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Spring 2018

Women and Girls in Transportation
Deploying Pavement Technologies
Managing Diversity in the Workforce

U.S. Department of Transportation
Federal Highway Administration

Public Roads

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

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Front Cover—These girls participated in FHWA's Take Your Sons and Daughters to Work Day in 2016, a fun day of scientific discovery to encourage children to consider careers in science, technology, engineering, and math (STEM). The U.S. Department of Transportation is supporting women in transportation through programs like the Women and Girls in Transportation Initiative. For more information, see "Ready, Willing & Able" on page 28 in this issue of PUBLIC ROADS.

Back cover—Crews install decking on the eastbound span of the George V. Voinovich Bridge in Cleveland. Together, the eastbound and westbound spans constituted Ohio DOT's largest bridge project ever. For more information, see "Building a Bridge to Sustainability" on page 4 in this issue of PUBLIC ROADS. *Photo: Cleveland Innerbelt Flickr.*

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Guest Editorial

Improving Work Zone Operations

This year, April 9 marks the start of National Work Zone Awareness Week. Work zones play a key role in maintaining and upgrading the Nation's roadways. With aging infrastructure and increasing traffic, roadways more frequently require work zones while remaining open, often leading to crashes and significant delays. With more than 35,000 injuries, 700 fatalities, and almost 900 million hours lost annually because of work zones, how can transportation agencies better manage them and minimize their impacts?

Start with better informed travelers and roadway operators. Providing road users with real-time information about work zones helps them make informed, dynamic trip decisions. Equipping agency operators with historic and real-time mobility and safety data helps them to assess the potential impact of a work zone and make more effective decisions.

The Federal Highway Administration is supporting enhanced dissemination of information through its Smarter Work Zones (SWZ) initiative. SWZ provides resources to pilot, implement, and institutionalize a number of technology applications focused on work zones. These include real-time traveler information, queue warning, incident management, automated enforcement, and performance measurement. Since its inception as part of the third round of the Every Day Counts initiative, SWZ efforts have directly resulted in 39 States incorporating technology applications into their agency practices.

These applications have numerous proven safety and mobility benefits. For example, along the I–35 corridor in Texas, end-of-queue warnings led to a 45-percent crash reduction and lowered the severity of those crashes.

SWZ technology is advancing rapidly, finding applications within the growing field of connected and automated vehicles. For example, Colorado recently began piloting autonomous truck-mounted attenuators for striping operations.

Technology is only part of the solution. Work zone information has become a necessity for data-driven efforts in the management and operation of transportation systems. Data measurement, management, security, assessment, and coordination are priorities for both passenger and commercial vehicles. Information on anticipated work zone impacts can enable freight operators to reduce costs and increase operational efficiencies.

In today's world, work zone data are important to both public agencies and private industry data providers. Private sector data sources can fill in the gaps for public agencies. For example, the Maryland State Highway Administration has implemented a Work Zone Performance Measure Application, which uses third-party probe data to conduct real-time monitoring of work zones and evaluate archived data.

Currently, there is wide variation in the type and completeness of available data, storage, utilization, and performance management practices. This lack of standardization limits the use and benefit of work zone data.

In response, FHWA's Work Zone Data Initiative is developing a consistent language for communicating information about work zone activity across jurisdictional and organizational boundaries. The initiative will consider how data are generated, shared, and used by key partners. Data applications will span all stages of project development and implementation, from better project coordination to more comprehensive cost assessments for accelerated construction.

The opportunities and benefits of using data and technology in managing work zone operations are far reaching and are leading to the next level of management practices. For more information, visit www.workzonesafety.org/swz or email Jawad.Paracha@dot.gov. To get involved in the Work Zone Data Initiative, please contact Todd.Peterson@dot.gov.

Jawad Paracha, PE, PTOE
Manager, Work Zone Management Program
Office of Transportation Operations
Federal Highway Administration

by Mark Sullivan

Leveraging Transportation Funding With Value Capture

Transportation improvements enhance accessibility and often generate significant increases in the value of surrounding land, benefiting landowners and developers. Value capture techniques harness part of these increased property values to pay for the transportation improvements themselves or to invest in future projects.

"Given the opportunity, value capture can fill in the gap when available funding falls short of transportation improvement needs," says Thay Bishop, senior program advisor for the Federal Highway Administration's Center for Innovative Finance Support (CIFS).

For agencies seeking funding alternatives for projects, CIFS provides tools, resources, and technical assistance on value capture and other options to help the transportation community implement alternative financial strategies to deliver infrastructure.

"We serve as a clearinghouse of best practices so States and localities can learn about what other jurisdictions have done," says Bishop. "We can also arrange peer exchanges so agencies can share why and how they used value capture."

Although value capture is more common in transit development, it also offers a funding source for highway projects. By tapping into ongoing revenue sources, such as property taxes, it can raise upfront dollars from lenders for projects or provide a stream of funds on a long-term basis.

> *"Given the opportunity, value capture can fill in the gap when available funding falls short of transportation improvement needs."*
> *—Thay Bishop, CIFS senior program advisor*

Applying Value Capture Strategies

A variety of value capture techniques are available for transportation investment in the United States. One of the most common is a special assessment or tax. Special assessment districts levy incremental property taxes on land and buildings that benefit from transportation improvements.

An example is the Route 28 Highway Transportation Improvement District in northern Virginia, where property owners agreed to assess an additional tax on commercial and industrial property on more than 10,200 acres (4,100 hectares) along the Route 28 corridor. The revenue is dedicated to highway improvements on the corridor, including road widening and interchange reconstruction.

Another value capture mechanism is the development impact fee, a one-time levy on new development to help recover the costs of growth-related public services, such as construction of local roads. Development impact fees are widely used in California, Colorado, Florida, and Texas.

Shirley Contracting

This aerial photo shows the interchange of Route 625 with Route 28, part of the Highway Transportation Improvement District in Virginia.

In California, 90 percent of cities and counties have adopted development impact fees. One of them is Orange County, where two organizations—the Foothill/Eastern and San Joaquin Hills Transportation Corridor Agencies—operate four public toll roads totaling almost 51 miles (82 kilometers) to provide congestion relief and connectivity. Development impact fees levied on developers of residential and commercial properties are used to supplement toll revenues for debt service payments on the toll roads.

