota Department of Transportation.

Workforce Development Programs

In addition to the pilot project, the center has ongoing initiatives to fill jobs in highway construction, transportation systems management and operations, and transit. For example, the center's On-the-Job Training Supportive Services Program helps highway agencies create training and apprenticeship programs, including programs to increase the participation of minority, women, and disadvantaged workers in the highway contracting workforce.

The center also offers post-secondary education programs, including the Dwight David Eisenhower Transportation Fellowship Program, which supports university students pursuing transportation-related degrees. The Summer Transportation Internship Program for Diverse Groups, provides students with hands-on experience working in the transportation industry.

Other programs target students in kindergarten through 12th grade. The Garrett A. Morgan Transportation Technology Education grants go to educators to develop curricula that enhance awareness of transportationrelated careers. In addition, the National Summer Transportation Institutes offer programs to middle and high school students to boost their science, technology, engineering, and math skills and encourage them to pursue transportation-related studies in college.

"These programs are all based on investing in our future," says Tsu. "Bringing these programs together in one center enables us to strengthen and grow our efforts to shape a workforce that can meet the demands of a 21st-century transportation system."

Learn more at www.fbwa.dot.gov/innovative programs/centers/workforce_dev.

Robert Ritter, P.E. is the managing director of FHWA's Office of Innovative Program Delivery.

States are turning freeway shoulders into part-time travel lanes to relieve congestion as a cost-effective alternative to traditional widening.

byiding a Shoulder to Drive On by Jim Hunt, Pete Jenior, and Greg Jones

(Above) More and more, States are considering parttime shoulder use, such as this application in Honolulu, HI, as a strategy to improve capacity when traditional road widening is not feasible. Photo: Lee A. Rodegerdts, P.E., Kittelson & Associates, Inc.

ransportation officials are having difficulty simply maintaining, let alone expanding, the Nation's highway infrastructure. Aging assets, a growing population, and revenue uncertainty add to the hurdles facing State and local transportation agencies.

Relieving congestion on urban freeways through conventional

widening projects is often impractical because of costs and the detrimental impacts of construction activities on travelers and surrounding businesses and residents. Plus, once a freeway widening project advances to implementation, it can take years to complete, delaying the realization of any benefits.



Freeway congestion often varies widely throughout the day, and part-time shoulder use can provide congestion relief when it is needed most, while maintaining shoulders for their primary purposes for the remainder of the day and night. Those primary uses include refuges for vehicles during emergency situations, access for first responders, and additional recovery areas for drivers who may have to swerve out of the travel lane to avoid conflicts in the adjoining travel lanes.

Engineers try to preserve wider shoulders when possible; however, the cost to widen a freeway is significant and each foot of pavement width counts. As a result, many examples of urban freeways with narrower lanes and shoulders exist and the value of having shoulders is diminished.

To assist State and local agencies in adopting the strategy, the Federal Highway Administration released the Use of Freeway Shoulders for Travel: Guide for Planning, Evaluating, and Designing Part-Time Shoulder Use as a Traffic Management Strategy (FHWA-HOP-15-023). The guide highlights more than 30 shoulder-use installations covering a range of design and operational approaches in 16 States. Part-time shoulder use requires special attention to planning, design, public outreach, implementation, safety, operations, and maintenance. The guide aims to help practitioners consider the strategy and promote consistent practices in evaluating and developing shoulder-use concepts.

How Does Part-Time Shoulder Use Work?

Because part-time shoulder use maximizes existing roadway capacity, the strategy provides a solution that transportation agencies can implement quickly, at a much lower cost and with fewer environmental impacts than traditional projects that expand capacity.

Part-time shoulder use, or "shoulder running," can take many forms. However, all scenarios involve use of the left or right shoulder of an existing roadway for temporary travel during certain hours of the day.

Current implementations of parttime shoulder use are primarily in locations where recurring congestion exists because of traffic bottlenecks or lack of capacity during peak periods. For example, Pace Suburban

In Chicago, bus-on-shoulder operations on I–55 have improved trip reliability and increased bus ridership significantly. *Photo: Pace Bus.*

Freeway congestion is a recurring performance problem, but it is also a condition that typically occurs only during limited hours of the day. One innovative, relatively low-cost solution States are now implementing is to allow traffic to use freeway shoulders as travel lanes on a part-time basis. Many transportation agencies are implementing or considering parttime shoulder use as a performancebased practical design solution to strategically invest limited transportation funding and maximize system performance. The United States has a growing list of successful projects, and other countries have a long history of effective shoulder use.



States Employing Part-Time Shoulder Use in 2016



Bus, a public transportation agency serving the greater Chicago, IL, area, identified bus-only shoulder use as a strategy that could increase the reliability and attractiveness of public transportation. Compared to constructing new dedicated bus lanes, bus use of shoulders is much more cost effective. In 2011, the agency implemented bus-on-shoulder service on the Stevenson Expressway (I-55) as a demonstration project. Because of the success of this demonstration, the State passed legislation permanently allowing buson-shoulder service and expanding that permission to all the region's expressways and tollways in 2014.

"Since Pace Bus received approval for bus-on-shoulder operations

Dynamic part-time shoulder use, as shown here on I–66 in northern Virginia, provides an "on-demand" strategy for when special events or conditions cause heavy congestion. Photo: Kittelson & Associates, Inc. on I-55 in 2011, bus ridership on that corridor has more than quadrupled," says Doug Sullivan, department manager of marketing with Pace Suburban Bus. "And on-time performance—which averaged less than 70 percent is now over 90 percent."

Objectives and Facility Considerations

Currently, 16 States operate some type of part-time shoulder use. Although historically allowing bus use on shoulders has been the most common type of implementation, several States



have locations that accommodate general traffic on the shoulder for a portion of the day and many others are exploring such implementations.

Determining the type of part-time shoulder use that is appropriate for a given corridor depends on an agency's objectives and specific facility characteristics. Typical part-time shoulder use aims to achieve one or more of the following objectives:

- Offer relief from peak-period congestion for a minimal cost compared to adding new general purpose lanes.
- Provide additional capacity on an interim basis while a conventional widening project works through the planning, design, environmental, and construction processes.
- Increase bus ridership by improving bus travel time and reliability.
- Preserve a full-width shoulder during off-peak periods, which provides safety performance benefits as compared to a widening project that results in narrower lanes and shoulders.

Among the facility characteristics that States need to consider are roadway and interchange geometrics including ramps, physical constraints, pavement type and quality, shoulder maintenance and stormwater management, travel demand patterns, and traffic characteristics.

Several types of design and operations options are available for part-time shoulder use. These include restricting shoulder use to authorized transit buses or allowing use by all (or most) vehicles. If all vehicles can use the shoulder, another option is to open it for travel only during fixed periods, such as each weekday peak period. This is known as static shoulder use. Alternatively, shoulder use can be based on prevailing and predicted conditions to accommodate special events or incidents that trigger heavy congestion. This is known as dynamic shoulder use and typically employs dynamic lane control signs (such as red X or green arrow indicators).

Other design and operations considerations include whether to allow travel on the left or right shoulder and whether to vary speed limits (or post speed advisories) on the general purpose or shoulder lanes when the shoulder is open.

FHWA's Simulated Part-Time Shoulder Capacity

Part-Time Shoulder-Use Scenario	Shoulder Capacity (Vehicles Per Hour)
Short segment and low quality	1,262
Long segment and low quality	1,334
Short segment and high quality	1,610
Long segment and high quality	1,687

Note: Short is defined as a 1,000-foot (305-meter) part-time shoulder encompassing the length of a bottleneck. Long is defined as a 1.5-mile (2.4-kilometer) part-time shoulder encompassing the length of a bottleneck and queue prior to it. A low-quality, part-time shoulder is defined as being 10 feet (3 meters) wide that only 50 percent of drivers are willing to use. A bigb-quality, part-time shoulder is defined as being 12 feet (3.7 meters) wide with "normal freeway lane design standards" that all drivers are willing to use.

Capacity and Safety Performance

Based on FHWA-sponsored research and simulation studies, the extent to which a shoulder may provide additional capacity compared to a general purpose freeway lane (albeit on a part-time basis) varies and is influenced by the quality of the shoulder. Quality factors include shoulder width and length, distance from the travel way to roadside features, and other elements that might make some drivers uncomfortable or unwilling to travel on the shoulder.

The results of FHWA's simulations are generally consistent with capacities observed in the field and the proven relationship between design features and capacity. For example, the lane designated for part-time shoulder use on I-66 in northern Virginia is 12 feet (3.7 meters) wide, has large portions of paved shoulder several feet wide beyond it, and has overhead dynamic lane control signs. Observed capacity of the shoulder during in-use periods is similar to the adjacent general purpose lanes (approximately 2,000 vehicles per hour per lane).

In contrast, the lanes designated for part-time shoulder use on I-93 in Massachusetts are less than 12 feet (3.7 meters) wide, generally have only a 1- to 2-foot (0.3- to 0.6-meter) paved shoulder beyond the shoulder lane, use limited dynamic signs,



Predicted Crash Frequency for Freeway Conversions



its guide on part-time shoulder use to help practitioners understand various design scenarios. It depicts a freeway ramp junction where shoulder use is permitted and the pavement markings were modified to have exiting traffic change lanes onto the shoulder for several hundred feet prior to the exit ramp.

and include interchanges with constrained geometries. The shoulder on I-93 was observed to have one-half to two-thirds the capacity of adjacent general purpose lanes. The range of potential capacity increases from shoulder use illustrates the influence of road geometrics such as shoulder lane width, effective shoulder width when the shoulder lanes are in use, and interchange spacing and design.

With regard to safety performance, the sources of safety-related research evaluating the specific changes in crash frequency and severity as a result of implementing part-time shoulder use is limited to only a few Federal and State empirical studies. Crash frequency has increased in some locations following part-time shoulder-use projects and decreased as a result in others. suggesting the effect of part-time shoulder use on crash frequency is influenced significantly by sitespecific operational and geometric characteristics. No transportation agencies have had to discontinue the practice of part-time shoulder use because of safety concerns.

The American Association of State Highway and Transportation Officials' *Highway Safety Manual* (HSM) is a tool that officials can use to help estimate the predicted highway crash frequency and severity as a result of a project. Currently, the HSM is not capable of analyzing part-time shoulder-use scenarios during the period of time when traffic is using the shoulder. However, the current

Source: FHWA.

edition of the HSM can inform project decisions by approximating the crash frequency of a freeway widening project that would result in narrower lanes or shoulders. Because narrower lanes and shoulders have a negative effect on safety, officials can use the HSM to estimate crash frequency and severity of a part-time shoulder alternative during the periods of the day when the shoulders are not being used as a travel lane. This comparison underscores the clear safety advantages of providing a full-width shoulder under less congested conditions in lieu of a freeway widening project that results in narrower lanes and shoulders.

In time, transportation agencies will have a more substantive understanding of the safety effects of part-time shoulder use. Until then, surrogate methods of assessing safety can help inform agencies about whether and how to implement this practice. For example, reducing congestion by allowing part-time shoulder use for all or most vehicles enables greater headways between vehicles and reduces stop-start activity that contributes to rear-end crashes. However, it may require compromises of other geometric design elements known to adversely influence crashes, such as effective shoulder width remaining when the shoulder lane is open to traffic or lateral offset to roadside features (such as median barriers and guardrails). It is important that FHWA continue monitoring the safety performance of part-time shoulder-use installations to build the body of safety knowledge.

Excerpt of Questions Covered in Use of Freeway Shoulders for Travel

Roadway Design	Implementation
 Has vertical clearance under bridges been checked? Have drainage patterns been checked? Has stopping sight distance been checked on curves adjacent to barriers? Have fixed object offsets been checked? Guardrails, signs, and other objects may need to be moved farther away from the roadway. Will safety turnouts be provided, and have locations been established? Are ramps taper-style or parallel-style, and will any need to be modified? 	 Is a Manual on Uniform Traffic Control Devices request to experiment necessary? Are stakeholders, such as police and emergency responders, engaged? Have State-specific legal issues, such as laws prohibiting driving on the shoulder, been addressed? For bus-on-shoulder implementation, is driver training occurring? Is a public outreach plan established?
Planning and Preliminary Engineering	Maintenance and Operations
 Planning and Preliminary Engineering Will physical roadway conditions permit shoulder use? Is the shoulder pavement strong enough to carry traffic? Will the right or left shoulder be used? If an area has a congestion management process, is shoulder use a compatible strategy? 	 Maintenance and Operations Is there a plan for plowing snow from the shoulder? Is there a maintenance plan for aggressive debris removal from the shoulder because it will be used for travel at times? What specific actions will occur each time the shoulder is opened or closed?

FHWA's Guide on Part-Time Shoulder Use

FHWA developed its guide on parttime shoulder use in response to increasing local, State, and Federal legislative interest in shoulder use and performance-based practical design. Efforts promoted by States and FHWA to evolve the highway design process from one driven primarily by design criteria to one that considers cost-effectiveness and systemwide performance also fueled the guide's development.

FHWA developed the guide based on interviews with its own subject matter experts and staff from agencies that have deployed shoulder-use treatments. The guide developers also researched appropriate analytical techniques, including those to estimate the safety and operations effects.

The guide provides information on all phases of the life cycle of a proposed shoulder-use project, including planning, environmental considerations, design, operations, and maintenance. It also covers a range of issues—from costs to design considerations to maintenance—that can help agencies advance shoulder-use concepts in their States in a more consistent manner. Planners and designers can use the guide to help address a number of questions at various stages in the project development process. However, knowledge gaps remain in some areas of the guide, such as estimating induced traffic and air quality impacts, estimating effects on crashes, and determining the optimal thresholds for opening up a shoulder for travel to maximize operational and safety performance. More experience with shoulder use and additional research is needed.

The guide also includes photos and illustrations depicting signing and design scenarios. In addition to these components, the guide provides a list of most known applications of shoulder use in the United States and presents several case studies of successful applications. What follows are two examples of applications of part-time shoulder use that mitigate different types of congestion.

Texas Addresses Weekday Congestion

In September 2015, the Texas Department of Transportation (TxDOT) and the Regional Transportation Council opened a shoulder lane for travel during peak periods on State Highway (SH) 161 in Irving. The 3-mile (4.8-kilometer) stretch of highway between SH 183 and



The average speeds for each 15-minute interval in the 4-hour morning peak period improved drastically after implementation of part-time shoulder use.

SH 114 has two general purpose lanes in each direction and connects with the President George Bush Turnpike, operated by the North Texas Tollway Authority, which has three general purpose lanes in each direction. The drop from three lanes to two creates a bottleneck that recurrently causes speeds to drop during peak periods.

The interim phase of implementation consisted of shoulder restriping to enable three general purpose lanes to operate during peak travel periods. The project team restriped the existing inside shoulder and main lanes to provide two general purpose lanes and an interim operational travel lane during morning and evening peak hours of travel (in each direction). The project also incorporated a variety of operational improvements, including closed circuit cameras, improved lighting, and strategically pre-positioned tow trucks, to ensure that the lanes function safely and efficiently. The staged tow trucks assist with opening and closing the lanes, while also providing expedited incident management.

The shoulder-use project improved travel speeds immediately. The average northbound (morning) rush-hour speed on the freeway for 8 workdays before implementing shoulder use was 30.7 miles per hour, mi/h (49 kilometers per hour, km/h). After opening the inside shoulder, the average northbound speed in the first 8 days increased to 66 mi/h (106 km/h). Speeds in the southbound direction during the evening peak period experienced similar improvements.

"The SH 161 shoulder lanes have achieved their goal of improving traffic flow through a major bottleneck," says Kelly Selman, P.E., an engineer with the TxDOT Dallas District. "TxDOT is pleased with their performance. Where appropriate, TxDOT will consider implementing them in other areas."

More recently, traffic managers have observed increasing traffic volumes on SH 161, which may dampen some of the speed gains. One possible cause for the increase in traffic is diversion from parallel routes to SH 161 because it now provides a more reliable trip. The North Central Texas Council of Governments and the Texas A&M Transportation Institute are finalizing



Note: The Mountain Express Lane stretches from the Veterans Memorial Tunnels to the U.S. 40 interchange (Empire Junction), but travel time and delay were studied on a slightly longer corridor from the Veterans Memorial Tunnels to Georgetown.

the collection of data for a study that will provide more insight into speeds and volumes, and information on origins and destinations.