Finally, one of the oldest value capture tools is tax increment financing (TIF), which uses the expected increase in property value to pay off capital bonds for public improvements within a TIF district. Local governments commonly use the strategy to promote housing, economic development, and redevelopment in established neighborhoods.

Some State laws specifically authorize the use of TIF for transportation purposes. Missouri, for example, has funded more than $575 million in public infrastructure statewide using TIF districts, many of which have invested in highway upgrades and improvements.

Learn More

"We encourage States and localities to explore the creative ways they can leverage the local benefits of highway infrastructure and capture monetary value to meet transportation needs," says Bishop.

More examples of value capture techniques and projects are on the CIFS website at www.fhwa.dot.gov/ipd/value_capture. For more information, contact Thay Bishop at 404-562-3695 or thay.bishop@dot.gov.

Mark Sullivan is director of the Center for Innovative Finance Support.

by Sara Lowry

Driving Innovation Through State Councils

Collaborative engagement, better results: This is the concept behind the State Transportation Innovation Councils (STICs) that now work across the country. Bringing together stakeholders from public agencies, industry, and academia fuels a collaborative environment that drives the generation of ideas, promotes buy-in for those ideas, and increases opportunities for successfully identifying and deploying innovations.

The Federal Highway Administration champions the national STIC network to promote this collective engagement and to strengthen a culture of innovation in the Nation's transportation agencies. STICs share information, identify champions to lead innovation efforts, and strengthen relationships among stakeholder partners. This network leads to improving the implementation of market-ready technologies and techniques, getting them into widespread practice as quickly as possible in locations where they offer the most benefit. It also provides a platform to brainstorm ideas that can lead to more innovations.

In one case, it even led to an innovative approach being put to work during a meeting in Texas—a creative way to present ideas.

Pitching Innovation in Texas

After the Texas Department of Transportation (TxDOT) formed a STIC in 2016, one of its first efforts was to look for ways to gain input from the State's large transportation community on future TxDOT research. The result was a novel approach based on a Hollywood-style pitch meeting.

When the Texas STIC met in June 2017, 68 public and private transportation stakeholders were on hand to receive a status update on innovations that TxDOT is advancing, including those selected for round 4 of FHWA's Every Day Counts initiative, EDC-4. The stakeholders also came to hear the pitches.

Seven researchers and project team members had 8 minutes each to pitch their projects to representatives from the Texas Highway Patrol, local governments, metropolitan planning organizations, industry, and the academic community. Then everyone in the room was asked to imagine they were a venture capitalist with their own money to invest in these transportation-related innovations. TxDOT will use the input from this exercise to inform the focus of its future research.

Jeff Zaharewicz, senior advisor at FHWA's Center for Accelerating Innovation, attended the meeting. "The pitches offered attendees an opportunity to not only learn about upcoming innovation research implementation projects within the State, but also to provide input into the potential application of these projects," he says. "Another result was the formation of many new opportunities to work together to further advance the innovations. This is one way STICs can empower transportation at the local level, so that innovation comes not only in the technology deliverables, but also in getting out their ideas through collaboration."

TxDOT research project manager Sonya Badgley explains that this collaboration will help ensure smart and efficient investment on behalf of everyone in the State. "Our 'venture capital' exercise actively engaged the audience and promoted involvement in the future of our program," she says. "Some of the projects presented are approaching implementation stages, and the June meeting helped to provide real-time feedback for those efforts."

Encouraging Engagement

During a STIC workshop presentation at the 2017 annual meeting of the Transportation Research Board, Badgley said that engaging local stakeholders is one of the primary goals of the Texas STIC.

"We have an unprecedented $38 billion over the next 10 years that will be transferred through the Texas Department of Transportation," says Badgley. "We're looking forward to engaging our local stakeholders through the STIC to make sure we're making wise decisions with our public funding."

Each STIC around the country has the potential to be a platform for leveraging knowledge, expertise, and creativity from the entire transportation community. Through collaboration within the STIC network, FHWA and the States can share innovations and get them into practice more rapidly to benefit the public.

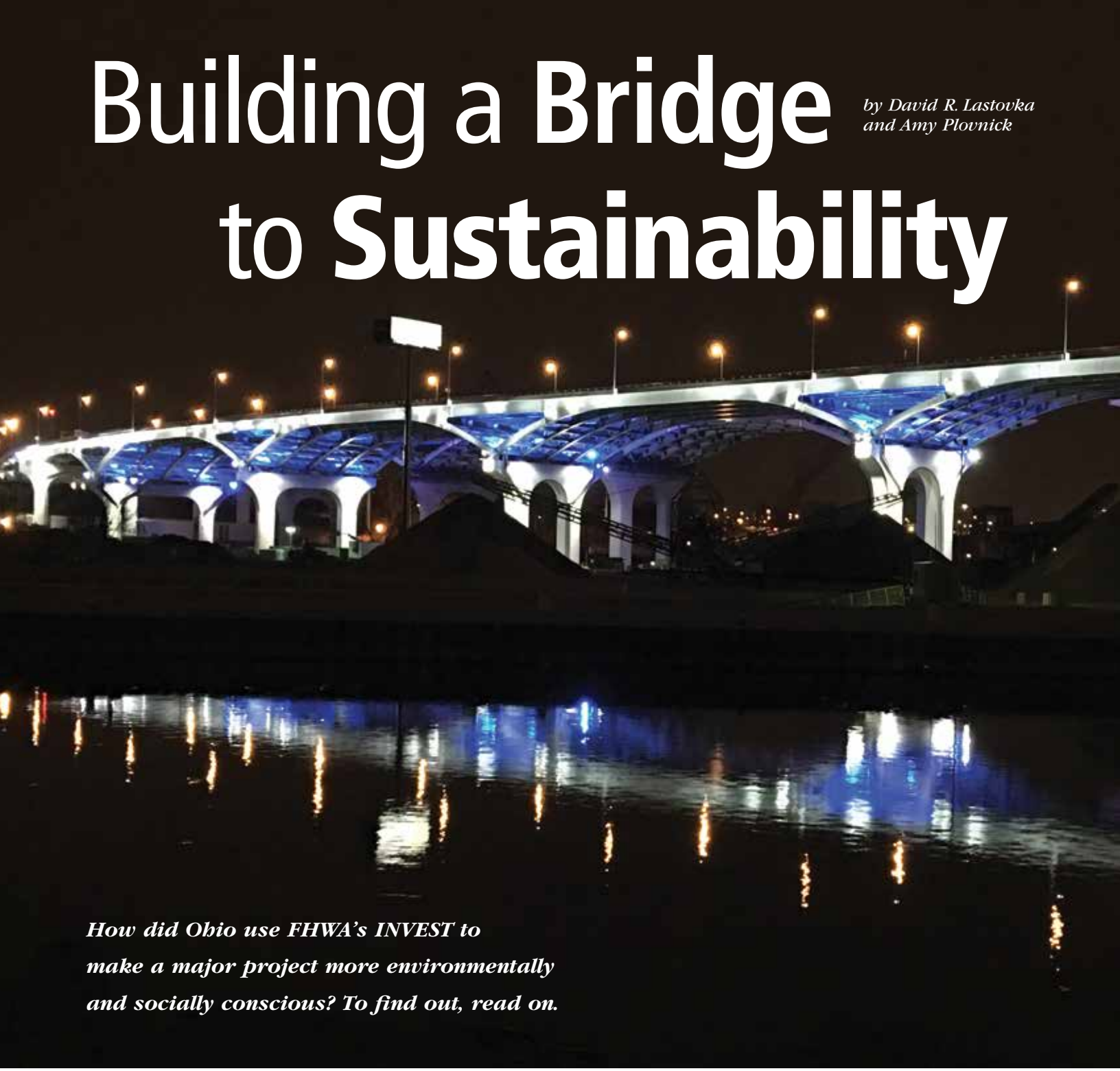
Visit www.fhwa.dot.gov/innovation/stic for more information.

Sara Lowry is a program coordinator at the Center for Accelerating Innovation, part of FHWA's Office of Innovative Program Delivery.

At a meeting of the Texas STIC in June 2017, participants completed a "venture capital" exercise that promoted involvement in transportation-related innovations.

Building a Bridge to Sustainability

by David R. Lastovka and Amy Plovnick



How did Ohio use FHWA's INVEST to make a major project more environmentally and socially conscious? To find out, read on.

By the early 2000s, a section of Interstate 90 through downtown Cleveland, OH, that had been constructed in the 1950s and 1960s was experiencing problems with pavement and bridge conditions, daily recurring congestion, and high rates of vehicular crashes. In addition, traffic volumes crossing I–90's Innerbelt Bridge had increased from approximately 119,000 per day in the 1970s to an estimated 150,000 per day in the 2000s. To address these issues, the Ohio Department of Transportation (ODOT) began studying ways to modernize the freeway to address safety, reduce congestion, and rehabilitate or replace aging infrastructure.

To add to the concerns, in 2008, an indepth inspection of the Innerbelt Bridge revealed conditions that prompted ODOT to restrict truck traffic on the bridge until emergency repairs could be completed. The condition of the bridge, even after these repairs were completed, spurred the agency to rate replacement as urgent. The phased replacement of the Innerbelt Bridge, now called the George V. Voinovich Bridge, involved constructing two new bridges (one eastbound and one westbound) to carry I–90 traffic and meet the growing transportation needs of northeastern Ohio.

Ohio used FHWA's Infrastructure Voluntary Evaluation Sustainability Tool (INVEST) to measure, track, and improve the sustainability performance of the George V. Voinovich Bridge project. The westbound span over the Cuyahoga River is shown here after completion. *Photo: ODOT.*

The two structures constituted ODOT's largest bridge project ever. The agency sought to make the project as sustainable as possible to reduce costs, maximize benefits to the community, and conserve resources. Motivated by the city of Cleveland's emphasis on sustainability, which had been demonstrated at the first annual Sustainable Cleveland Summit held in 2009, ODOT set a standard of excellence in sustainable design for its projects. The agency also aimed to highlight many of the efforts that it was already carrying out.

As ODOT was looking for a way to measure the project's sustainability performance, conversations with the Federal Highway Administration's Ohio Division Office led to discussions about FHWA's Infrastructure Voluntary Evaluation Sustainability Tool (INVEST).

"We turned to INVEST to track the sustainability performance of the project and showcase our best practices," says Myron Pakush, ODOT's District 12 deputy director.

Incorporating Sustainability Into Transportation

INVEST (www.sustainablehighways.org) is a Web-based tool for conducting self-evaluations of voluntary best practices, called sustainability criteria, that cover the full life cycle of transportation services, including system planning, project planning, design, construction, and operations and maintenance. The INVEST sustainability criteria are divided into four modules: System Planning for States, System Planning for Regions, Project Development, and Operations and Maintenance.

The total points that a project earns across the criteria determine its achievement level (bronze, silver, gold, and platinum), which serves as a relative benchmark for its sustainability accomplishments. For example, to reach the platinum achievement level in the Project Development module, a project must receive 76 points.

The INVEST criteria help transportation agencies consider the "triple bottom line" of sustainability-related social, environmental, and economic considerations. INVEST also encourages projects to go beyond what is required for federally funded programs or projects and to pursue innovative and ambitious sustainability strategies.

For the George V. Voinovich (Innerbelt) Bridge, ODOT used INVEST's Project Development module, which is used to evaluate projects from early planning through construction.

Retrospective INVEST Evaluation

The first phase of the replacement of the Cleveland bridge involved construction of the westbound bridge, which was completed in 2013. ODOT began the second phase, design and construction of the eastbound bridge, in 2014 and expects to finish in fall 2018. Early in the first phase, ODOT established seven categories of sustainability goals to be achieved during construction. Known collectively as the Green 7, the goals relate to (1) energy and energy efficiency, (2) community environment, (3) green building, (4) waste reduction and recycling, (5) green project administration, (6) materials and resources, and (7) construction practices.