Colorado Takes on Seasonal Weekend Congestion

The Colorado Department of Transportation (CDOT) employs part-time shoulder use on I-70 eastbound between the U.S. 40 (Empire Junction) Interchange and the Veterans Memorial Tunnels (formerly the Twin Tunnels) west of Denver. Referred to as the Mountain Express Lane, the project officially opened in December 2015 and operates about 100 days out of the year. When open, the shoulder lane is tolled.

The Mountain Express Lane differs from most shoulder-use projects because it does not address daily peak period congestion. Instead, the project targets seasonal congestion on the weekends and on holidays related to tourism and recreation. This section of I-70 experiences high congestion on Fridays (westbound) and Sundays (eastbound) while travelers are on their way to and from the mountains west of Denver.

In addition to safety and mobility challenges, other factors made traditional roadway widening problematic. For example, this section of I-70 passes through sensitive natural environments and historic communities. CDOT needed to preserve these areas while accommodating the recreational activities that attract many travelers to Colorado. "Part-time shoulder running is a perfectly matched operational solution to the unique patterns and problems of our intense recreational traffic demands," says Ryan Rice, director of Transportation Systems Management & Operations at CDOT. "We have seen high benefit relative to the cost of the project."

Compared to the winter season prior to implementation (December 2014-March 2015), the Mountain Express Lane has reduced the total amount of delay (evident during the first winter season after implementation December 2015-March 2016). This improvement is especially noteworthy considering that throughput volumes increased an average of 14 percent despite 12 percent more snowfall the season following implementation. Drivers have experienced improved average travel times, reduced delays, and significantly less time spent in excessive traffic (delay greater than 30 minutes).

"The I-70 Mountain Express Lane has impacted the frontage [local county] roads, which aren't as congested with people getting off the highway," says Megan Castle, communications manager with CDOT's High-Performance Transportation Enterprise. "Business is up and people are getting into their communities."

FHWA's Next Steps

With the completion of FHWA's Use of Freeway Shoulders for Travel: Guide for Planning, Evaluating, and Designing Part-Time Shoulder Use as a Traffic Management Strategy, agency officials now plan on developing additional guidance, sharing best practices, providing outreach through workshops and webinars, and continuing to collaborate with national organizations to raise the collective understanding of part-time shoulder use.

FHWA also will undertake additional research on the crash and safety implications of part-time shoulder use and the optimal conditions to open shoulders dynamically. The ultimate goal of the research, collaboration, and additional outreach is more efficient use of the Nation's urban freeways.

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Focus on Freight: Article 1

The Times They Are Definitely Changing

Shipping today requires a complex network of air, rail, marine, pipeline, and highway transport. That's why the U.S. Department of Transportation and the Federal Highway Administration are emphasizing a focus on multimodalism. *Photo:* © *ThinkstockPhotos.*

by Chandra Bondzie

Together, USDOT and FHWA are encouraging a multimodal approach for analyzing freight movements throughout the United States and across its borders. o foster the Nation's economic growth and competitiveness, the U.S. Department of Transportation is leading the way to creating a more efficient freight transportation system. What is afoot at USDOT is nothing short of transformational.

The Nation's freight transportation system consists of a vast network of roads, railways, navigable channels, airways, and pipelines connecting hundreds of ports, airports, and intermodal facilities. This network supports the U.S.'s supply chain-based economy and is integral to the movement of raw materials and finished products throughout the country and across the Nation's borders.

In the past, the transportation community in many instances viewed and assessed freight issues from the perspective of one mode. But now, to improve freight planning and investment, USDOT is changing the way it assesses the movement of goods to determine how well the transportation system is meeting the needs of the Nation. Instead of separate modes, the focus is more on the movement of freight along supply chains via multiple modes of transportation. By fostering multimodal strategic planning and investment, USDOT's goal is to improve the efficiency of the system, support global connectivity, and strengthen the Nation's economic competitiveness.

To implement this approach, USDOT is actively crafting new multimodal transportation policies and programs across its agencies, as well as targeting investment to explicitly multimodal freight programs that have the potential to produce significant national and regional benefits. To encourage a multimodal perspective, USDOT is investing strategically to enable the movement of goods and people more efficiently, and at the same time is addressing the impacts of freight movement on communities. Recent program developments enhancing this work at USDOT include new multimodal funding opportunities, multimodal research, and performance measures for the transportation system.

The new approach is also underway at the Federal Highway Administration. Within FHWA, the Office of Freight Management and Operations is developing several new initiatives to advance the national multimodal freight policy goals, including

new approaches for collecting and analyzing freight data. The freight office has a key role at FHWA in implementing funding programs that can be used to deliver multimodal projects, including primary responsibility for the agency's role in implementing the Transportation Investment Generating Economic Recovery (TIGER) grants and oversight of the National Highway Freight Program. The office also administers the new Fostering Advancements in Shipping and Transportation for the Long-Term Achievement of National Efficiencies (FASTLANE) grant program.

"The FHWA freight office is promoting efficient and seamless freight flows on the U.S. transportation system and across U.S. borders to accomplish a smooth and secure movement of freight," said former Federal Highway Administrator Gregory G. Nadeau. "But FHWA cannot do it alone. The economic prosperity and competitiveness of America is inherently dependent on the efficiency and performance of a multimodal system."

Supply Chains: Critical Components

A supply chain is an end-to-end path of freight moves to deliver raw materials to a manufacturer or finished products to a marketplace. A supply chain may be a trip accomplished by a single truck move within a specific metropolitan area, State, or region. Or it might be a long trip accomplished by a combination of truck, rail, ship, airplane, or pipeline freight moves spanning regions and continents. The country's supply chains consist of complex logistical moves that depend on modes of transportation that are global, intricate, and multiple.

Information on how supply chains perform from the perspectives of shippers, carriers, and receivers is critical to knowing whether the supply chains are working or failing. That information is, in turn, essential to determining whether and where public investment might improve the performance of the freight system and support economic competitiveness and growth.

Encouraging the Multimodal Approach: MAP-21

The multimodal approach can be said to have originated in the 1990s. The Federal surface transportation program governed by the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) exerted a major influence on the performance



and development of intermodal freight transportation in the United States. This program was one of several Federal public works programs that provide freight facilities. Other programs build, maintain, and operate the inland waterways; provide aid to airports; maintain the air traffic control system; and maintain harbors. The Federal highway program in ISTEA was the largest of these programs and the most important for freight in the sense that trucking is the largest freight mode in terms of value of services provided. ISTEA also was important for intermodal freight because the legislation was the vehicle for declaring the new Federal policy concern with intermodalism.

Two decades later, the Moving Ahead for Progress in the 21st Century (MAP-21) Act, passed in 2012, set in motion a critical process for communicating, planning, and ultimately funding important freight projects and began to foster a multimodal perspective.

The freight goals in MAP-21 focused on improving the condition and performance of the National Freight Network to expand competition in the global economy. To support these goals, Congress directed USDOT to develop a National Freight Strategic Plan. That strategic plan calls for the Nation to invest in the efficiency of the movement of people and goods, while utilizing existing capacity across all transportation modes.

MAP-21 also directed USDOT to develop the first highway-based national freight network. This network, incorporating a core set of roadways to be designated as the Primary Freight Network, was intended to assist States in strategically directing resources toward improved system performance for the efficient movement of freight on the highway portion of the Nation's freight transportation system.

This Primary Freight Network included the National Highway System, freight intermodal connectors, and aerotropolis transportation systems. An aerotropolis is an urban plan in which the design. infrastructure, and economy are centered on an airport to speed the connectivity of goods and people.

under MAP-21, FHWA used a data-

driven methodology to identify approximately 27,000 centerline miles (43,500 kilometers) in the Primary Freight Network. The methodology included assessing network connectivity and freight tonnage volumes on roadways.

At the time of release of a draft Primary Freight Network in November 2013, however, FHWA recognized the limitations of a highway-focused National Freight Network. Comments from the public indicated that the highway Primary Freight Network was not sufficient in its approach and that a more comprehensive and multimodal network was necessary to assess and improve the freight system. This public feedback on the Primary Freight Network spurred activity by USDOT modal administrations to develop a multimodal approach. in part to support the drafting of the National Freight Strategic Plan.

Although specific commodities are likely to be moved on a particular mode or series of modes, a complex multimodal system is required to carry the growing volume of bulk and high-velocity, high-value goods. As identified in an October 2015 Federal Register Notice relating to a Multimodal Freight Network drafted by FHWA, freight in the United States travels over an extensive network of 985,000 miles (1.6 million kilometers) of Federal-aid highways; 141,000 miles (227,000 kilometers) of railroads; 28,000 miles (45,000 kilometers) of waterways; and more than 2.6 million miles (4.2 million kilometers) of pipelines. There are more than 13,000 airports in the United States, with approximately 500 serving commercial operations, and over 5.000 coastal, Great Lakes, and inland waterway facilities moving cargo.

The Multimodal Mandate: The FAST Act

The FHWA freight office developed a multimodal network alternative to the highway-limited Primary Freight Network and opened this new draft for comment in October 2015. The public comments ultimately led to the more comprehensive and multimodal freight network proposed by FHWA and subsequently identified as the draft Multimodal Freight Network.

The Fixing America's Surface Transportation (FAST) Act of

December 4, 2015, repealed the prior networks created under MAP-21 and established a National Highway Freight Network. Further, the FAST Act linked this network in part to eligibility under the National Highway Freight Program formula funding and the FASTLANE grant program in order to encourage strategic investments in freight infrastructure.

The FAST Act provides \$4.5 billion in grant funds and \$6.3 billion in formula funds over 5 years. Although subject to certain caps, the following organizations can use a portion of these funds for intermodal projects: State or multistate transportation agencies, metropolitan planning organizations that represent areas with populations over 200,000, local governments, political subdivisions, special purpose districts or public authorities with transportation functions, tribal governments, Federal land management agencies, or multistate or multijurisdictional entities. In fact, USDOT has announced the first round of recipients of FASTLANE grants, and the grant awards are in line with the goals of the Department's draft National Freight Strategic Plan and are multimodal in scope.

National Freight Strategic Plan

The FAST Act also required the development of a new National Freight Strategic Plan to implement the goals of the new national multimodal freight policy as well as a National Multimodal Freight Network. The new strategic plan will address the conditions and performance of the multimodal freight system, identify strategies and best practices to improve intermodal connectivity and performance of the national freight system, and mitigate the impacts of freight movement on communities.

The Maritime Administration, Federal Railroad Administration. Federal Aviation Administration. and FHWA are collaborating with USDOT's Office of the Secretary to develop a final National Multimodal Freight Network that can serve as the transportation planning support piece for the National Freight Strategic Plan. The network is intended to (1) assist States in strategically directing resources toward improved system performance for the efficient movement of freight,

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(2) inform freight transportation planning, (3) assist in the prioritization of Federal investments, and
(4) assess and support Federal investments to achieve the goals of the national multimodal freight policy. A draft National Freight Strategic Plan is available for review at www.transportation.gov/freight/NFSP.

Performance Measures

Performance measures are important because measuring results from activities that have been identified as program goals provides a mechanism to track the performance of a program and identify needs and opportunities. Decisionmaking that is based on agreed-upon performance measures leads to improved performance against stated desired outcomes, is quantifiable and replicable, and can be used comparatively to assess across program areas. Performance measures therefore can be used across a range of management functions to improve results, set goals and objectives, and allocate resources.

The U.S. transportation community is starting to implement broader use of performance measures to document the progress and success of its programs. A significant part of the reforms made by MAP-21 included transitioning to a performance-based program, including establishing national performance goals for Federal-aid highway programs. MAP-21 called for development of a freight performance measure for the interstate highway system, an effort that is currently progressing through the rulemaking process.

The FAST Act continues the overall performance management approach, within which States invest resources in projects that collectively will make progress toward national goals. Transportation performance measures will enable USDOT to measure the effectiveness of new freight multimodal programs and help State, local, and regional governments better understand the movement of goods on their transportation systems.

Canada's Multimodal Research

Various operating administrations, FHWA, and other Federal agencies are working with Transport Canada, the Canadian counterpart to USDOT, to develop a tool to understand the multimodal performance of goods movement within the United States and across the borders to Canada and Mexico.

Transport Canada has been a leader in an innovative approach to

measuring freight performance. The Canadian approach, known as the fluidity concept, refers to how well goods move throughout the transportation system in North America, including the end-to-end transit times of freight. The fluidity concept incorporates multimodal data on freight movement in key corridors and reveals congestion points and trends. The fluidity system has been used as a tool for economic development and transportation improvements at the national, provincial, and local government levels.

Transport Canada has used the multimodal data to identify the most needed operational investments and has helped Canada realize opportunities to improve its environment as well as its economy. Fluidity analysis includes measuring the reliability and variability of transit times for cargo, identifying bottlenecks and impediments to cargo movements, pinpointing immediate and residual impacts of disruptions to the transportation network, estimating border wait times for trucks, and measuring carbon footprints. Examples of fluidity analysis include a geospatial analysis of southbound truck border wait times at the U.S. Peace Bridge/Canadian Fort Erie crossing and also an analysis of container



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The three freight transportation modes portrayed here—air, highway, and marine—symbolize USDOT's new multimodal perspective, which is helping to support an economically competitive and resilient system for the movement of goods.

dwell time versus historical port throughput at the Port of Vancouver, WA.

The Canadian effort is also applicable to provincial and local governments, as the tool provides the opportunity to focus both broadly at the total system level and specifically on congestion points. Canada has begun to include selected U.S. locations in the fluidity analysis, reflecting the importance of considering freight flows throughout North America and the significance to regional and global economies.

FHWA Multimodal Research

To build on the Canadian approach, FHWA is leading efforts in the United States to implement a fluidity concept of freight performance measurement and analysis. Improved information on the performance of supply chains has the potential to benefit a wide range of freight stakeholders and to stimulate new private sector services and tools to plan and optimize freight trips throughout the freight transportation network.

To implement this research, FHWA engaged partners from Canada and Mexico, other operating administrations, Federal agencies, academic institutions, the Transportation Research Board, and the private sector to discuss and design a path forward for implementing fluidity analysis in the United States. In a series of workshops, experts presented information related to the applications of fluidity, supply chains, performance measurement of freight movement, and other areas of consideration.

During the initial phase of fluidity research, which began in 2014 and ended in late 2015, FHWA and its partners examined examples of



The result was a research path leading to further exploration, under which FHWA and its partners are building on the previous work to launch an indepth study to support the application of freight fluidity research and analysis to multimodal supply chains. This next phase is expected to start in early 2017 and will evaluate freight performance measurement through a multimodal, trip-based perspective that will best support State and regional freight transportation planning.

In this future work, FHWA will establish national monitoring of freight fluidity and support State and regional implementation of fluidity measurement. The primary focus for the national view will be on U.S. freight flows, but FHWA intends to coordinate with Canada and Mexico to explore a North American application as well.

"Multimodal research and analysis are top priorities for freight entities within USDOT operating administrations and among Federal economic, environmental, agricultural, energy, and other agencies," said former Administrator Nadeau.

Fluidity research is a part of FHWA's efforts to meet the requirements in MAP-21 and the FAST Act to develop multimodal performance measures and freight policy in order to support statewide and regional freight planning through the ability to identify bottlenecks in the freight network.

With the implementation of the FAST Act over the next few years and the dedicated funding that will be spent on freight-related projects, the importance of freight in U.S. society and the information needed to better manage and inform policy decisions will continue to grow and be even more relevant.

The transformation to the new multimodal world has just begun. Stay tuned for future articles on the new era of freight transportation.

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Doubling Down on Safety by Michael S. Griffith, Joseph Cheung, Cathy Satterfield, and Jeff Shaw

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FHWA's Every Day Counts program promotes proven but underutilized technologies to advance the transportation sector. Take a look at five successful initiatives from the four rounds of the program.