Crews ready the new westbound bridge for the final concrete pour for the new driving surface. *Photo: Cleveland Innerbelt Flickr.*

Phase I Achievements

Saved more than **100,400 gallons (380,000 liters)** of diesel fuel

Saved **22 million gallons (83 million liters)** of water

Prevented more than **125,100 cubic yards (95,600 cubic meters)** of waste from entering landfills

It was only after completion of phase I that ODOT first used INVEST to validate the project's sustainability achievements in reaching the Green 7 goals. The evaluation determined that the first phase met and, in some cases, even exceeded those goals. The phase I project scored 59 points on the pilot test version of the INVEST Project Development module, achieving gold level. Notably, the project accomplished the following:

- Saved more than 100,400 gallons (380,000 liters) of diesel fuel with earthwork and recycling efforts—enough to power a big-rig from Cleveland to Salt Lake City and back 145 times.
- Recycled more than 5.65 million pounds (2.56 million kilograms) of steel—about the weight of 1,414 average-size sedans.
- Saved 22 million gallons (83 million liters) of water—enough to power a shower around the clock for almost 8 years.
- Prevented more than 125,100 cubic yards (95,600 cubic meters) of waste from entering landfills—more than twice the concrete it took to build FirstEnergy Stadium, home of the Cleveland Browns.

Prospective INVEST Evaluation

For phase II, the eastbound bridge, ODOT was able to use INVEST prospectively. The agency incorporated INVEST into the evaluation criteria for the contracting process and used the tool's scoring to keep track of sustainability progress at decision points throughout the project's planning and construction.

In 2013, ODOT issued a request for proposals for a value-based design-build contract for phase II. The request required the contractor to develop a sustainability plan and use INVEST to demonstrate sustainability achievements. ODOT asked contractors to state in their proposals how many INVEST points they could deliver and to commit to achieving a certain sustainability level. ODOT considered sustainability as part of the technical score for each proposal, representing 5 out of a possible 100 points.

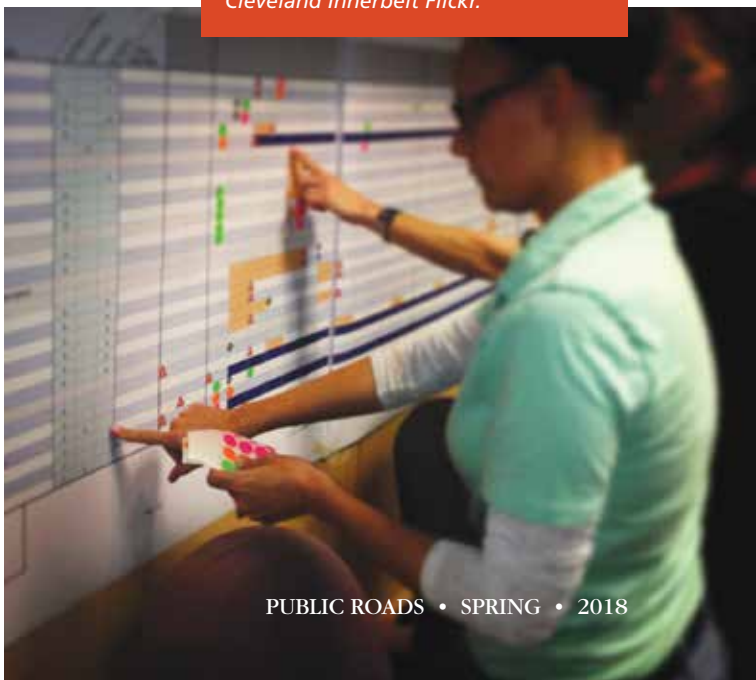
"When FHWA developed INVEST, we believed that it would help State departments of transportation learn about the importance of sustainability and what types of sustainable practices could be implemented to improve their transportation systems and programs," says Mike Culp, team leader of FHWA's Sustainable Transportation and Resilience Team. "The decision by ODOT to make sustainability in general, and INVEST in particular, an integral part of its contracting process has gone beyond even our own expectations of how INVEST can be used and how beneficial it can be. ODOT's approach was a creative and innovative application of our tool that has become a model for other State DOTs to follow."

ODOT selected the winning contractor team using a best value formula with price contributing to 70 percent of the final score, schedule 10 percent, and technical score 20 percent. The winning contractor committed in its technical proposal to achieving 95 INVEST points out of a possible 118, higher than the 76 points necessary for a platinum achievement level. The contractor bid $273 million, which was $19 million below the ODOT official engineering estimate. As such, the value-based design-build process yielded a winning proposal with higher sustainability and lower cost than the department had estimated.

Collaborative and Ongoing INVEST Scoring

After the award of the project, the contractor, ODOT, and FHWA held an eco-charrette to discuss how to implement sustainability practices during phase II using INVEST. At the eco-charrette, the contractor and ODOT formed breakout groups based on subject matter expertise, and the groups reviewed the INVEST Project Development criteria. Looking at each scoring criterion, the groups determined whether the likelihood of obtaining points

In January 2014, ODOT, the project contractor, and FHWA held an eco-charrette to determine how to better incorporate sustainability into phase II of the George V. Voinovich Bridge project. *Photo: Cleveland Innerbelt Flickr.*