(Above) A road diet in Washington, DC, enabled the District Department of Transportation to add protected bike lanes in both directions along Pennsylvania Avenue. Road diets are one of five successful safety innovations championed by FHWA's Every Day Counts initiative and are included in EDC-4 with several other pedestrian safety countermeasures. Increasingly, the transportation industry faces challenges from tightened budgets and the need for greater accountability and transparency. Highway agencies need effective tools and methods to make roads safer and last longer, reduce the use of resources, and decrease project delivery times. Since 2009, the Federal Highway Administration's Every Day Counts (EDC) initiative, now in its fourth round, has worked to meet these needs and challenges.

The EDC initiative is a cooperative effort involving FHWA, the American Association of State Highway and Transportation Officials, and other stakeholders in the public and private sectors to advance a culture of innovation in the transportation community. Through this collaborative. Statebased effort, the partners advance the rapid deployment of proven, market-ready strategies and technologies to shorten the project delivery process, enhance roadway safety, reduce congestion, and improve environmental outcomes. Designed to complement other initiatives centering on innovative technologies, practices, and investments, EDC plays an important role in helping transportation agencies fulfill their obligation to deliver the greatest value for the tax dollars spent.

In each of the program's 2-year cycles, FHWA works with State transportation departments, local governments, tribes, private industry, and other stakeholders to identify a new set of innovative technologies and practices that merit widespread deployment. Once innovations are selected, State Transportation Innovation Councils work to bring together stakeholders from the public and private sectors to evaluate innovations and spearhead their deployment in each State.

"EDC's collaborative, State-based approach to deploying innovation enables States to decide which innovations will work best for them and their customers," says Tom Harman, director of FHWA's Center for Accelerating Innovation.

Five safety innovations were promoted during the first three rounds of EDC: the SafetyEdgeSM in round 1 (2011-2012), intersection/interchange geometrics and high-friction surface treatments in round 2 (2013-2014), and road diets and data-driven safety analysis in round 3 (2015-2016). These last two are being continued in EDC-4

An engineer measures the angle of a SafetyEdge application on a roadway in Shawano, WI. (2017-2018), with road diets included as one of five pedestrian safety countermeasures promoted under the Safe Transportation for Every Pedestrian initiative.

SafetyEdge

The development of the SafetyEdge is an excellent example of how two engineering disciplines—safety and pavements—came together to solve a problem. Pavement edge dropoffs have been linked to many serious crashes from roadway departures, including fatal crashes. To mitigate vertical dropoffs, FHWA advocates installing the SafetyEdge on pavements during paving or resurfacing.

Researchers at Northwestern University in Illinois first identified the problem of pavement edge dropoff as early as 1959, and studies by California and Texas in the 1970s and 1980s further quantified the problem. Although researchers in the 1980s documented the solution of a 45-degree angled wedge, most States failed to find a construction process that did not result in breakage, causing the same dropoff problem and requiring constant maintenance.

In 2003, maintenance engineers with the Georgia Department of Transportation, along with two FHWA experts (one in safety and one in pavements), pursued the constructability issue. Their efforts resulted in a 30-degree taper and the basic device that could form the shape in a way that is durable, does not slow down the paving process, and costs very little in extra effort or materials. However, the new technology and the safety benefits it offers did not gain traction among State transportation agencies until FHWA committed significant resources to pursue change.

FHWA's EDC initiative and its predecessor, Highways for Life, gave the SafetyEdge technology the visibility needed to spread the word at leadership levels in State DOTs and to a wider audience in a short period. The EDC initiative was critical in convincing many agencies to acknowledge the problem of pavement edge dropoffs and that the SafetyEdge could not only solve it, but could do so at almost no cost-and likely extend the life of pavements by improving density at the pavement edge, which makes the pavement more durable. Because edge raveling is reduced, the roads may require less frequent maintenance.

For FHWA, partnering with State and local agencies, as well as Local Technical Assistance Program





centers, to make devices available and host open houses and demonstrations was critical to spurring widespread adoption, as was involving the paving equipment industry. For example, when the West Virginia DOT approached a paving contractor about including the SafetyEdge on a project, the contractor was able to apply the technique immediately because it had recently purchased a new paver that came equipped with the necessary device.

Prior to EDC, no States (and only one district in Georgia and a few counties in the country) had used the SafetyEdge as a standard practice. At the end of the first round of EDC, 36 State DOTs had adopted a standard specification with the SafetyEdge or some equivalent design.

Intersection and Interchange Geometrics

Intersections and interchanges are points of conflict where vehicles, pedestrians, and bicyclists cross paths or change direction—inherently resulting in conditions that can lead to serious crashes. More than 25 percent of annual highway fatalities in the United States occur at intersections or are intersection related. For crashes that result in injury but no fatality, intersections represent closer to half of the safety challenge.

To address that situation, the second round of EDC promoted alternative intersection and interchange designs, selected for their underutilization and potential for improving safety for all users while also reducing congestion.

A common characteristic among alternative intersection and interchange geometries is reduced or modified conflict points, particularly those associated with left turns across opposing traffic, facilitating simplified decisionmaking and safer movements through intersections by motorists, pedestrians, and bicyclists. EDC-2 focused on five design configurations under the umbrella of intersection and interchange geometrics: modern roundabouts, diverging diamond interchanges, displaced left-turn intersections, median U-turn intersections, and restricted crossing U-turn intersections.

The relationship between the geometry of the intersection and the type of traffic control used whether yield, stop, or signal—can be optimized by improving the choreography of movement across the intersection. Although some of these geometric designs may seem complex or even counterintuitive, results from field studies and reDiverging diamond interchanges, like the one shown here from above on I–15 in Utah, reduce the conflict points between different directions of traffic, resulting in fewer crashes.

search demonstrate that users are able to navigate them effectively.

Increased safety and reduced congestion at intersections also can provide economic benefits to businesses and communities. The potential economic benefits, combined with improved safety, mobility, and maintained access to properties near intersections and interchanges, make alternative designs attractive transportation solutions for communities of all sizes.

The efforts under EDC to encourage the use of innovative intersections increased the momentum on several fronts. The use of roundabouts had been increasing to varying degrees for many years, but the design needed a coordinated push to achieve widespread acceptance. Similarly, despite a spike in interest in diverging diamond interchanges prior to EDC-2, a majority of States remained hesitant because of limited data on their use and results. And a lack of authoritative guidance hampered further progress on innovative intersection designs such as restricted crossing U-turn intersections, displaced left-turn intersections, median U-turn intersections, and others.

The EDC initiative focused the scattered and uncoordinated progress and experience into a unified effort. Through the partnership framework with AASHTO members

EDC-2 Intersection and Interchange Guides

Displaced Left Turn Intersection	http://safety.fhwa.dot.gov/intersection/alter
Informational Guide (FHWA-SA-14-068)	_design/pdf/fhwasa14068_dlt_infoguide.pdf
Diverging Diamond Interchange	http://safety.fhwa.dot.gov/intersection/alter
Informational Guide (FHWA-SA-14-067)	_design/pdf/fhwasa14067_ddi_infoguide.pdf
Median U-Turn Intersection Informational	http://safety.fhwa.dot.gov/intersection/alter
Guide (FHWA-SA-14-069)	_design/pdf/fhwasa14069_mut_infoguide.pdf
Restricted Crossing U-Turn Intersection	http://safety.fhwa.dot.gov/intersection/alter
Informational Guide (FHWA-SA-14-070)	_design/pdf/fhwasa14070_rcut_infoguide.pdf

and other stakeholders, planners and engineers received the resources to advance the state of the practice and create a legacy of experience that would sustain progress for innovative intersections beyond EDC-2. The effort included a series of informational guides, which are comprehensive planning and design resources for each of the different designs.

FHWA conducted training workshops and presentations and provided technical assistance, resulting in well over 1,000 professionals from dozens of States being educated about innovative designs. The EDC focus also resulted in outreach and educational materials such as videos and brochures, case studies, proceedings from the Transportation **Research Board's Alternative** Intersections and Interchanges Symposium held in July 2014, and a robust program of continuing research and evaluation of innovative intersections and interchanges. For more information, visit http:// safety.fhwa.dot.gov/intersection.

After EDC-2, the number of States (including Puerto Rico) actively implementing 2 or more of the 5 design configurations increased from 16 to 39, with 7 States reporting that they have made it a standard practice to consider alternative designs for all projects.

High-Friction Surface Treatments

Horizontal curves make up only a small percentage of U.S. highway miles but are the sites of more than 25 percent of highway fatalities in the Nation each year. Historically, highway agencies have used two approaches to reduce crashes at horizontal curves. The first, involving the redesign of the curve's geometry, is expensive. The second, installing low-cost solutions such as signing, markings, and rumble strips, may address issues of driver error.

High-friction surface treatments, such as the one applied on this curve on a rural road in Thurston County, WA, are a low-cost method to reduce crashes and improve safety without redesigning a road's geometry. High-friction surface treatment (HFST) offers an innovative third solution. This low- to moderate-cost alternative can help significantly reduce crashes on these curves.

The deterioration of pavement surface friction can be a contributing factor to crashes on horizontal curves because vehicles need more friction in a curve to change the trajectory than on other sections of the road. At locations such as sharp horizontal curves and ramps, approaches to intersections, and downgrades where vehicles may brake excessively, the road surface of standard pavements may become prematurely polished, reducing the available pavement friction. HFST technology offers an overlay option that supplies more friction than traditional overlays and maintains that friction for a much longer time.

HFST is a thin layer of specially engineered, durable, high-friction aggregates applied as a topping on resins or polymers—usually urethane, silicon, or epoxy—with a binder. These aggregate systems have long-lasting skid resistance and make the overlay much more resistant to wear and polishing. HFST can be installed using any of the three main application methods: fully automated, semiautomated, and manual. However, mechanical installation is preferred as it requires much shorter installation time, reduces secondary crash exposure, and ensures a higher quality application.

The resin or polymer binder combination locks the aggregate firmly in place, creating an extremely rough, hard surface capable of withstanding everyday roadway demands, such as heavy braking and even snowplowing. When applied by maintenance crews, HFST restores pavement surfaces where high traffic volumes have worn down existing surface aggregates. The treatment also can serve as an alternative that compensates for substandard geometric designs, such as sharp curves and inadequate superelevation (the transverse cross slope designed to counter centrifugal force at a curve, preventing a vehicle from departing the roadway).

European countries have been using HFST as a standard practice for decades. The United Kingdom first evaluated the concept of applying skid-resistant surface treatments in the 1960s. After a successful trial near London, the treatments were used widely and now are required on certain curves, roundabouts, and intersection approaches. Other countries also began to apply HFST, and a 1976 U.S. study found a 31-percent reduction in crashes at intersections with the treatments. By the early 2000s, a handful of States had implemented surface treatments at curves, but transportation agencies were not





using the method widely when it was selected as an EDC-2 innovation.

The EDC-2 campaign established goals to accelerate HFST deployment and adoption. The team created a plan to serve as a roadmap for rapid implementation, including technical guidance and assistance, benchmarking, marketing and communications, training, and project demonstrations to highlight notable practices. The effort included fact sheets, brochures, and videos; case studies; and specifications developed in partnership with AASHTO and the American Traffic Safety Services Association's High Friction Surfacing Council.

Before-and-after evaluations of HFST applications show positive safety benefits. Kentucky placed HFST on 26 curves and, to date, has seen an average reduction from 6.2 to 1.9 crashes per year at those locations. The Marquette Interchange in Milwaukee, WI, experienced 219 crashes in the 3 years prior to HFST installation. A study after the installation in 2011 found a total of nine reported crashes in the following 3 years. A recent before-and-after study from the South Carolina DOT on a series of HFST installations on horizontal curves indicates a benefit-cost ratio of 24 to 1.

Other benefits of HFST include negligible environmental impacts, reduced construction time and cost compared to other solutions, and minimal effect on traffic from the rougher surface. In addition, project installations for HFST are brief, and the materials set up quickly, so the treatments often can be applied in hours, requiring minimal impact on traffic during installation compared to a conventional pavement overlay project.

By the end of the 2-year EDC cycle, the number of States using HFST grew from 14 to 37 States, plus Washington, DC, and Puerto Rico. Fourteen States have made the use of HFST a standard practice for reducing crashes at critical locations.

Road Diets

Historically, adding lanes and widening roads has been one of the preferred solutions for reducing traffic congestion. However, the complete streets movement has brought an alternative: the road diet. A road diet is a roadway reconfiguration that typically involves narrowing or eliminating one or more traffic lanes and adding bicycle lanes and improved pedestrian facilities (such as sidewalks).

The reconfiguration offers several high-value improvements at a low cost when applied to traditional four-lane, undivided roadways. The primary benefits include enhanced safety, mobility, and access for all road users to accommodate a variety of transportation modes. A classic road diet involves converting an existing four-lane, undivided roadway segment to a three-lane segment consisting of two through lanes and a center, two-way left-turn lane. FHWA advises that roadways with average traffic volumes of 20,000 vehicles or less per day may be

good candidates for a road diet and should be evaluated for feasibility.

Studies show that road diets result in an estimated crash reduction of 19 to 47 percent, reduced vehicle speed differential in the traffic flow, and integration of the roadway into surrounding uses that offers residents, businesses, and visitors an enhanced quality of life. A key feature of a road diet is that it enables reclaimed space to be allocated for other uses, such as turn lanes, bus lanes, pedestrian refuge islands, bike lanes, sidewalks, bus shelters, parking, or landscaping.

In January 2012, FHWA designated road diets as a proven safety countermeasure and a safety-focused design alternative to traditional four-lane, undivided roadways for certain applications. In 2015, FHWA selected road diets as an EDC-3 innovation, and it continues as a subset of an overarching pedestrian focus in EDC-4.

"With a road diet, pedestrians can be safely accommodated," says Becky Crowe, a transportation specialist in FHWA's Office of Safety. "The road diet program [that] started in EDC-3 will continue into EDC-4 through the Safe Transportation for Every Pedestrian [STEP] initiative. Road diets, along with four other countermeasures, will be advanced to improve pedestrian safety." The other measures under STEP are pedestrian hybrid beacons, pedestrian refuge islands, raised crosswalks, and crosswalk visibility enhancements, such as lighting, signing, and marking.

As more communities desire complete streets and more livable spaces, they look to transportation agencies to find opportunities to better integrate pedestrian and bicycle facilities and transit options along their corridors. When an agency implements a road diet in conjunction with reconstruction or simple overlay projects, the safety and operational benefits are achieved essentially for the cost of restriping. FHWA is working closely with State and local agencies to develop guidance on road diet applications, perform feasibility studies, and support local and State marketing efforts.

Road diets have been implemented by transportation agencies for more than three decades, but only recently have they received serious consideration as a design alternative. By the end of EDC-3 in December 2016, half of the States had plans to make road diets a standard practice.

In Arizona, for example, Phoenix is implementing a comprehensive bicycle master plan and complete streets ordinance. Both projects rely heavily on road diets to improve safety and accommodate bicyclists and pedestrians. Utah's largest metropolitan planning organization, Wasatch Front Regional Council. added road diets to the toolbox of solutions that member towns can request assistance for under the Local Planning Resource Program. And the Virginia DOT's Northern Virginia District is close to institutionalizing road diets. Since 2010, the department has installed 15 road diets, 5 of them added in Fairfax County during the summer of 2015 alone.

In 2014, FHWA developed the *Road Diet Informational Guide* (FHWA-SA-14-028) to help communities understand the benefits of road diets and assist agencies in determining whether they are a good fit for

certain corridors. In 2015, FHWA published *Road Diet Case Studies* (FHWA-SA-15-052) to provide stakeholders with examples and advice that can guide them in implementing road diets in their own jurisdictions. That same year, FHWA developed the *Road Diet Desk Reference* (FHWA-SA-15-046) to provide a quick overview of all the benefits associated with road diets.

During the EDC-3 promotion of road diets, 18 States institutionalized the use of road diets, exceeding FHWA's target of 15 States by September 30, 2016.

Data-Driven Safety Analysis

"How many crashes on a roadway are beyond what's expected from an engineering perspective?"This question has plagued transportation professionals for years. Now, there are methods to answer it.

With limited funding available to address transportation needs, highway professionals are constantly challenged to make decisions that maximize the return on investment. Evaluating a roadway in terms of generally accepted guidelines is no longer sufficient. Decisionmakers need to determine whether a roadway will perform satisfactorily in terms of crashes now and into the future and to do this, they need data.

The data-driven safety analysis innovation has been championed under EDC-3 and again in EDC-4. It is the application of predictive and systemic analysis approaches to safety management and project

This road diet in Honolulu, HI, converted a road with two lanes in each direction to one lane in each direction with a shared center turn lane, dedicated bike lanes on each side, and parking for the residential neighborhood.



development to support improved decisionmaking and more efficient, effective investments, resulting in fewer severe crashes.

Predictive analysis. Predictive analysis approaches combine crash, roadway inventory, and traffic volume data to provide more reliable estimates of the expected safety performance of an existing or proposed roadway. The results inform decisionmakers on how to manage roadway safety and project development as well as select and evaluate safety countermeasures. Predictive analysis enables planners to determine, among possible design alternatives, which might have the greatest reduction of fatal and injury crashes.

Examples of tools that State and local highway agencies can use to apply predictive approaches include AASHTO's *Highway Safety Manual*, AASHTOWare Safety Analyst[™] software, FHWA's Interactive Highway Safety Design Model (IHSDM), the National Cooperative Highway Research Program's Enhanced Interchange Safety Analysis Tool (ISATe), FHWA's Crash Modification Factors Clearinghouse, State-developed tools, and several commercial products available in the marketplace.

Before the development of predictive methods, agencies had no way to quantify the anticipated safety impacts of transportation decisions. This knowledge gap made it hard to fully evaluate safety impacts alongside criteria such as environmental and operational effects. Agencies also faced challenges when comparing treatments to spot locations and corridors to determine which ones had the greatest potential to reduce fatal and serious injury crashes.

In 2010, AASHTO published its *Highway Safety Manual*, an authoritative resource for both crash prediction models and crash modification factors for segments of two-lane rural roads, rural multilane highways, urban/suburban arterials, and intersections on all of those roads. In 2014, AASHTO added models for freeways, interchanges, and ramps to the previous set of prediction models, creating a comprehensive toolbox of evidence-based models to predict safety performance in terms of crash frequency and severity.

Systemic analysis. Systemic analysis approaches employ a systemwide screening of a roadway network based on the presence of high-risk roadway characteristics associated with particular severe crash types. Examples of such features include shoulder width, horizontal curvature, roadside rating, and intersection skew. This approach can be particularly helpful when a significant number of crashes occur over a wide area, such as in States with an extensive rural or local roadway system. Systemic analysis also can be applied to investigate specific severe crash types such as horizontal curve, cross-median, and pedestrian crashes. A comprehensive safety management program incorporates a systemic approach to complement traditional site analysis (or "hot spot") approaches.

Previously, agencies largely relied on simple analysis of hot spot sites. Although high-crash locations do exist, many times the hot-spot treatment approach led agencies to make high-cost improvements at a limited number of locations. Often, locations that were at risk of severe crashes had to wait for a crash to happen before they could be treated. This approach to treating high-crash locations led many States to fund only projects on highvolume roads, often on the Stateowned system. Using a systemic approach, however, States can better understand and quantify safety risks without having to rely solely on crash experience, providing an opportunity to improve safety performance across their road networks.

For example, in identifying locations for a cable median barrier along a divided roadway, an agency could determine where to install the barrier based solely on historical data on fatal crashes. However, these investment decisions would benefit from looking at the issue from a crash risk perspective. Roadway characteristics such as median width, horizontal curvature, traffic volume, number of traffic lanes, and proximity to access points can all greatly affect safety performance. Conducting a systemic safety analysis by reviewing the impacts that these features have on safety performance enables an agency to make informed investment decisions.

Under EDC-3, FHWA set a target of 36 States reaching the demonstration stage (defined as testing and piloting the innovation) or better using data-driven safety analysis by September 30, 2016. As of late 2016, 37 States had reached that stage. As of November 2016, the Office of Safety provided datadriven safety analysis support to



Using predictive analysis, highway planners can determine which of three potential roadway designs should result in the fewest crashes and injuries. Here, the estimate for the existing roadway configuration is 110 fatal and injury crashes per year. For the first alternative, the estimate is 65 crashes, and for the second alternative, 45 crashes. *Photos: Washington State DOT.*



A systemic safety analysis can help planners determine where to implement safety measures. These images illustrate some of the factors in addition to crash history that an agency may consider in identifying and prioritizing locations to install cable median barriers, such as horizontal curves (left), entrance and exit ramps (center), median width (right), and high traffic volume. *Photos: Iowa DOT.*

41 States, resulting in the delivery of 7 peer exchanges and 125 training and technical assistance sessions. FHWA's efforts resulted in 19 States developing policies and procedures related to data-driven safety analysis and 29 States developing action or implementation plans for integrating safety performance into all highway investment decisions.

"So far, 42 States have employed data-driving safety analysis to identify and properly scope projects, evaluate alternatives, select design criteria, and monitor system performance," says Jerry Roche, a safety engineer in the FHWA Office of Safety. "Under EDC-4, we hope to institutionalize data-driven safety analysis in State procedures, as well as increase usage by local agencies."

By advocating for broader deployment of predictive and systemic analysis approaches to decisionmaking on investments in highway safety, the EDC focus on data-driven safety assessment seeks to improve on traditional approaches that rely on crash history data at a given site and prioritizing hot-spot fixes. The net result is a more scientifically sound, data-driven approach to allocating resources—and, ultimately, fewer and less severe crashes.

The EDC-3 initiative focused largely on reaching out to State DOT personnel. Under EDC-4, this initiative will expand its emphasis to local agencies. The development of local road safety plans to identify and prioritize the funding of lowcost safety improvements has proven to be a highly successful strategy to implement the systemic approach and will be added to the activities promoted under data-driven safety analysis. Local road safety plans result in greater safety awareness among local agencies and greater participation in their State's Strategic Highway Safety Plan and Highway Safety Improvement Program. The EDC-4 effort will build on work accomplished under EDC-3 to ensure that safety planning at the State and local levels is data driven and efficiently addresses safety on all public roads.

Continuing Innovation

FHWA's EDC initiative has sparked greater use of innovative technologies and processes within the U.S. transportation industry. In the area of safety, the focus on implementing SafetyEdge, highfriction surface treatments, intersection and interchange geometrics, road diets, and data-driven safety analysis has saved many lives.

"The long-term goal of EDC is to integrate these innovative technologies or processes into the standards, specifications, and manuals that highway professionals use every day, and, more broadly, to demonstrate the value of continually seeking new and innovative ways for the transportation industry to work better, smarter, and faster," says Tony Furst, FHWA's Chief Innovation Officer.

Legislators recognized the positive results from the EDC program in the Fixing America's Surface Transportation (FAST) Act, signed on December 4, 2015. As part of this law, Congress directed FHWA to continue the EDC program, identifying and promoting a new collection of marketready innovations and best practices at least every 2 years. With four rounds and counting, the EDC initiative will continue to foster and promote safety innovations that improve the Nation's roadways for all users.

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For more information, visit www.fbwa.dot.gov/innovation /everydaycounts or contact Michael Griffith at 202-366-9469 or mike.griffitb@dot.gov. Florida and New York are working together to ensure civil rights requirements are met on innovative contracts for major bighway projects.

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Learning by Marvin Williams From Each Other

Peer exchanges between Florida and New York have resulted in improved guidance and best practices for agencies undertaking innovative and major projects. Here, members of the peer exchange group visit the construction site of the Port Miami Tunnel in 2013.

Innovative contracts that can speed up project delivery and lower costs are becoming more common. In May 2016, more than 65 percent of active major projects used an innovative contracting method, compared to 40 percent in 2001. The Federal Highway Administration's Every Day Counts initiative has encouraged and promoted use of innovative project delivery, such as design-build, to stretch Federal dollars further for highway improvements.

However, for major projects costing more than \$500 million, the details and complexities can necessitate additional guidance, especially when using innovative project contracts. In particular, agencies have lacked specifics for ensuring compliance with civil rights regulations such as the Disadvantaged Business Enterprise (DBE) program and requirements for equal employment opportunity.

Florida and New York both have faced this challenge. In response, the two States formed a partnership with FHWA staff in the Office of Civil Rights that has resulted in an ongoing peer exchange to provide the missing guidance for compliance with civil rights regulations.

In January 2012, Christine Thorkildsen, the major projects civil rights program manager for FHWA's New York Division, assumed oversight of civil rights contract administration for major projects, which include publicprivate partnerships and other innovative projects.

"Our projects are growing in size and cost," she says. "At the same time, we are working with nontraditional partners, including contractors and financiers from other countries. Certainly, this means greater economic opportunities, but it also increases risks for noncompliance. Further, State departments of transportation are no longer the lone sponsors of FHWAfunded projects. We are working with local agencies, expressway and port authorities, and planning organizations. All stakeholders must serve as guardians of equal opportunity and stewards of public trust."

Carey Shepherd, the civil rights officer for FHWA's Florida Division, agrees. "We were actively moving toward more and more design-build and innovative contracts, but [lacked] guidance on how to oversee compliance for DBE, on-the-job training, equal employment opportunity, and prevailing wages."

Starting the Conversation

Florida was one of the early adopters of designbuild and was just as quick to explore public-private partnerships. For example, the State's I-75 Roadway Expansion, known as the iROX project, opened in 2009 and was the largest roadway project in the history of the Florida Department of Transportation (FDOT). It used a design-build contractor and was the first time FDOT entered into a public-private partnership.

"In theory, all the same civil rights rules apply," says Shepherd. "But as a practical matter, I could see that the greater-than-average numbers of subcontractors and workers created a paperwork nightmare for compliance staff. I needed context, a sounding board."

In New York, the Tappan Zee, Kosciuszko, and Goethals Bridge replacement projects are currently under construction. Each represents a unique method for project development and delivery. The Tappan Zee replacement, called the New NY Bridge project, is a design-build contract owned by the New York Thruway Authority with a total cost of \$3.98 billion and construction undertaken by a consortium of some of the world's largest contractors. The Kosciuszko Bridge replacement has a price tag of \$555 million, and it is the New York State Department of Transportation's largest design-build project to date for which a joint venture will both design and construct the structure. Finally, Goethals Bridge is a \$1.5 billion project of the Port Authority of New York & New Jersey. The project uses a combination of Federal funding from the Transportation Infrastructure Finance and Innovation Act (TIFIA), private backers, and toll revenue for



design, construction, operation, and maintenance. A partnership between three firms is managing construction.

Federal regulations governing civil rights programs were drafted primarily within the context of the designbid-build delivery model and did not sufficiently take into account the size, complexity, and risk of these major projects, says Thorkildsen. "We are in entirely new territory here. These are staggering sums governed by contracts intended to transfer risk to the developer. We cannot wait until this becomes standard practice to decide how to ensure equal opportunity and nondiscrimination."

Shepherd and Thorkildsen met at an event in September 2012, introduced by Martha Kenley, the manager of FHWA's national DBE program. They found common ground in discussions of how the industry had outpaced regulatory language for the administration and oversight of contract administration and civil rights programs in the context of alternate program delivery.

Working closely with the Office of Civil Rights, Shepherd and Thorkildsen formed an ad hoc partnership, regularly calling each other to discuss applying oversight guidance to major projects.

"It helps to know you aren't forging ahead alone," says Thorkildsen. "We generally touch base on DBE

Christine Thorkildsen, second from left, and Carey Shepherd, fifth from left, visited Florida's I–595 Express project along with others from FHWA and FDOT in April 2013. matters such as determining commercially useful function and counting DBE credit. But we also talk about review scheduling, Federal reporting, all sorts of things. It helps that our program manager in headquarters is so knowledgeable and always quick to help with emerging or unusual issues on major projects."

Creating a Peer Exchange

During these conversations between Shepherd and Thorkildsen, the idea of a major project peer exchange was born. In April 2013, Thorkildsen traveled to Florida to look at the State's then largest projects, the I-595 Express and the Port Miami Tunnel, two public-private partnerships worth a combined total of more than \$2 billion. The projects went on to win the American Association of State Highway and Transportation Officials' 2015 People's Choice and the Grand Prize Awards, respectively. The group that Thorkildsen visited with included several representatives from FDOT as well as FHWA staff members from the Florida Division and the Office of Civil Rights.

Information displays, such as this one at an overlook in Westchester County, NY, provide visitors with explanations of the work being done to replace the Tappan Zee Bridge, visible in the background.

Thorkildsen recognized that the two projects were suitable models for New York's enormous bridge projects. "I learned so much in Florida: the importance of automated payroll systems, supportive services for ensuring an adequate pool of DBEs, and how the layers of responsibility interact with each other," she says. "I also felt that it should be more than just a learning experience for FHWA civil rights."

So when it came time to reciprocate 3 years later—when the Tappan Zee, Kosciuszko, and Goethals Bridge replacements were all underway-Thorkildsen invited a large group to New York. Participants included major project engineers from Florida and New York and FDOT staff responsible for civil rights oversight on I-4 Ultimate, Florida's largest transportation project to date. Also, FHWA's Ohio Division sent its major project engineer to provide the perspective of another office also engaged in delivery of major projects. The result was an intensive, week-long dialogue about civil rights on major projects with a broad range of topics.

"We talked about everything," says Jennifer Smith, a construction services manager with FDOT and the manager for I-4 Ultimate compliance. "How and when to engage DBEs and small businesses, recruiting and retaining female labor, risk-based monitoring, technology solutions for managing copious data, community partnership, unbundling of work items, on-the-job





training versus apprenticeship, you name it. The only downside was how little time we had. I could have easily spent all week at any one of the New York projects."

What They Learned

The peer exchange group unanimously agrees on three key takeaways from the experience that can enhance compliance for major projects. The first is implementing clear and unambiguous contract language, including a requirement that staff with experience in civil rights contract administration be key personnel on the project. A second essential is identifying and using electronic data systems cooperatively to manage the enormous amounts of information generated and to reduce the duplication of efforts. Finally, it is critical to provide targeted supportive services to DBEs and other small businesses, both before and during project design and construction.

These considerations, says Smith, all underscore that "elevating the importance of equal opportunity compliance on the front end avoids problems later on. And in major projects, problems get expensive for us, for the developer and contractors, and ultimately for the public, our customers."

The peer exchange team participated in an FHWA webinar in July 2016 to discuss these findings and the lessons learned. Another FHWA-hosted webinar for stakeholders is scheduled for 2017, and four members of the peer group presented a summary of the exchange in October 2016 at the Ohio Transportation Engineering Conference.

In addition, a third, smaller peer exchange occurred in July 2016 when several Florida team members met with an engineer from the Colorado Department of Transportation who visited the I-4 Ultimate project. "It was just a couple of hours," says Shepherd, "but we shared lessons learned and picked up some tips on environmental justice mitigation from him."

Fostering Continued Cooperation

The peer exchange team hopes that the success of these efforts encourages a spirit of cooperation among project sponsors, builders, and oversight agencies. "This is a *team* effort," stresses Thorkildsen. "We recognize that civil rights is a piece of the whole pie of major projects, just like design, materials testing, or tying rebar."

As part of an FHWA workgroup, Shepherd and Thorkildsen intend to use the knowledge gained from the exchange to develop a series of practical tools, including a resource list to provide a network of contacts for civil rights on major projects and a handbook of lessons learned for compliance practitioners in the field.

Shepherd says, "Understanding the various partner roles and responsibilities fosters an environment of trust. We provide a better product and build lasting relationships with our stakeholders."

FDOT's Jennifer Smith, right, and FHWA's Tracy Duval study the old concrete foundations of New York's Kosciuszko Bridge, which opened to the public in 1939. Smith and Duval visited the bridge replacement project in April 2016 as part of a peer exchange. This peer exchange group toured the construction site of Florida's I–595 Express project as part of an April 2013 visit.