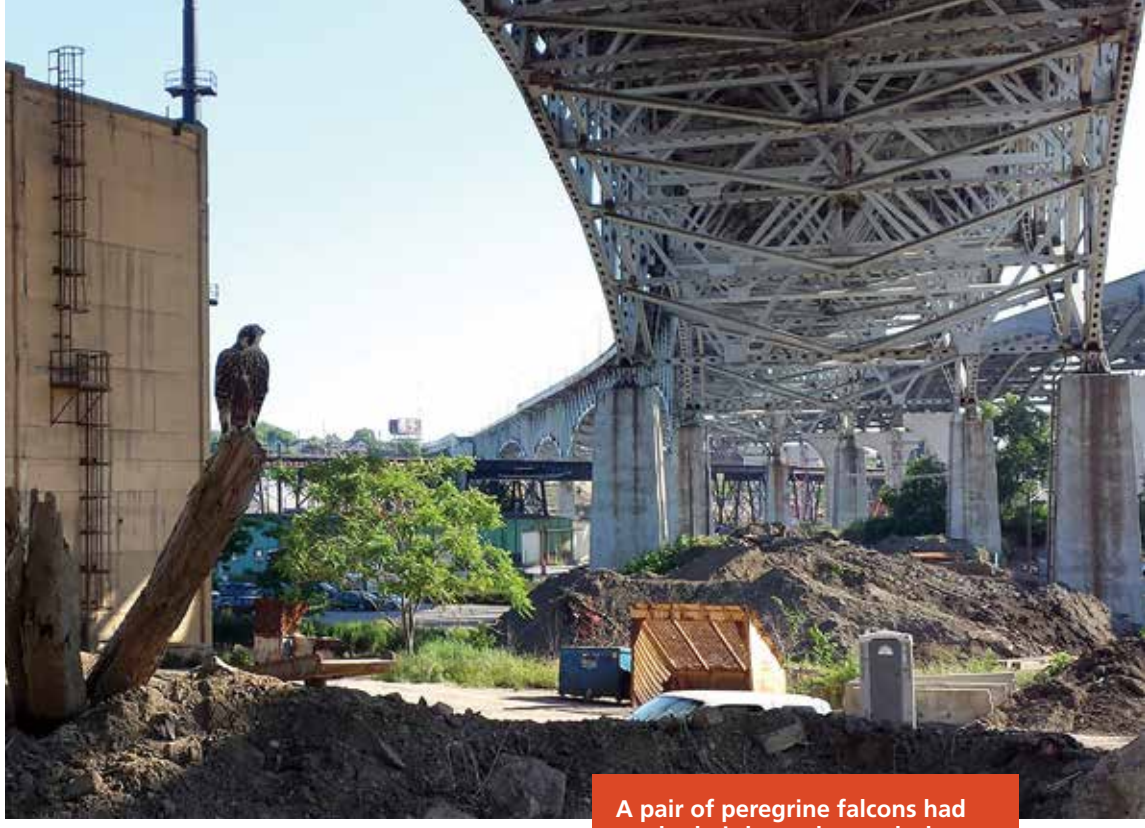
for the project was *Yes* (it is in the project), *Probable Yes* (it is likely and under consideration), *Probable No* (it is unlikely but still under consideration), or *No* (it has been evaluated and is not in the project or is not applicable).

The eco-charrette participants identified responsible parties to follow up on action items after the workshop to help gather any necessary information to finalize each scoring criterion. Because the project was design-build, many scoring items could not be fully scored until later in the project. By bringing together all of the key stakeholders from the contractor and ODOT to walk through INVEST's nationally vetted sustainability criteria, the eco-charrette enabled the team to integrate sustainability into the numerous decisions to be made during the project's design and construction.

At the end of the eco-charrette, the project stood at 67 *Yes* points, 22 *Probable Yes* points, and 17 *Probable No* points. This meant that for the project to achieve a platinum score (76 points minimum), the team would need to move 9 of the *Probable Yes* points to *Yes* over the course of the design and construction. For the team to achieve the contractor's original goal of earning 95 points, the team would need to move all 22 *Probable Yes* and 6 *Probable No* points to *Yes*.

As the project progressed, the team met every 6 months to re-score the project using INVEST to track progress toward sustainability goals. To ensure that each criterion was addressed at the optimal time, the contractor developed a sustainability schedule intended to overlay the project schedule. The schedule highlighted action items and key dates to ensure that the team made efficient use of time and did not miss windows of opportunity to fulfill INVEST criteria.

Based on the final scoring workshop in August 2016, the team determined that the project should receive 95 points, achieving the committed platinum scoring level and the contractor's goal.



A pair of peregrine falcons had made their home beneath the old Innerbelt Bridge. The project team worked with the Ohio Department of Natural Resources to construct a new habitat for relocation of the birds prior to the demolition of the bridge. *Photo: Cleveland Innerbelt Flickr.*

"We were surprised, and somewhat skeptical, when the contractor committed to reach the INVEST platinum level on the project," says Pakush. "We knew that achievement level was going to take a lot of work, and quite a bit of project collaboration. We think the project team was challenged by our initial skepticism. The team worked very hard, and I am happy to say that they achieved the platinum level status—the highest level attainable under the INVEST program."

George V. Voinovich Bridge: Sustainability Accomplishments

Phase II of the George V. Voinovich Bridge project incorporated a number of exemplary sustainability strategies and scored highly in many INVEST Project Development (PD) criteria, some of which are highlighted below.

PD-07 Habitat Restoration. The Innerbelt Bridge, before it was demolished, hosted a known peregrine falcon nest. Prior to the demolition, the project team worked with the Ohio Department of Natural Resources to construct a new habitat where the birds could be relocated. The project also restored natural river function and improved habitats for fish whose life cycles demand that they migrate downstream. The improved habitats involved constructing a "green" bulkhead wall along the Cuyahoga River to provide food, shelter, and oxygen for the fish.

PD-08 Stormwater. The project improved water quality and the management of stormwater runoff, using technology that mimics natural hydrology. The enhancements included detention ponds and biofilter swales for treatment of stormwater. The contractor treated all of the runoff from the construction areas, and that treated area is significantly greater than any impervious area added by the project.

PD-17 Energy Efficiency. By using LED lights for all of the lighting on the bridge, the project reduced the lighting system's energy consumption while still meeting safety standards. The switch to LED lighting reduced the bridge's energy use by 57 percent.

PD-19 Reduce and Reuse Materials. ODOT reused or recycled 100 percent of the materials from the old Innerbelt Bridge. In all, the phase II project reused more

ODOT recycled more than 26 million pounds (11.7 million kilograms) of concrete during phase II of the project. Here, crews removed the concrete driving surface from the old Innerbelt Bridge. *Photo: Cleveland Innerbelt Flickr.*

Summary of INVEST Scoring for Phase II of the Innerbelt Project

Criteria	Score	Maximum Possible Score
PD-01: Economic Analyses	5	5
PD-02: Life-Cycle Cost Analyses	1	3
PD-03: Context Sensitive Project Delivery	5	5
PD-04: Highway and Traffic Safety	8	10
PD-05: Educational Outreach	2	2
PD-06: Tracking Environmental Commitments	5	5
PD-07: Habitat Restoration	3	3
PD-08: Stormwater	8	9
PD-09: Ecological Connectivity	3	3
PD-10: Pedestrian Access	2	2
PD-11: Bicycle Access	2	2
PD-12: Transit & HOV [High-Occupancy Vehicle] Access	2	5
PD-13: Freight Mobility	4	7
PD-14: ITS [Intelligent Transportation Systems] for System Operations	5	5
PD-15: Historical, Archeological, and Cultural Preservation	3	3
PD-16: Scenic, Natural, or Recreational Qualities	3	3
PD-17: Energy Efficiency	4	8
PD-18: Site Vegetation	2	3
PD-19: Reduce and Reuse Materials	8	8
PD-20: Recycle Materials	2	8
PD-21: Earthwork Balance	3	3
PD-23: Reduced Energy and Emissions in Pavement Materials	3	3
PD-25: Construction Environmental Training	1	1
PD-26: Construction Equipment Emission Reduction	2	2
PD-27: Construction Noise Mitigation	1	2
PD-28: Construction Quality Control Plan	5	5
PD-29: Construction Waste Management	3	3
Total	**95**	**118**

Source: ODOT, www.sustainablebigbways.org/files/3647.pdf.
Note: PD-22 Long Life Pavement Design and PD-24 Contractor Warranty were not used for this project.

than 4.6 million pounds (2 million kilograms) of rebar and more than 26 million pounds (11.7 million kilograms) of concrete. In addition, the project preserved existing pavement where possible, refurbished the bearings on one of the bridges to reduce the need for new materials, and used slag (an industrial byproduct) in the concrete mix used for the bridge.