The peer exchange team will continue to meet regularly to share innovative ideas and to strategize ways of meeting civil rights compliance requirements on major or alternative delivery projects. Working collaboratively assists those new to major projects and facilitates equity without impeding project delivery.

"We'd like to see partners set up peer exchanges of their own," says Shepherd. "More important, we want to remain a resource for those new to major projects and to serve as a repository of lessons learned and best practices."

Marvin Williams is the major projects engineer for FHWA's Florida Division. He holds a degree in civil engineering technology from Florida Agricultural and Mechanical University.

For more information, visit www .fbwa.dot.gov/civilrights and www .fbwa.dot.gov/ipd/project_delivery. Or contact Carey Shepherd at 850-553-2206 or carey.shepherd @dot.gov or Christine Thorkildsen at 518-431-8866 or christine .thorkildsen@dot.gov.



Onward and Upward

by David M. Jared

AASHTO's research committees and initiatives are belping to foster a national culture of innovation on transportation projects to move research into practice.

ith rapid changes and increasing sophistication in transportation technology, and concomitant policy changes, the need for innovation in the transportation world has intensified. However, constrained resources challenge State departments of transportation and other transportation organizations to do more with less. Whether the motivation is proactive or reactive, or both,

(Above) State DOTs face many barriers to implementing emerging techniques, processes, and products. For example, the Maintenance Decision Support System is an innovation that can help transportation agencies determine the most appropriate winter highway treatments. Photo: © Pi-Lens, Shutterstock. one thing is clear: State DOTs would like to embrace a culture of innovation. However, limited resources; changes in technology, policy, and priorities; and difficulty communicating the value to end users make it not always easy to move research innovations into practice.

To help address these challenges, transportation organizations are taking a proactive approach to innovation by developing better ways of doing things, technologically and procedurally. For example, the American Association of State Highway and Transportation Officials, through its Standing Committee on Research and supporting Research Advisory Committee, and other initiatives, is fostering this national culture of innovation by helping State DOTs move research into practice.

A Dynamic Duo

Promoting innovation is an integral part of AASHTO's overall mission. The association's most recent strategic plan (2014–2019) is built upon four strategic goals, including the provision of "innovative technical and professional services and products" that are "widely used by members and the larger domestic and international transportation community." One strategy to accomplish this goal is the Standing Committee on Research "identify[ing] and support[ing] high-priority research."

The purview of the committee includes identification of national research priorities, especially through the Cooperative Research Programs of the Transportation Research Board, identification of research gaps, and collaboration with other AASHTO committees, the Federal Highway Administration, and partners to develop and implement effective research efforts for filling those gaps and addressing national priorities. The Standing Committee on Research is one of only a few AASHTO committees with limited membership selected by AASHTO rather than having a representative from each State.

A key partner for the Standing Committee on Research's work within AASHTO is the Research Advisory Committee, which is typically staffed by research administrators from all 50 States, the District of Columbia, and Puerto Rico. Besides providing a roundtable for State DOT research staff, this committee has launched strategic task forces over the past 10 years with the intent to advance the implementation of research results into practical products.

Kirk Steudle, director of the Michigan Department of Transportation and former AASHTO president, described the importance of bringing States together in an issue of AASHTO's *Research Makes the Difference*: "Collaboration among States is invaluable. AASHTO helps States jointly define and address research needs, and just as importantly, put the findings to work in improving the design, construction, and safe operation of our transportation infrastructure."

AASHTO Initiatives

AASHTO promotes the progression of research into practice on at least five fronts: (1) applying the results of the Transportation Research Board's **Cooperative Research Programs**, (2) supporting exploratory analysis for innovations, (3) promoting innovations already in use by AASHTO's members, (4) leveraging resources of the Research Advisory Committee through special task forces, and (5) supporting other national initiatives such as the second Strategic Highway Research Program (SHRP2) and FHWA's Every Day Counts (EDC) initiative. These programs and their products, described below, demonstrate the breadth of AASHTO efforts to foster and implement innovation.

National Cooperative Higbway Research Program (NCHRP) Project 20-44, Accelerating the Application of NCHRP Research Results. This project, launched in 1995, emphasizes that "in an applied research program like the National Cooperative Highway Research Program, application of results is the most important measure of success." To ensure the fulfillment of its mission, NCHRP recently appointed an implementation coordinator from the Transportation Research Board to direct this project.

Products from the NCHRP Project 20-44 include beta testing of pavement design software (Project 1-37A), development of recommended specifications for modular bridge joints (Projects 10-52 and 12-40), and software for evaluating the environmental effects of pavement marking materials (Project 4-22). For more information on the application of NCHRP results, visit www.trb.org/NCHRP /NCHRPImpactsonPractice.aspx.

Innovations Deserving Exploratory Analysis (IDEA) Programs. These programs, funded by AASHTO through the Cooperative Research Programs and managed by the Transportation Research Board, "provide start-up funding for promising, but unproven, innovations" in highway and intermodal surface transportation systems. Begun in 1988 under the Strategic Highway Research Program, three IDEA programs seek to support solutions to transportation problems that are unlikely to receive funding from traditional sources. Proposals are selected based on innovativeness, expected benefits, and scientific approach.

The IDEA programs focus on highways, transit, and railroad safety. The highway component, NCHRP Highway IDEA program, supports innovative concepts for highway design and construction, materials, operations, maintenance, and other areas of highway systems. The Transit IDEA program aims to enhance security, increase ridership, and improve efficiency for transit systems. The third program, Rail Safety IDEA, focuses on improving railroad safety and performance.

All of the IDEA programs are integrated to support advances in highway, transit, safety, rail, and intermodal systems. Funding under these programs is open to all individuals, including entrepreneurs, small and large businesses, and institutions. The IDEA programs review proposals for funding twice a year.

One example of a product supported by the IDEA programs is the hybrid-composite beam, which is a structural member used in railroad and highway bridges. The hybrid-composite beam combines a fiber-reinforced plastic box beam (shell), portland cement concrete (compression reinforcement), and steel fibers (tension reinforcement). The beam weighs about one-tenth that of a typical precast concrete beam for the same span length and improves speed of construction.

AASHTO Innovation Initiative. Formerly the AASHTO Technology Implementation Group, the Innovation Initiative identifies and champions the deployment of select, ready-to-use technologies, products, or processes that are likely to yield significant economic or qualitative benefits. Each year, the

AASHTO's many efforts to encourage and promote innovations in States include supporting other national initiatives with similar goals. Widespread adoption of safety innovations in work zones, such as this use of movable barriers on I-70 in Indiana, prove these partnerships are succeeding. Photo: Indiana Department of Transportation.





Innovation Initiative works with the Standing Committee on Research, the Research Advisory Committee, and others to identify technologies, processes, software, or other innovations that have been adopted by at least one agency, have been proven in use, and will be of significant benefit to other agencies. Lead States then team up to champion these focus technologies to accelerate their adoption by DOTs nationwide.

For example, the Innovation Initiative led efforts to foster adoption of the cable median barrier. For use in existing medians to prevent crossover crashes, the cable median barrier is a life-saving, adaptable traffic device. When installed by agencies across the country, the device has contributed to a significant decrease in fatalities and the severity of cross-median crashes.

Another example is the Innovation Initiative's promotion of automated machine guidance, which links sophisticated software with construction equipment to direct the operation of machinery with a high level of precision, improving the speed and accuracy of highway construction. The method is gaining popularity for grading operations because it offers the opportunity to move soil and other materials with fewer workers, enhancing safety and overall cost efficiency.

In addition, in May 2016, the Innovation Initiative signed a memorandum of agreement with FHWA's Center for Accelerating Innovation, vowing to share resources to advance deployment of innovations and "foster a culture of innovation within the highway community."

Research Advisory Committee Task Forces. One of the five goals in the Standing Committee on Research's strategic plan is for the committee to "champion and facilitate the dissemination and deployment of effective, high-priority research results." Accordingly, task forces of the Research Advisory Committee have developed initiatives that support this goal. Efforts undertaken by these task forces include annual awards to 16 AASHTO members for high-value research, a "living" database of highvalue research nominees on the AASHTO Web site, and Putting Research into Practice fliers on recognized high-value research projects. The task forces also conduct surveys of AASHTO members to gather updates on the implementation status of NCHRP products.

As Frederick "Bud" Wright, executive director of AASHTO, noted in the organization's 2013 *Research Makes the Difference*, "Innovations in transportation and the application of research findings are keys to improving the Nation's mobility, boosting the economy, and enhancing our quality of life." The hybrid-composite beam, shown here installed on a railway bridge, improves speed of construction because of its light weight compared to traditional beams. The IDEA programs have supported this product. *Photo: AASHTO, IDEA.*

Other National Initiatives

AASHTO members have played leading roles in other efforts to implement research at the national level, such as studies under SHRP2, EDC, and the State Transportation Innovation Councils (STICs).

Currently, all 50 States are engaged in implementing the broad suite of SHRP2 solutions. One SHRP2 product, New Strategies for Managing Complex Projects, developed a five-dimensional approach to project management that adds project context and funding mechanisms to the standard three factors of cost, schedule, and engineering requirements. The SHRP2 product includes case studies of complex projects such as the addition of highoccupancy vehicle/high-occupancy toll lanes on the Capital Beltway (I-495) in northern Virginia and the Louisville-Southern Indiana Ohio River Bridges Project. For more details on where and how States are using this product and other SHRP2 products, visit www.fhwa.dot.gov /goshrp2/solutions/solutionsinthefield.

The EDC initiative, a strategic innovation partnership among State DOTs, FHWA, and various public and private entities, is now in its fourth round of deployments since 2011. EDC has encouraged the use of a number of tools and innovations. One innovation is the National Traffic Incident Management (TIM) Responder Training, which educates first responders on best practices for handling incidents on highways in a manner that minimizes impacts to traffic flow and enhances the safety of motorists and responders. As of late 2016, more than 200,000 first responders have completed the TIM training nationwide.

Lastly, STICs are a key component and an offshoot of EDC, bringing various segments of the highway community together in each State to consider sources of innovation. A STIC puts the State in the driver's

seat to select the innovations that best fit its unique program needs and quickly put those innovations into practice. For example, e-Construction, a paperless process for administering the delivery of construction projects, has realized increased adoption through STICs. Many State DOTs (for example, the Florida, Iowa, Michigan, Minnesota, North Carolina, Pennsylvania, Texas, Utah, and Wisconsin DOTs) and industry practitioners are already using or testing some aspects of e-Construction, such as electronic document routing and approvals. Some States are in the process of mainstreaming a number of e-Construction practices.

Innovations in Asset Management

Many AASHTO members have produced significant achievements in moving research into practice. Information gathered by AASHTO's Research Advisory Committee details some of the successes in asset management, mobility, policy, and safety, as demonstrated in the following profiles.

For bridge repairs that otherwise would require replacement or costly repair techniques, the Kentucky Transportation Cabinet (KYTC) saw the potential of carbon fiber-reinforced polymer fabric. The retrofit of a three-span prestressed bridge on KY 3297 over Little Sandy River in Carter County was studied by engineers from KYTC and the Kentucky Transportation Center for a decade and demonstrated outstanding performance. Based on this success, Kentucky then employed this material on a dozen additional bridges. Using this material, the State can save approximately \$500,000 per bridge, and motorists are able to continue using spans that remain open during repairs.

Determining when to repair bridges can be just as important as how, as the Maine DOT demonstrated with its advanced SlabRate software. Using finite element analysis and calculations from the AASHTO *Manual for Bridge Evaluation*, Maine assessed the loadcarrying capacities of 20 concrete slab bridges. Among these, more than a dozen that would not have had acceptable operating ratings using traditional assessment methods were shown to be sound when evaluated using these advanced techniques. Given the cost for just one bridge replacement, the modest research cost is already paying off and helping Maine position itself to better direct its repair efforts.

In another example, the Maintenance Decision Support System pooled fund study is a collaborative effort of 19 State DOTs. Led by the South Dakota DOT, the program developed a winter maintenance tool that weighs such factors as road conditions, weather, and feasible treatment options. By analyzing alternatives and modeling predicted performance, the system can recommend the most appropriate maintenance treatments given an agency's available resources and service goals. Together, the States in the study have conducted field deployment trials on nearly 20,000 miles (32,000 kilometers) of inservice highways. Some experienced savings exceeding 25 percent. In the most dramatic example, the Indiana Department of Transportation documented savings of \$11 million on a \$40 million winter maintenance program.

In another effort, the Maryland State Highway Administration extensively studied ground-penetrating radar (GPR)—a proven technology to detect and evaluate subsurface features and anomalies-to take advantage of its potential for maintenance systems. The research showed that by using advanced application methods and analysis. GPR could more accurately evaluate pavements and provide data needed for rehabilitation decisions. Maryland also uncovered the potential for GPR in other applications, such as to measure cover depth reliably in bridge decks. and to measure section thickness, cover depth, and reinforcement locations with precast concrete sections.

Moving on Mobility

State DOTs are implementing innovative tools to manage traffic and relieve congestion on overburdened roads. One such tool, adaptive signal controls, adjusts the timing of stoplights to accommodate changing traffic patterns and ease congestion, providing optimal and equitable green-light time for all motorists. While the timing of traditional, manually programmed traffic lights may become out of date as traffic



patterns change over time, the adaptive technology gathers data on traffic in real time and automatically responds to dynamic conditions. The benefits are numerous: fuel savings, reduced emissions, improved mobility, and enhanced customer satisfaction. Through EDC, agencies are adopting this technology and seeing motorists' travel times improve by as much as 50 percent.

In another implementation of an innovation, the California Department of Transportation (Caltrans) successfully deployed the Intelligent Roadway Information System, an advanced traffic management system, in four of California's districts. Caltrans found that the system offers rural areas a robust and unified traffic management program that is expandable, scalable, and reliable. Traffic management operators can manage traffic devices and applications from a single integrated interface. The Intelligent Roadway Information System employs an open source methodology that reduced life-cycle costs by approximately 72 percent compared with the full advanced software package used in urban areas. Caltrans developed the following new features to enhance its application of the system: automated warning of stopped or slow traffic, poor visibility, high winds; a performance measurement system; closed-circuit television; changeable message signs; and integrated mapping.



State DOTs are embracing environmental stewardship through reuse and recycling across all areas of operation—from construction to maintenance—to enhance mobility. In one example, the Washington State Department of Transportation (WSDOT) looked to use recycled concrete aggregate as a replacement for natural aggregate in new concrete pavements. After rigorous testing, the recycled aggregate proved to be a viable alternative. At a replacement rate of 45 percent of the natural aggregate, the recycled concrete aggregate showed no significant effects on the new hardened concrete. WSDOT is poised to see significant savings in reduced landfill costs and requirements for virgin materials.

To stabilize slopes and prevent landslides and slope failures, especially on bridge embankments, the West Virginia DOT often uses driven piles or micropiles. Recently, the department developed an improved design procedure for slope stabilization that uses new methods to assess the stability of vulnerable slopes before and after deploying piles. The procedure includes new software, called PSSLOPE, which enables engineers to model loads transferred to piles from the soil more realistically. Designers can make a more accurate assessment of the effect of a sliding soil mass on the performance of bridge foundations and choose the best pile size for stabilizing slopes. The new design procedure is more accurate and less labor intensive than the method it replaces, and it

will lower the risk of slope failure and associated costs in West Virginia.

Progress in Policy and Program Delivery

Innovative approaches to regulations on heavy trucks have proven effective at lessening road and bridge damage. For example, researchers at the Louisiana Department of Transportation & Development found that the average annual damage caused by heavy sugarcane trucks—\$2,000 per vehicle to highways and \$3,500 to bridges-far exceeded the State's \$100 special truck permit. Rather than increasing the permit fee, an alternative approach showed that requiring a minimum of six axles on the sugarcane trucks could effectively mitigate the damage. This solution became Louisiana State law in 2012. Requiring six axles not only ended the costly cycle of damage and repair to roads and bridges, but tax incentives helped cover truck owners' costs to convert or replace noncompliant trailers.

On the program delivery front, research is affording the Wyoming DOT a savings of \$90 million over a decade on its transportation project pipeline. The Wyoming DOT developed a research-based simulation tool to analyze its project pipeline and to consider various funding scenarios, leading to process improvements and new techniques to reduce the risk of costs associated with delays in project lettings. The techniques also shift revenue uncertainties from major projects to National TIM Responder Training, an innovation promoted through EDC, educates first responders, such as those shown here, on best practices for handling incidents on highways. *Photo: Washington State Department* of Transportation.

minor ones, helping to keep critical, high-impact projects from sitting on the shelf. Wyoming calculated the bottom-line savings from the new methods at a representative 3 percent. For a 10-year project pipeline worth \$3 billion, this means an average savings of \$9 million per year.

To leverage design-build contracting for project delivery in Georgia, the State DOT sponsored research to develop a selection tool that assesses the benefits and risks of designbuild selection. The tool also provides systematic guidance on when design-build is the most suitable contracting option. By combining design engineering and construction services into a single contract, design-build contracting can reduce project costs, improve communication, and expedite project delivery. By ensuring transparent and consistent designbuild implementation, the research results supported State legislative action in 2012 that raised the cap on design-build from 30 to 50 percent of Georgia DOT projects. Additional legislation in 2013 allowed for best value design-build contracting (that is, a procurement system that looks at factors other than only price, such as quality and expertise).

Advancing Safety Solutions

Many States have moved research into implementation to improve safety for drivers, pedestrians, and bicyclists. For example, the Iowa DOT correlated crash data with levels of reflectivity for various pavement marking types. The findings provided guidance on pavement marking decisions, such as when and where to reapply treatments to increase drivers' safety. The study also identified locations that might be made safer with more durable treatments beyond the standard application. The results are helping Iowa optimize expenditures on its pavement marking program to maximize safety.

Roundabouts are another innovative method for improving safety for drivers that many States are using. The Mississippi DOT studied two signalized intersections converted to roundabouts and found a 37.5-percent reduction in total crashes and a 60-percent reduction in injury crashes. Benefits extended beyond safety, with reductions in delay, wasted fuel, and idling vehicle emissions. The DOT estimated combined annual user savings at \$806,000.

To improve bicycle and pedestrian safety, the District of Columbia DOT conducted a before-and-after study on new bicycle facilities including bicycle boxes at intersections, dedicated lanes, and bicycle signals. The study provided insights on bicyclist and driver behavior and is helping the DOT tweak existing facilities and improve the designs of new ones.

In another example, the Utah DOT analyzed high- and low-risk intersections for bicyclists and pedestrians and found that incorporating longer pedestrian signal lengths, providing dedicated rightturn lanes, and adding trees in the right-of-way along the corridor can significantly reduce nonmotorized crashes. The DOT incorporated some of the research findings into design standards (for example, a new midblock crossing standard and increased pedestrian signal times).

Work zone safety has also benefitted. For example, the Indiana DOT used the reconstruction of a 6-mile (9.7-kilometer) stretch of I-70 in central Indianapolis to test the effectiveness of new safety countermeasures for work zones. The study employed advanced safety models to measure the effectiveness of targeted techniques for traffic management. Rerouting the heaviest vehicles to other interstates proved to be a highly successful management strategy, as did the combination of additional police enforcement and reduced speeds in work zones. Using these

Roundabouts, like this one in Missouri, are innovations that have the potential to improve safety and reduce delays. Photo: Missouri Department of Transportation. approaches, the agency estimates it reduced the number of crashes by 40 percent. The overall savings for the agency and the public was approximately \$2 million.

The Kansas DOT also worked toward improving work zone safety by testing the effectiveness of portable, plastic rumble strips as a short-term traffic control device. The research showed that drivers reduced their speed by as much as 11 miles (17.7 kilometers) per hour, and research identified possible improvements to the strips and other promising control tools for work zones.

The Road Ahead

AASHTO's multifront promotion of research shows not only a commitment to implementation of studies, but also, more fundamentally, a commitment to fostering a culture of innovation through the breadth of its committees and initiatives. In this framework, return on investment is realized through implementation, and the committees and initiatives encourage a wellspring of new ideas to sustain that return. Although research results are important, even more important is the structure in place to ensure they are put into practice.

The synergy within the committees and initiatives is building. Each stakeholder continues to demonstrate commitment to fostering innovation and moving research into practice, in partnership with other stakeholders. Stakeholders have become more strategic about implementation since expectations regarding return on investment for research seem to have risen in recent years.

"Our ultimate success will be in creating a transportation culture of innovation that's open to new ideas and new ways of doing things," said former Deputy Secretary of Transportation Victor Mendez. "We want things that seem new today to be common practice tomorrow, and for that process to keep renewing itself as new ideas and new technologies are developed."

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Working Smarter, Together Ly Kevin Chesnik and Michael Smith

Today's Federal-Aid Highway Program represents a unique Federal, State, and local partnership that is fundamental to building, maintaining, and rebuilding the Nation's highway and bridge infrastructure. The Federal Highway Administration and State highway agencies have cooperated in implementing the Federal-aid program for more than 60 years, and during that time it has grown to include local governments and involve additional Federal agencies.

Federal-aid program funds come with guidelines from Congress regarding how they may be spent, and Federal-aid projects must meet not only Federal, but also State and local road-building requirements. Although these high standards have helped create the best transportation system in the world, they may cause projects to take longer to deliver and add to project costs. These increased time and cost issues can make Federal-aid projects a challenge for the cities, counties, and other local public agencies that own the majority of the Nation's roads and half of its bridges.

"Federal aid can support local public agencies in keeping local roads and bridges, as well as public sidewalks, walking trails, and biking paths, in a state of good repair,

Stakeholder partnering serves as a platform for launching improvements to local Federal-aid programs, which help local agencies fund projects such as this new bridge along Natural Bridge Road in Leon County, FL. A collaborative effort by Leon County, the Florida DOT, and the Florida Park Service replaced a 70-year-old, onelane bridge with a safer, two-lane structure that blends with the historical and natural significance of the area. Photo: Florida Department of Transportation.

> Partnering for more effective project delivery can produce innovative ideas for using Federal aid. Read on to see bow States and local public agencies overcome barriers.

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but only if it's cost effective for them to use," says Brian Roberts, executive director of the National Association of County Engineers. "Complying with the various regulations tied to Federal aid can require significant time and resources from local agencies, as well as the State departments of transportation tasked with monitoring those projects."

One tool that States are using to help save time and money on locally administered Federal-aid projects is stakeholder partnering. This method involves creating a committee composed of representatives from the State, local, and Federal levels who can work together to identify inefficiencies in the delivery of Federalaid programs and create practices that can improve program results and maximize transportation dollars.

The many benefits of stakeholder partnering include better communication, lower project costs, reduced administrative burden, and greater compliance with road-building regulations. Stakeholder partnering creates open channels of communication that improve relationships and build trust. As a result, local agencies have a greater say in their projects as they move forward and greater control over their project delivery schedules. State and Federal agencies are able to leverage their programs and maximize the use of limited staffing resources.

Project-Level Issues, Program-Level Solutions

State DOTs develop processes meant to help local agencies navigate the Federal-aid program's requirements in areas such as consultant advertisement and selection, rightsof-way, the National Environmental Policy Act, Buy America, and Disadvantaged Business Enterprise goals. The challenge is developing processes that are helpful while avoiding burdening staff at the State or local level with administrative requirements that may increase time and costs unnecessarily.

In addition, some local agencies use Federal-aid funds only occasionally, so they may not be up to date on the most applicable laws or regulations. Another consideration is agency turnover, as occurs in any place of business. These types of issues are to be expected, but the effects can be mitigated through

Stakeholder Partnering Supported by Every Day Counts

Stakeholder partnering was one of 11 innovative practices promoted in the third round of FHWA's Every Day Counts initiative to improve delivery of federally funded projects. As defined within EDC, stakeholder partnering is a process where collaboration occurs among Federal, State, and local agencies at the programmatic level to address concerns and issues, as well as to take advantage of opportunities for process improvements and streamlining. The intent is not to debate the merits of Federal regulations, but rather to focus on efficient and effective implementation.

As of February 2017, stakeholder partnering is an institutionalized practice in 21 States, and several additional States are progressing with efforts to establish these collaborative councils.

improved procedures that streamline and bring consistency to project delivery and that stakeholder partnering committees can target.

"The idea is to bring stakeholders together to discuss program-level issues and look for opportunities to resolve them," Roberts says. "These partnerships give the State and FHWA a better understanding of local concerns—information they can then use to find opportunities for streamlining processes, targeting training, and supporting project success in a way that benefits each agency involved."

When issues are addressed at the program level via process and procedure improvements, it eliminates the need to handle them repeatedly on a project-level basis. For example, one stakeholder group determined that many local agencies had minimal understanding of environmental requirements and were conducting unnecessary environmental reviews. By recommending specific changes to the State's environmental manual, the stakeholder partnering committee found a way to accelerate simple bridge projects.

FHWA's Every Day Counts initiative promoted stakeholder partnering in round two as part of a focus on locally administered Federal-aid projects and in round three as a specific practice. As with other EDC innovations, stakeholder partnering is already in place and working effectively in several States and has the potential for successful implementation in many more.

Strengthening Partnerships

In the Federal-aid program, relationships between local public agencies and FHWA occur primarily through State DOTs. When State, local, and Federal representatives sit down at the same table, however, it provides new lines of communication that increase understanding of Federal-aid and State requirements and each agency's role, resources, and limitations.

"One benefit of stakeholder partnering is good communication that can reduce conflicting responses and differing interpretation of regulations," Roberts says. "It provides a setting from which discrepancies can be identified and then resolved. It really supports a consistent approach."

Some States have had stakeholder committees supporting improved project delivery for many years, while others are just getting started. The committee makeup and meeting arrangements vary by State, but successful partnerships have three common elements: representation from key stakeholders at the State, local, and Federal levels; open





Shown here is construction underway at the Hamilton Road improvement project in Franklin County, OH, one of more than 250 projects administered annually through ODOT's local program. The project includes widening the road from two to four lanes, adding turn lanes at several intersections, and constructing two modern roundabouts to better accommodate motorists, pedestrians, and bicyclists. Photo: Franklin County Engineer's Office, Franklin County, OH.

communications through regular meetings that promote a shared understanding of programmatic issues; and tangible progress on addressing issues identified by stakeholders.

Following are examples of how stakeholder partnering works in five States.

Ohio's Local Public Agency Advisory Group

With a large local program that is continually growing in size, the Ohio Department of Transportation (ODOT) implemented a stakeholder partnering group in 2014 as a venue for working on a programmatic level with local agencies to deliver Federal-aid projects. The face-toface communication inherent in stakeholder partnering has since produced a number of accomplishments and strengthened the overall working relationship between ODOT and the local agency community.

"Our goal in implementing stakeholder partnering is to get feedback and support from, and be an advocate for, the locals as they develop transportation projects," says Andrea Stevenson, administrator of ODOT's Local Programs office. "We want to look at the process from the big picture point of view and solve problems in a way that enables locals to get the most benefit from a broad, statewide perspective."

When the Ohio group meets, the agenda items reflect the diverse interests of local public agencies, based on what the local members are seeing in the field as they advance through the State's project delivery process. Before the meetings, Victoria Beale, assistant administrator of ODOT's Local Programs office, solicits agenda items from the advisory group and from the various disciplines across ODOT. Stevenson and Beale then fill in the agenda with any other updates or items that they think are important to share.

Priority concerns during the group's first years included streamlining environmental and rightof-way processes and expanding knowledge of funding opportunities for different types of projects around the State. To increase awareness of existing and new funding opportunities, ODOT developed its *Resource Guide*, which provides information on capital programs and how ODOT funds programs for local agencies.

In addition, ODOT made revenue from turnpike tolls available specifically to small cities for use as local matching funds for municipal bridges and for ODOT's Transportation Alternatives Program, which provides funds for projects that advance nonmotorized transportation facilities, historic transportation preservation, environmental mitigation, and vegetation management activities.

Finally, ODOT also conducted a "deep dive" survey of all local public agencies to identify opportunities for improving the process of administering local public agency projects, State DOT staff support to those agencies, and other areas critical to the success of local public agency projects. ODOT used the results as a foundation for its advisory group's focus on project improvement going forward.

Missouri's Advisory Committee

In 2010, the Missouri transportation agency (MoDOT) formed the LPA (Local Public Agency) Strategic Vision Team. The purpose was to develop a statewide vision for the local program and define the steps needed to implement that vision.

One outcome was the formation of an advisory committee in 2011 to serve as a continuous improvement team. The committee currently includes 15 members with representatives from local public agencies and consultants from cities, counties, councils of governments, regional planning commissions, engineering firms, and the disadvantaged business enterprise community, as well as members from MoDOT and the FHWA Missouri Division.

During the advisory committee's first year, the primary objectives were to support MoDOT in implementing a statewide training program for local agencies and in rewriting sections of the agency's training manual. After the first year, the variety of items the committee has addressed include goal setting for disadvantaged business enterprises, changes in construction oversight and the rightof-way acquisition process, and the creation of an oncall consultant list.

Inputs from the committee helped MoDOT identify processes that cause costs to escalate on smaller projects. Identifying and mitigating these processes led to remarkable accomplishments for the State's local Federal-aid program. "At the time we formed the vision team, an FHWA review had found that Missouri's local program was 15 percent compliant on Federal law," says MoDOT Local Programs Administrator Kenny Voss. "By 2015, our TAP [Transportation Alternatives Program] review was 93 percent compliant."

He continues, "Also, we had a large balance of unobligated Federal funds in 2012. We were only obligating about 43 percent of the funds that the local entities were given. That has increased to 92 percent, and we hope to have it at 100 percent by the end of [the 2016] Federal fiscal year."

Projects are being delivered faster as well. In 2012, the amount of time from project programming to construction award was reduced from 1,100 days to 750 days. Voss said MoDOT has also seen significant improvements in the timeliness of project closeout.

"We significantly overhauled our local program about 5 years ago, and we are continuing to build off that," Voss says. "Through the committee, we can explain what our goals are, with FHWA as a partner in the room, and show what we are trying to improve and how we are measuring improvement, and then find out, from their point of view, what types of things are holding us back."

Florida's Community Of Practice

The Florida Department of Transportation (FDOT) is a decentralized agency with 7 district offices that partner with more than 250 local agencies to implement transportation projects. Its Local Agency Program Community of Practice is helping provide a consistent, statewide approach to locally administered Federal-aid projects.

"The Community of Practice serves as a channel for receiving local input on FDOT processes," says Chad Thompson, program operations team leader for the FHWA Florida Division. "It gives local agencies the opportunity to question why the department asks for certain things, and it provides FDOT staff with the opportunity to explain to stakeholders the reasoning behind the program requirements."

Thompson adds, "This communication has led to a better understanding among the groups. It has allowed FDOT to examine agency processes and identify areas where more flexibility in meeting Federal requirements can be provided. This has ultimately been useful in several streamlining efforts."

Stakeholder Partnering In Virginia

The Virginia Department of Transportation (VDOT) administers a well-established stakeholder partnering program that began with a group of municipalities managing their construction program under a programmatic agreement called the Urban Construction Initiative. In 2003, VDOT began an informal partnering process with this group as a way to work on program issues, and after that the partnership grew and developed.

Local public agencies use a variety of funding to deliver projects ranging from complex roadway interchanges to multiuse walking and biking trails such as the Katy Trail Overpass in Sedalia, MO, shown here. The overpass was a joint effort by Pettis County, the city of Sedalia, MoDOT, and the Missouri Department of Natural Resources, and was delivered using Transportation Alternatives Program funding. *Photos: City of Sedalia, MO*.



In Leon County, FL, this project is near the site of a Civil War battlefield, so the project used context sensitive solutions such as incorporating a wood pattern texture into the driving surface and applying a natural-toned concrete stain. Florida's stakeholder partnering group helps facilitate these types of projects statewide by identifying process efficiencies at the program level. Photo: Florida Department of Transportation.

Russ Dudley of VDOT's Local Assistance Division says that, as an exercise during one of their meetings in 2012, members were asked to describe the benefits of the partnering efforts.