Next Steps

"We hope to continue using INVEST on ODOT projects in the future," says Pakush. In fact, ODOT District 12 plans to use INVEST to track sustainability improvements on two upcoming projects.

One project, an estimated $228 million rehabilitation of the I-480 bridge over the Cuyahoga River, 7 miles (11 kilometers) south of downtown Cleveland, was awarded in October 2017. ODOT used a two-step, low-bid, design-build process for the contract. The design-build team is required to use

the INVEST process and to track sustainability practices through the life of the project to meet at least the INVEST silver rating.

The second, section 3 of the Opportunity Corridor Project, is an estimated $200 million new roadway alignment project within the city limits of Cleveland. The Opportunity Corridor Project is a community partnership to develop a planned boulevard that will run from East 55th Street at I–490 to East 105th Street in University Circle. For section 3 of the project, which will be awarded in 2018, ODOT plans to use a value-based design-build process, and teams will be required to use FHWA's INVEST or the Envision rating process of the Institute for Sustainable Infrastructure to track sustainability practices through the life of the project. Teams will be required to meet at least a silver sustainability rating in their selected rating system.

"ODOT's use of INVEST helped them integrate sustainability throughout the project development process, from design through construction, as well as in contracting," says FHWA's Culp. "It is encouraging to see ODOT use the lessons learned from the George V. Voinovich Bridge project to expand the use of INVEST to other projects. Using INVEST, ODOT and other transportation agencies can measure the sustainability impact of their projects and strive to build transportation infrastructure that is cost-effective, long-lasting, and minimizes environmental impacts."

David R. Lastovka, P.E., is the project manager for Cleveland's Innerbelt Project at ODOT District 12. Lastovka is responsible for overall project management for the proposed $2 billion reconstruction of I–90 in downtown Cleveland. He has a bachelor of science degree in civil engineering from Ohio State University and has been with ODOT for 25 years.

Amy Plovnick is a community planner at the U.S. Department of Transportation's Volpe Center. Her work involves research, coordination, and policy analysis for projects related to resilience, sustainability, active transportation, and transportation planning. Plovnick has a master's degree in city planning from the Massachusetts Institute of Technology and a bachelor's degree in political science and environmental studies from Washington University in St. Louis.

For more information see www.sustainablehighways.org/779/94/ohio-dot-george-v-voinovich-bridge cleveland-innerbelt-corridor.html and www.dot.state.oh.us/projects/ClevelandUrbanCoreProjects/Innerbelt/InnerbeltBridge/NewsInformation/Pages/SustainabilityInitiatives.aspx, or contact Amanda McFarland at 216-584-2005 or amanda.mcfarland@dot.ohio.gov.

Shown here is a view of the eastbound bridge from East 9th Street. The bridge includes this decorative monument facing a city street. *Photo: Cleveland Innerbelt Flickr.*

Rolling Out Pavement Technologies

by Gina Ahlstrom

Innovative approaches to construct and maintain roadway surfaces have the potential to save money and improve performance. FHWA is facilitating their use across the country.

Today's highway users expect a high-quality traveling experience on roads that are safe and well maintained with the least possible delay. The Federal Highway Administration plays a leadership role in ensuring that innovative technologies that can improve the safety and performance of the transportation system are deployed and implemented on the Nation's roadways.

One way FHWA is leading the way is through the Accelerated Implementation and Deployment of Pavement Technologies (AID-PT) program. Congress established the program in 2012 under the Moving Ahead for Progress in the 21st Century Act (MAP-21). The purpose is to document, demonstrate, and deploy innovative pavement technologies, including their applications, performance, and benefits. In 2015, Congress continued the AID-PT program in the Fixing America's Surface Transportation (FAST) Act, with funding available through fiscal year 2020.

Central to the AID-PT program are various technology transfer and outreach efforts that deliver insights, experience, and practices to the transportation community through meaningful and cost-effective strategies, ranging from site reviews, demonstrations, and webinars to guidance documents. Transportation agencies have implemented a number of technologies in areas such as concrete overlays, asphalt pavement durability, and sustainability.

Ongoing Initiatives

In its AID-PT 2016–2017 annual report, FHWA highlights case studies that discuss the anticipated long-term improvements in cost savings, project delivery time, congestion relief, enhanced safety, and pavement performance because of the program. Specifically, FHWA is engaged in a variety of efforts

The Wisconsin Department of Transportation is constructing experimental sections on State Highway 21, near Necedah, WI, as part of a demonstration project to evaluate the performance of asphalt pavements with increased compaction density. Here, a material transfer vehicle helps move asphalt mixture from the delivery truck to the paver at a uniform temperature.
Photo: WisDOT.

to improve paving materials and deliver guidance to help highway agencies design and construct both asphalt and concrete pavements more effectively.

Examples of ongoing initiatives include the following:

- Encouraging implementation of the methodology described in the *Mechanistic-Empirical Pavement Design Guide* published by the American Association of State Highway and Transportation Officials. Fourteen highway agencies have implemented the procedure for asphalt pavements, while another 31 plan to implement. For concrete pavements, 13 agencies have implemented, and another 32 plan to do so.
- Increasing the use and application of recycled concrete aggregate in new and reconstructed pavements and the use of ground tire rubber in asphalt pavements. These practices not only save on costs but also support an overarching focus on sustainability and reduce the impact of pavements on the environment.
- Improving construction processes for asphalt pavements, particularly in the use of more effective compaction practices that lead to longer lasting pavements at little to no additional cost.
- Advancing and promoting approaches in the design of both asphalt and concrete pavement mixtures that focus on extended performance and long-term durability.