"From the localities, we heard that they like the opportunity to discuss and identify issues together, because sometimes they find that what they thought was an isolated issue is more pervasive," says Dudley. "Once an issue like this is identified, it gives us an opportunity to work on solutions as a group."

The city of Norton, VA, used a combination of project and grant funding to help turn abandoned mine land into this safe, terraced pedestrian connection between local schools and the downtown. The city opened the new path with a ribbon-cutting ceremony on Walk to School Day in October 2015. Virginia's stakeholder partnering groups provide inputs that help the State align its efforts with the needs of local governments in administering these types of projects. Photo: City of Norton, VA.





He adds, "Localities get to know each other and become resources for each other. Of course, they also like having a voice in the program and having input into its future. From my perspective at the Local Assistance Division, it helps us align our goals with our stakeholders' needs."

Following the success of the Urban Construction Initiative, in 2013 VDOT started another partnering group that represents the entire local public agency program statewide.VDOT assembled the Local Stakeholder Partnering Group to provide a venue for gaining more local input into the Local Assistance Division's programs, to ensure the division's efforts align with the needs and concerns of the local governments in administering projects, and to gather input for major initiatives.

Arizona's Stakeholder Council

Compared to some of the other State departments, the Arizona Department of Transportation (ADOT) is relatively new to stakeholder partnering, choosing to pursue it as part of the second round of Every Day Counts. ADOT's local public agency Stakeholder Council held its first meeting in December 2013 with representatives from local agencies, councils of government, metropolitan planning organizations, ADOT, and FHWA.

To identify prevalent issues and formulate a plan for addressing them,

ADOT's Local Public Agency section monitors any concerns brought forward by the group. Council members take information back to the regions they represent and communicate it through their networks. As they reach out to the broader groups they are involved with, they bring back information, examples, problems, potential solutions, and innovative ideas related to implementing local government Federal-aid projects.

Susan Anderson, ADOT's local public agency process manager, says that small, incremental changes brought by sharing experience with the Federal program through the council are adding up to create long-term improvement.

"Having all three sides—Federal, State, and local—at the table is really allowing us to better understand each other's challenges within the Federal-aid program," she says. "Whenever there is an opportunity to enhance our communications, we can learn a great deal and improve. We are all working to achieve the same goal—the successful delivery of the Federal program."

Where to Start

Learn more about efforts in these and other States to use stakeholder partnering as a platform by visiting FHWA's Stakeholder Partnering Resource Library at www.fhwa.dot .gov/innovation/everydaycounts /edc-3/partnering_library.

The library is a central repository for case studies, videos, webinars,

The city of Tempe, AZ, used Federal funds to complete a multiuse path in 2015 that covers an abandoned gas pipeline and connects schools and neighborhoods. Arizona's Stakeholder Council is enhancing communication among agencies at the local, State, and Federal levels, which will ultimately benefit these types of locally administered Federal-aid projects statewide. Photo: City of Tempe, AZ.

sample committee charters, links to additional articles, and more that can aid those who are initiating stakeholder partnering programs or enhancing existing ones. These materials are offered as aids to States as they start or advance stakeholder partnering strategies and work with their local public agency partners to determine how both States and local agencies can benefit from implementation.

Working together, transportation agencies can implement innovative solutions for improving locally administered, federally funded project delivery. Members of the State, local public agency, and Federal highway communities, when collaborating at a program level, can improve processes and ultimately help those who are on the frontlines of project delivery do their jobs in the most efficient ways possible.

Kevin Chesnik, P.E., is a principal engineer with Applied Research Associates, Inc., and is supporting the FHWA EDC-3 Stakeholder Partnering team. He has a B.S. in civil engineering and a B.S. in construction administration from the University of Wisconsin-Madison.

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For more information, visit www.fbwa.dot.gov/innovation /everydaycounts/edc-3/partnering .cfm or contact Michael Smith at 470-728-1049 or michael.smith@dot.gov.

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 bigbway community. This information comes from U.S. Department of Transportation sources unless otherwise indicated. Your suggestions and input are welcome. Let's meet along the road.

Policy and Legislation

NHTSA Sets "Quiet Car" Safety Standard

The National Highway Traffic Safety Administration recently announced a sound requirement for all newly manufactured hybrid and electric light-duty vehicles to help protect pedestrians. The new Federal safety standard will help pedestrians who are blind or have low vision detect the presence, direction, and location of these vehicles when they are traveling at low speeds. NHTSA estimates the requirement will help prevent about 2,400 pedestrian injuries each year once all hybrids in the fleet are properly equipped.



Under a new regulation, electric light duty vehicles, such as this car at a charging station, will be required to produce an audible noise at low speeds to help alert pedestrians.

Under the new rule, all hybrid and electric light vehicles with four wheels and a gross vehicle weight rating of 10,000 pounds (4,500 kilograms) or less will be required to make audible noise when traveling in reverse or forward at speeds up to 19 miles (30 kilometers) per hour. At higher speeds, the sound alert is not required because other factors, such as tire and wind noise, provide adequate audible warning to pedestrians.

The new standard responds to Congress' mandate in the Pedestrian Safety Enhancement Act that hybrid and electric vehicles meet minimum sound requirements to provide an audible alert for the benefit of blind and visually impaired pedestrians. Manufacturers have until September 1, 2019, to equip all new hybrid and electric vehicles with sounds that meet the new Federal safety standard. Half of new hybrid and electric vehicles must be in compliance 1 year before the final deadline. For more information, visit www.transportation.gov /briefing-room/nbtsa2716.

Technical News

FHWA Unveils Alternative Fuel Corridors

The Federal Highway Administration recently announced 55 routes that will serve as the basis for a national network of alternative fuel corridors spanning 35 States. The network is nearly 85,000 miles (137,000 kilometers) long, and more miles will be added in the future as fueling and charging stations are built to accommodate electric, hydrogen, propane, and natural gas vehicles.

Corridors for Charging Electric Vehicles



Corridors designated as "sign ready," meaning routes where alternative fuel stations are currently in operation, are eligible to feature new signs alerting drivers where they can find alternative fuels for their vehicles. These signs are similar to existing signage that alerts drivers to gas stations, food, and lodging. The designation of these corridors fulfills a directive in the Fixing America's Surface Transportation (FAST) Act of 2015.

To develop the network, FHWA asked States to nominate corridors along major highways with plug-in electric vehicle charging and hydrogen, propane, and natural gas fueling stations. Congress designated these specific fuels in the FAST Act.

In 2015, the United States pledged to reduce greenhouse gas emissions by 80 percent or more by 2050. By supporting lower emission vehicles, alternative fuel corridors will help to reduce transportation emissions, one of the leading sources of U.S. greenhouse gas emissions.

For more information, visit www.fbwa.dot.gov /environment/alternative_fuel_corridors.

Public Information and Information Exchange

Partnership Aims to End Traffic Fatalities

Three USDOT operating administrations—NHTSA, FHWA, and the Federal Motor Carrier Safety Administration—are joining forces with the National Safety Council to launch the Road to Zero Coalition. The coalition's goal is to end

fatalities on the Nation's roads within the next 30 years. USDOT has committed \$1 million per year for the next 3 years to provide grants to organizations working on lifesaving programs.

The largest increase in traffic deaths since 1966 occurred in 2015, and preliminary estimates for the first half of 2016 show an alarming uptick in fatalities: an increase of about 10.4 percent as compared to the number of fatalities in the first half of 2015.

The Road to Zero Coalition will initially focus on promoting proven lifesaving strategies, such as seatbelt use, rumble strips, truck safety, campaigns to change behavior, and data-driven enforcement. In addition, the coalition will lead the development of a new scenariobased vision for how to achieve zero traffic deaths using evidence-based strategies and a systematic approach to eliminating risks.

The "zero deaths" idea was first conceived in Sweden in 1994 as Vision Zero and since then has spread across the country and across the world. A growing number of States and cities have adopted zero fatality visions because of the belief that even one fatality is too many.

FHWA Becomes Ambassador for Preparedness

In October 2016, FHWA officially became a Weather-Ready Nation Ambassador as part of a National Oceanic and Atmospheric Administration (NOAA) initiative aimed at improving the Nation's preparedness and strengthening resilience to extreme weather events.



Extreme weather events can cause dangerous driving conditions. FHWA is partnering with the National Weather Service to improve the preparedness of local communities.

NOAA is working to improve accuracy in forecasts and warnings, evolve services to serve community decisionmakers, and find better ways to communicate risk to stakeholders and the public. For the Weather-Ready Nation initiative, NOAA partners with Federal, State, and local agencies, commercial industry, researchers, and other groups to prepare communities for potential weather disasters.

Under its Every Day Counts initiative, FHWA is working to deploy two distinct solutions that enable State and local agencies to manage their transportation systems proactively ahead of and during bad weather. The first, Pathfinder, lays out a multistep process for determining the information to share and how best to do so before, during, and after severe weather events. The second, Integrating Mobile Observations, focuses on vehiclebased technologies. It involves collecting data on weather and road conditions from sensors on vehicles that can inform DOT staff about critical conditions, such as pavement temperature.

As part of the Weather-Ready Nation initiative, teams from FHWA and the National Weather Service will work together to better understand the risks associated with extreme weather events to build stronger communities and upgrade their preparedness.

For more information, visit www.transportation.gov /fastlane/fbwa-becomes-%E2%80%98weather-ready -nation%E2%80%99-ambassador.

MPOwerment Initiative Helps Transportation Decisionmakers Innovate

Transportation planning is critical to addressing regional priorities. To help local and regional decisionmakers, USDOT launched the MPOwerment initiative to engage with metropolitan planning organizations (MPOs) and other agencies involved in the transportation decisionmaking process. The initiative's goal is to improve prioritization of Federal funds by providing a forum for candid conversations that help USDOT understand the challenges and opportunities for transportation agencies at all levels to work together to strengthen regional planning processes, improve regional coordination, and streamline decisionmaking.

The MPOwerment initiative responds to one of the key challenges identified in USDOT's *Beyond Traffic: Trends and Choices 2045.* Specifically, the initiative aims to improve how Federal, regional, State, and local agencies work together to improve transportation decision-making regionally and locally. The initiative is focused on the role of MPOs in encouraging collaboration, increasing public participation, and growing opportunity through the transportation planning process.

The MPOwerment initiative consists of a series of 1-day workshops across the country led by USDOT to engage transportation decisionmakers in discussions about ways to improve regional planning, prioritize and expand Federal investments that revitalize communities, and connect people to opportunity. The first four workshops were held in October and November 2016.

For more information, contact MPOwerment@dot.gov.

USDOT Issues Automated Vehicle Policy

In the fall of 2016, USDOT released the Federal Automated Vehicles Policy, which "sets out an ambitious approach to accelerate the [highly automated vehicle] revolution." The policy is an important step in the Department's efforts to build expertise and knowledge in this rapidly emerging technology. The policy lays a path for the safe testing and deployment of new automated vehicle technologies that have enormous potential for improving safety and mobility on U.S. roads.



In the fall of 2016 in Washington, DC, then Secretary of Transportation Anthony Foxx announced the Federal Automated Vehicles Policy.

"Automated vehicles have the potential to save thousands of lives, driving the single biggest leap in road safety that our country has ever taken," said then U.S. Secretary of Transportation Anthony Foxx.

The policy sets a proactive approach through four key parts. First, guidance on vehicle performance uses a 15-point safety assessment to set clear expectations for manufacturers developing automated vehicle technologies. Second, model State policy delineates the Federal and State roles for the regulation of highly automated vehicle technologies as part of an effort to build a consistent national framework of laws to govern selfdriving vehicles. Third, the policy outlines options for the further use of current Federal authorities to expedite the safe introduction of highly automated vehicles into the marketplace. Finally, the policy discusses new tools and authorities the Federal Government may need as the technology evolves and is deployed more widely.

To develop the policy, USDOT consulted with industry leaders, experts in the field, State governments, the traveling public, and safety advocates, among others. The Department is requesting public comment on the policy and plans to conduct significant public outreach to inform the next update.

For more information, visit www.transportation .gov/AV.

Data Shows Nearly 20 Percent Of U.S. Drivers Are Over 65

FHWA data shows that there are more drivers than ever before—an estimated 217.9 million—and that 42.8 million, or nearly one in five, are over 65 years old. Drivers over 65 are one of the fastest growing demographic groups among U.S. motorists. With a 2-percent increase over 2015, representing 4.4 million more drivers over 65, it is the biggest single-year percent increase on record for that population.

FHWA researchers continue to develop and improve safety enhancements for the Nation's roads to address the challenges facing older drivers, ranging from declining vision to decreased flexibility and psychomotor performance, and changes in perceptual and cognitive performance. Some innovations include longer merge lanes, roundabouts, better lighting, more visible signage, and other intersection improvements.

Additional information about how FHWA designs roads for older drivers can be found in the *Handbook for Designing Roadways for the Aging Population* (FHWA-SA-14-015), available online at http://safety.fhwa.dot.gov /older_users/handbook, which offers substantial information on the methods and techniques used to accommodate this growing driver demographic.

Framework Guides Life Cycle Assessments of Pavements

Increased awareness of the importance of environmental protection and the possible impacts associated with the production, use, and retirement of products has generated considerable interest within the transportation community. One area of interest is the use of assessment methods to better understand and address environmental impacts. A technique developed for this purpose is life cycle assessment, which quantifies environmental impacts over the full life cycle of a product or system, including impacts that occur throughout the supply chain.

Life cycle assessment has a commonly accepted standard method published by the International Organization for Standardization. However, there are no widely accepted standards that focus specifically on the life cycle assessment of pavements. To address this gap, FHWA recently published *Pavement Life Cycle Assessment Framework* (FHWA-HIF-16-014), which provides an important first step. The publication presents a framework for performing an assessment specific to pavement systems along with guidance on the overall approach, methodology, system boundaries, and current knowledge gaps.

Life cycle assessment provides a comprehensive approach for evaluating the total environmental burden of a product by examining all the inputs and outputs over the life cycle, from raw material production to the end-of-life. For pavements, this cycle includes the material production, design, construction, use, maintenance and rehabilitation, and end-of-life stages.

For more information, visit www.fbwa.dot.gov /pavement/sustainability/bif16014.pdf.

GAO Recommends Tracking Link Between Funding and Bridge Conditions

The U.S. Government Accountability Office (GAO) released a report, *Highway Bridges: Linking Funding to Conditions May Help Demonstrate Impact of Federal Investment* (GAO-16-779), that examines trends in the condition, management, and funding of the Nation's bridges. The 612,000 bridges in the United States are critical elements of the surface transportation system, which is under growing strain. Funding the system is on GAO's High Risk List. Although FHWA estimates total funds dedicated to bridges and collects data on bridge conditions nationwide, it does not track the linkage between Federal funds and changes in bridge conditions.

Bridge conditions have generally improved nationwide from 2006 to 2015, based on the GAO analysis of Federal bridge data. And, Federal funds obligated for bridge projects have remained relatively stable over the same period—between \$6 billion and \$7 billion in most years. Linking performance outcomes with resources invested can help agencies to determine more clearly how changes in investments may affect performance. The GAO report recommends that FHWA develop measures on the linkage between Federal funding of bridges and desired outcomes—maintained or improved bridge conditions—and report the results to Congress.

For more information, visit www.gao.gov/products /GAO-16-779.

GAO

Arizona Holds Inaugural Innovation Day

In October 2016, Arizona highlighted advanced technologies and solutions as part of the State's first Innovation Exchange Day. Hosted by the Arizona Council for Transportation Innovation, the event focused on the future of transportation and included an innovation showcase. Exhibitors from the public and private sectors spoke about new technologies and techniques they are developing.

Some of the innovations on display included a smartphone app that rewards drivers for taking the least congested routes, an advanced mobile-mapping system, and technology being developed to produce a 3-D-printed, fully recyclable vehicle. The event also highlighted low-tech improvements, such as a method for adding new synthetic materials to asphalt to increase strength and lengthen the lifespan of roadways.

The Arizona Department of Transportation (ADOT) participated as well, highlighting the agency's efforts to detect wrong-way drivers and to reduce rush hour congestion with responsive ramp meter timing.

"We need to continually look for innovations that will save lives and make the transportation experience better for all of us," says Dallas Hammit, ADOT's deputy director for transportation.

More than 150 people attended the 1-day event, which received overwhelmingly positive feedback. Planning is underway for the 2017 AZ Innovation Exchange Day.

For more information, visit www.azdot.gov/acti or contact Randy Everett at randolf.everett@dot.gov or 602-382-8989.

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Internet Watch

by Carrie Boris

A Home for ITS Application Development

In recent years, the U.S. Department of Transportation has increased focus on intelligent transportation systems (ITS), an area of rapidly emerging, transformative technology. With many stakeholders involved in the research and development of ITS technologies and related applications, the Department identified the need for a centralized source for applications, research, and data.

The Open Source Application Development Portal (OSADP) provides a virtual community space to enable developers, State and local agencies, researchers, and industry to share ITS applications. USDOT developed the portal to provide access to and support the collaboration, development, and use of mobility and

transportation-related applications. The OSADP helps USDOT facilitate the advancement of research, development, planning, testing, and deployment of connected vehicle and traveler-related applications and ITS.

USDOT launched version 2.0 of the OSADP in February 2016 at http:// itsforge.net. This update "was to enable users to quickly browse, search, access, and download applications and their supporting resources of interest," says Jon Obenberger, a senior transportation research engineer in FHWA's Office of Operations Research and Development.

An Extensive Repository

The OSADP is a Web-based portal that features source code, software, applications, and resources (such as documentation, licenses, and data) to support the use of ITS-related applications or further their development. All applications developed under USDOT sponsorship are expected to make their source code and documentation, once completed, available on the

OSADP. Public agencies, service providers, application developers, researchers, and others are able to use the open source applications, which are being added continually to the OSADP.

The portal provides a means for developers to upload and download completed mobility applications as well as collaborate on development projects in progress. The OSADP is intended to be a forum to enable developers to implement their ideas on new open source projects, collaborate on and discuss projects that are new or underway, and to use or augment other developers' code.

Registered OSADP users can upload, download, and collaborate on open source applications. All users have access to the discussion forums and technical resources, as well as assistance in accessing and downloading the applications. As of December 2016, the site had more than 650 registered users.

Enabling Access, Innovation, and Collaboration

In addition to housing completed applications from federally funded projects, OSADP is open to emerging open source transportation applications, both in development or completed. All applications must be open source and include source code and documentation, so developers can reuse, modify, or enhance existing applications to meet their needs or add their own software projects.

The interactive forums enable users to discuss applications under development and ideas for new applications, as well as to provide feedback about the OSADP. Users are encouraged to report bugs and fixes or ask questions, discuss ideas for new transportation applications or technologies, share ideas on how to improve the OSADP, collaborate to enhance existing transportation applications, and request the ability to collaborate on improvements.



Users also can access a variety of other resources to support the use of different applications, including a range of project-specific documentation such as concepts of operations, requirements, and design documents; testing and evaluations; datasets; and resources to support the installation and use of applications. The portal also offers question-and-answer forums and links to external resources, including the Research Data Exchange, Connected Vehicle Pilot Deployment Program, Connected Vehicle Reference Implementation Architecture, and the GitHub development platform.

For more information, contact Kate Hartman at kate.hartman@dot.gov.

Carrie Boris is a contributing editor for PUBLIC ROADS.



Training Update

by Judy Francis

Supporting Intelligent Transportation Systems

Intelligent transportation systems (ITS) encompass a broad range of communications-based information and electronics technologies, and they are some of the most innovative and evolving technologies in transportation. ITS improve transportation safety and mobility and enhance the Nation's productivity through the integration of advanced communications technologies into vehicles and the transportation infrastructure. These systems can enable road users of all types to make better, more informed decisions.

Drivers, pedestrians, and users of public transportation interact with ITS daily. Early ITS efforts consisted of dynamic message signs, ramp management techniques, and invehicle navigation and route guidance systems.

Today, advances in technology have greatly increased the impact of ITS on transportation environments. Invehicle technologies now can detect roadway hazards and alert drivers of dangerous conditions using advanced safety mechanisms such as collision avoidance systems, lane departure warnings, and drowsy driving warnings. Infrastructure-based safety systems are using technology embedded in or adjacent to roadways to prevent crashes. These systems include innovative road weather sensors, wildlife detectors, dynamic curve warnings, and collision avoidance warnings at intersections.

The field of ITS is evolving rapidly. To help transportation professionals successfully acquire effective goods, services, and work to meet emerging ITS needs on time and on budget, the National Highway Institute developed ITS Procurement (course number 137049).

The Unique Challenges of ITS

Projects involving ITS are different from traditional road and bridge work. For roads and bridges, there are many standard design guides and manuals. In addition, much of the work in road or bridge design and procurement is described graphically using blueprints, plots, and plans. ITS, on the other hand, rely more heavily on words rather than images to define what is needed. Defining and clearly communicating those needs are essential to building successful ITS.

Hardware and software needs for ITS projects may not fit typical procurement strategies, which can create challenges with advancing ITS initiatives. NHI's ITS Procurement course presents an approach to defining ITS projects and desired outcomes to help State and local agencies meet their needs. The key is to determine complete and correct requirements. These requirements can be used as the basis for procurement documents, selection, submittal, review, acceptance testing, and ongoing systems support. By improving procurement processes, agencies can increase project success.



Intelligent transportation systems, such as connected vehicle warning devices, can help drivers avoid serious lane change crashes. NHI's ITS Procurement course helps agency staff improve their process for requesting ITS products and services.

Improving the Procurement Process

The ITS Procurement course is a 3.5-hour Web-based training that focuses on the procurement stage of the overall acquisition process, from identifying needs to developing a procurement process that helps participants obtain what they need through contractor selection. Course participants learn how to integrate systems engineering with contracting processes and contract management approaches.

"The course was highly informative by giving a historic overview... and continuing into the depths of procurement aspects," says Jared Deck of the County of Los Angeles Department of Public Works." [It covers] all the necessary tools to drive the right decision process."

The course features scenarios and examples to illustrate different decision points, problems, successes, and surprises to gain new perspectives on various ITS projects. Participants are provided with tools to develop the key aspects of a request for quote, request for proposal, invitation for bid, and goods contract advertisement to ensure a successful procurement. The course also discusses the four factors that support success in procurements: defining and communicating needs, matching procurement methods with purchases; selecting an appropriate vendor, contractor, or consultant; and checking that needs are met.

This training is recommended for public agency ITS program and project managers, support staff, and consultants; public agency procurement/contract managers and support staff; and Federal field staff involved in ITS. The course also will benefit planners who will be assisting in interagency coordination/cooperation and ITS projects. Participants who successfully complete the training will receive 0.3 continuing education units.

For more information, visit www.nbi.fbwa.dot.gov.

Judy Francis is a contracted marketing analyst for NHI.

Communication Product Updates

Compiled by Lisa A. Shuler 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 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 (PDC).

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 5301 Shawnee Road Alexandria, VA 22312 Telephone: 703–605–6050 Toll-free number: 1–888–584–8332 Web site: www.ntis.gov Email: customerservice@ntis.gov

Requests for items available from the R&T Product Distribution Center should be addressed to:

R&T Product Distribution Center Szanca Solutions/FHWA PDC 700 North 3rd Avenue Altoona, PA 16601 Telephone: 814–239–1160 Fax: 814–239–2156 Email: report.center@dot.gov

For more information on R&T communications products available from FHWA, visit FHWA's Web site at www.fbwa.dot.gov, the FHWA Research Library at www.fbwa.dot.gov/research/library (or email fbwalibrary@dot.gov), or the National Transportation Library at ntl.bts.gov (or email library@dot.gov).

Updating HEC-18 Pier Scour Equations For Noncohesive Soils (Report) Publication Number: FHWA-HRT-16-045

Balancing safety and cost is critical to smart investment when estimating scour at bridge piers in noncohesive soils. This report summarizes a study to improve techniques for estimating scour under a broad range of conditions using quantitative measures of reliability and accuracy. The researchers focused on situations with higher uncertainty, including sites with coarse bed materials and bridge designs with pier groups. The study, conducted at FHWA's J. Sterling Jones Hydraulics Laboratory at the Turner-Fairbank Highway Research Center, aimed to provide improved guidance to bridge engineers involved with foundation design.

Researchers compiled a dataset of 594 bridge pier scour observations from 2 laboratory and 3 field studies. The dataset served as the testing ground for evaluating potential enhancements to the pier scour tools for noncohesive soils in Hydraulic Engineering Circular 18 (HEC-18). The current (fifth) edition of HEC-18



provides two primary equations for pier scour in noncohesive soils. One is the general equation applicable to most situations, including clear water and live bed conditions. The second is a coarse bed material equation recommended only for use under clear water conditions with coarse bed materials. The objective of this research was to determine if the coarse bed materials equation could be used for conditions beyond those to which it is currently limited, including live bed conditions (for example, the movement of sediment during storm events). To do so, researchers developed a framework for evaluating the equations using qualitative and quantitative tools.

To analyze the equation currently limited to use with coarse bed material, researchers partitioned subsets of the available data based on key conditions, including coarse bed criteria, gradation, and median grain size. The equation performed reasonably consistently in all partitioned datasets, leading to the conclusion that it may be used for a broader range of conditions. The study also assessed a subset of pier group scour observations to determine whether the equation also could be used for pier groups. The equation performed better for single piers but offered a basis for predicting local scour at pier groups.

Considering these findings, the researchers recommend the modified equation for use on a broader range of noncohesive soil conditions for pier scour. The document is available to download at www.fhwa.dot.gov /publications/research/infrastructure/structures/bridge /16045/index.cfm.

Investigating the Impact of Lack Of Motorcycle Annual Average Daily Traffic Data In Crash Modeling and the Estimation Of Crash Modification Factors (Report) Publication Number: FHWA-HRT-16-054

Motorcycle crashes, which account for more than 14 percent of all motor vehicle fatalities, continue to be a significant safety concern on U.S. highways. Developing safety performance functions (SPFs) and crash modification factors (CMFs) that measure the safety effectiveness of highway safety improvements requires data on traffic exposure. The analysis of motorcycle crashes can be especially challenging in this regard because few jurisdictions collect motor-

cycle traffic volume data systematically.

This report discusses a research project conducted to address this challenge. The project involved performing several analyses to explore how much predictive power for an SPF is lost when motorcycle volumes are unknown and how this lack of information may affect the development of CMFs for motorcycle crashes. The



project also explored alternative

methods for deriving accurate predictions of motorcycle crashes or motorcycle volumes.

Results of the analyses show that when motorcycle volumes are not known, using total average annual daily traffic on its own is sufficient for developing SPFs and CMFs. However, the project team's attempts to predict motorcycle volumes based on typically available roadway and county-level data were largely unsuccessful.

A more significant issue in developing motorcycle crash SPFs and CMFs is working with relatively rare crash types. In the analyses undertaken, SPFs could not be developed for all motorcycle crash types or site types. In estimating CMFs using simulated data, the CMF value varied significantly between simulation runs because of the low frequency of motorcycle crashes.

The report identifies several research gaps related to analytical methods and data limitations. This effort identified the need for a database that includes implemented countermeasures expected to affect motorcycle crashes, along with the location, date of treatment, and treatment description. This information would aid researchers in identifying treatments that are feasible for study.

The document is available to download at www.fhwa .dot.gov/publications/research/safety/16054/index.cfm.

Implementation of Remaining Service Interval Concept (TechBrief) Publication Number: FHWA-HRT-16-066

This TechBrief discusses a research project focused on demonstrating and validating with real data the application of the concept of remaining service intervals for pavements. The document describes the concept and then addresses the following key questions: Does the concept work? How can applying the concept of remaining service interval benefit highway agencies? What do agencies need to do to implement the concept?

Remaining service interval is based on the idea that pavement maintenance and rehabilitation requirements cannot be defined by a single value representing the end of life of the pavement. Instead, pavements should be described based on intervals used to communicate the amount of time before a treatment type is required to provide acceptable or above acceptable level of service at the lowest practical life-cycle cost.



The remaining service interval concept does not provide an alternative to assessing the health of the network or making decisions about how to spend available funds. It simply provides clear terminology and a logical process that will create a consistent construction event-based terminology and understanding. An added benefit of adopting the remaining service interval terminology is that it provides a readily available way to communicate impacts of alternate budget scenarios.

The concept unifies the outcome of different approaches for determining needs by focusing on when and what treatments are needed as well as the service interruption created. The concept uses a structured sequence of maintenance, preservation, rehabilitation, and replacement actions through life-cycle cost considerations to provide acceptable service over the life cycle of the assets at minimum practicable cost.

Results from the validation efforts support the conclusion that the remaining service interval represents a valid approach to determining and communicating the future maintenance and rehabilitation needs of a pavement. Optimal pavement management decisions should not be predicated solely on condition-based threshold values for treatments, but instead may include the application of treatments well before a threshold condition is reached, in order to minimize life-cycle costs.

This document is available to download at www.fhwa .dot.gov/publications/research/infrastructure/pavements /16066/index.cfm.

FHWA Research and Technology Evaluation Program Summary Report Spring 2016 (Report) Publication Number: FHWA-HRT-16-071

The Federal Government has the responsibility to fund and conduct research and technology (R&T) activities of national interest that will lead to solutions to highway transportation issues. These efforts aim to significantly advance technological innovation with a clear public benefit when private investment is neither present nor sufficient. In 2003, FHWA leadership adopted a strategic management framework called the *Corporate Master*

Plan (CMP) for Research and Deployment of Technology & Innovation. Performance evaluation and measurement together form a major part of the CMP.

FHWA shapes and executes a national R&T program comprising eight research components. Four of these components take place under the guidance of the Turner-Fairbank

Highway Research Center in McLean, VA.

The research center's leadership has adopted a strategic plan to guide the center's continued development and capitalize on its significant accomplishments. The research evaluation efforts described in this report focus

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directly on goal 5 of the strategic plan, which specifies that research activities and outcomes are appropriately advanced through effective alignment of resources, dissemination of knowledge, and technology transition.

In support of the CMP and the strategic plan, FHWA's R&T program developed a research agenda to communicate to external customers, stakeholders, and within FHWA; provide a means for input and comment across the entire FHWA R&T portfolio; open opportunities for greater coordination of and collaboration on research and development; provide support system performance measures; and guide the investment of FHWA resources.

This report furthers the research agenda, summarizing 16 evaluations currently being conducted by staff at Volpe, the National Transportation Systems Center, and sponsored by FHWA's R&T program. The evaluations are grouped into two waves. The first wave consists of six retrospective and four prospective evaluations, while the second wave involves six prospective evaluations.

This report should be of interest to program managers, office directors, and executives within FHWA, as well as others within USDOT or other parts of the Federal Government interested in the outcomes and impacts of FHWA research.

The document is available to download at www.fhwa.dot.gov/publications/research/randt /evaluations/16071/16071.pdf.

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EDC-4 Promotes Safety Innovations

Data-Driven Safety Analysis

Cutting-edge tools can analyze crash and roadway data and help to determine the expected safety performance of roadway projects more reliably. Transportation professionals can use Data-Driven Safety Analysis to quantify safety effects just as they do with environmental, traffic, and other traditional impacts. The analyses result in more scientifically sound, data-driven approaches to committing resources, as well as fewer and less severe crashes on the Nation's roadways.





Safe Transportation for Every Pedestrian

A majority of pedestrian fatalities occur at uncontrolled crossing locations (such as nonintersections) or at intersections with no traffic signal or STOP sign. Safe Transportation for Every Pedestrian, or STEP, helps transportation agencies address these crashes by promoting cost-effective safety countermeasures:

- Road diets
- · Pedestrian hybrid beacons
- Pedestrian refuge islands
- Raised crosswalks
- Crosswalk visibility enhancements, such as lighting and enhanced signing and marking

U.S. Department of Transportation Federal Highway Administration



For more information, visit www.fhwa.dot.gov/innovation /everydaycounts/edc_4.

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