With strong stakeholder support, the AID-PT program is providing benefits ranging from shorter project delivery times and less congestion to cost savings and fewer roadway fatalities.

Gaining Ground

FHWA highlights concrete overlays in its AID-PT report because of its growing popularity as a sustainable, cost-effective solution for maintaining and preserving pavements. Using a concrete overlay to rehabilitate an existing pavement offers benefits that include extending service life, increasing structural capacity, reducing maintenance, and lowering life-cycle costs.

FHWA's Concrete Overlay Field Application Program, administered by the National Concrete Pavement Technology Center (CP Tech Center) at Iowa State University, addresses questions often posed regarding this technology, including when and where to use concrete overlays and considerations for design and construction.

"The goal of the program is to provide technical assistance to agencies in the overall concrete overlay process, from the selection of candidate projects through the design and construction of the project itself," says Dale Harrington, a civil engineer at Snyder and Associates, the firm that oversees the program for the CP Tech Center.

In other words, the goal is to increase awareness and knowledge among State departments of transportation and local agencies, contractors, and engineering consultants regarding how to apply concrete overlays successfully.

Sample Results from the AID-PT Program

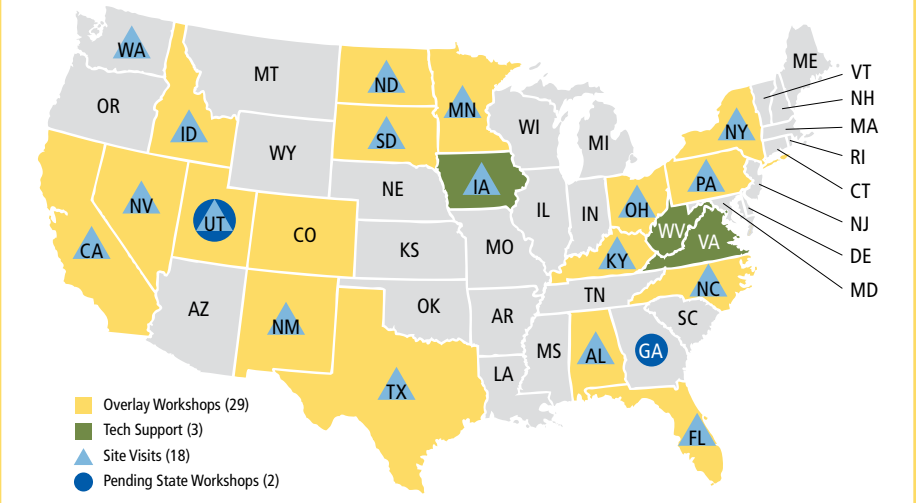
The AID-PT program is having significant impacts on highway practices:

- As a result of a demonstration project on density, 7 of the 10 participating States are revising their specifications to help improve the performance of asphalt pavements.
- Forty-four State highway agencies now allow use of recycled concrete aggregate for applications ranging from granular base and embankment fill to coarse aggregate.
- Thin asphalt overlays have been shown to be effective in preserving asphalt pavement structures while offering cost savings of up to 30 percent over traditional mixes.
- The use of concrete overlays continues to grow as a rehabilitation treatment for existing concrete and asphalt pavements, with more than 4 million square yards (3.3 million square meters) placed in 2016.

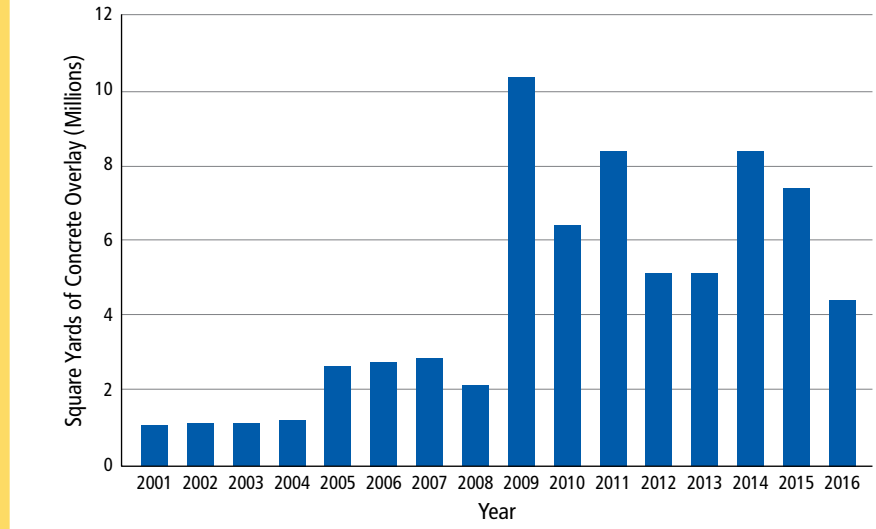
Types of Overlay Solutions

Crews can apply either bonded or unbonded concrete overlays on top of existing asphalt, composite, and concrete pavements. If the existing pavement is in good structural condition, bonded concrete overlays can eliminate surface distress or add structural capacity. This approach requires crews to take specific steps to bond the new overlay to the existing pavement so it behaves as a single structure.

If the existing pavement has moderate to severe deterioration, unbonded concrete overlays may be used to restore structural capacity. The new overlay is separate from the existing pavement to ensure that the distress in the underlying pavement does not affect the performance of the new overlay.



The Concrete Overlay Field Application Program has provided workshops, technical support, and site visits at these locations across the United States. Some States have hosted multiple workshops. *Source: Dale Harrington, CP Tech Center.*



Use of concrete overlays peaked in 2009 and has continued at a much higher rate than the previous decade. *Source: Dale Harrington, CP Tech Center.*

Seeing Results

Participants in the Concrete Overlay Field Application Program gain first-hand knowledge of overlay solutions, enabling their agencies to reap both technical and financial dividends.

"The Concrete Overlay Technical Assistance Program reviewed a 17-mile [27-kilometer] project on I–85 in North Carolina," says Clark Morrison, State pavement design engineer with the North Carolina Department of Transportation (NCDOT).

The existing pavement was a 50-year-old jointed concrete with numerous asphalt patches. NCDOT selected an unbonded concrete overlay. The team from the CP Tech Center visited the site and conducted a workshop with NCDOT engineers. Two recommendations resulted from the workshop: (1) to leave most of the existing asphalt patches in place, and (2) to use drainage fabric in lieu of a permeable asphalt drainage course—resulting in significant savings in both construction costs and time. Morrison estimates that the cost savings in full-depth repairs alone were at least $3.25 million.

Adoption of concrete overlays is on the rise in other highway agencies too, according to Harrington, at the CP Tech Center. "In the last several years, we've seen a significant increase in the use of concrete overlays," he says. "From September 2013 through September 2016, 11 different State DOTs who received the concrete overlay training constructed more than 115 concrete pavement overlay projects, representing more than $750 million in construction costs."

As more agencies gain a working knowledge of concrete overlays and experience with the technology, FHWA officials expect its use as a pavement preservation and rehabilitation alternative to grow.

A number of resources are available to assist highway agencies in evaluating and applying concrete overlay solutions. Guidebooks, technical briefs, documentation of case studies, and training are just some of the resources available that cover all aspects of concrete overlays—from selection to design to construction—and for a range of applications, including highways, urban streets, and parking lots.

For more information, visit www.cptechcenter.org/research/research-initiatives/overlays.

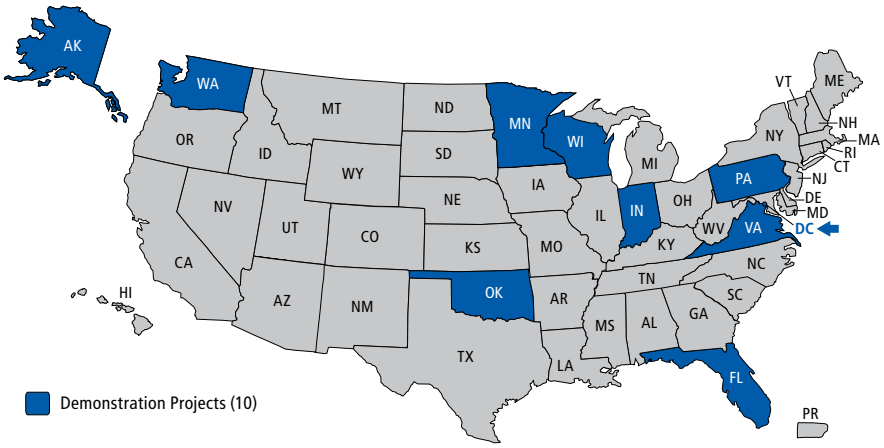
Increased Density, Improved Durability

Also highlighted in FHWA's annual AID-PT report is the importance of asphalt density in the more than 9.6 million lane miles (15.4 million kilometers) that make up the U.S. highway network—one of the country's largest assets. Keeping the system in good working order comes at a high cost. In its report to Congress, *2015 Status of the Nation's Highways, Bridges, and Transit: Conditions & Performance* (FHWA-PL-17-001), FHWA estimates that the average annual investment needed between 2013 and 2032 to maintain the condition and performance of the Nation's highway system as a whole is $89.9 billion.

Any improvements in the performance of pavement structures would help reduce the magnitude of that required annual investment. For asphalt pavements, one simple, straightforward, and relatively low-cost means of improving performance is by achieving

The Pennsylvania Department of Transportation employed these three vibratory steel wheel roller compactors operating in an echelon formation to help achieve increased density targets for its demonstration test sections. *Photo: Victor (Lee) Gallivan, Gallivan Consulting Inc.*

States Hosting In-Place Density Demonstration Sites



Source: FHWA.

higher density levels during construction. Higher levels of asphalt density improve the pavement's durability, extend the service life, and delay future rehabilitation and reconstruction activities.

The Appeal of Compaction

Over the years, innovations and advancements in equipment, techniques, and technology have increased pavement performance and reduced costs. Today, engineers know that combining controlled compaction with higher in-place pavement density can have a dramatic effect on the performance of asphalt pavements.

Studies have shown that increasing the density and reducing the air void content of asphalt pavements results in lower permeability, increased resistance to load-related cracking and rutting, and, ultimately, a longer pavement life. For example, one study by researchers with the National Center for Asphalt Technology at Auburn University found that an increase in compaction resulting in a 1-percent decrease in the air void content can provide an 8- to 44-percent increase in fatigue life and a 7- to 66-percent increase in rutting performance, based on both laboratory and field data.

Comparing the estimated lifecycle cost of an asphalt pavement overlay constructed at 92 percent of maximum theoretical density to a similar overlay constructed at 93 percent shows the potential savings made possible by increasing the minimum required in-place density by only 1 percent. Using a conservative 10-percent increase in service life, the FHWA-sponsored report *Enhanced Compaction to Improve Durability and Extend Pavement Service Life: A Literature Review* (NCAT Report No. 16-02) cites a cost savings in net present value of $88,000 on a $1 million paving project.

Contractors have the ability to achieve higher densities through increased compaction, but excessive compaction may damage the pavement. Fortunately, recent improvements such as warm-mix asphalt technologies (which improve mixture workability), intelligent compaction, high-tech pavers, and quality control processes have made it possible to achieve higher in-place density while avoiding that risk. And, unlike other methods to achieve increased pavement performance that involve costlier materials or construction practices, additional in-place pavement density does not add significantly to the cost in order to gain substantial performance improvement.

The Minnesota Department of Transportation used roller compactors, shown here, equipped with intelligent compaction instrumentation to monitor the densification of its test sections. *Photo: MnDOT.*

FHWA Launches a Demonstration Project

In 2016, after recognizing the importance of in-place density in building cost-effective, long-lasting asphalt pavements, FHWA initiated a demonstration project called Enhanced Durability Through Increased In-Place Pavement Density. The objective was to demonstrate that the in-place density required to improve the performance of asphalt pavement could be achieved without a significant increase in construction costs. Through an application process, FHWA selected 10 States to construct test sections and participate in the demonstration.

At each demonstration site, crews constructed one standard section as a control and one or two test sections with increased density. Each State also constructed additional test sections with alternative approaches for improving the pavement density. These alternatives involved a number of recent technological improvements, such as warm-mix asphalt, intelligent compaction, rolling density meters, and infrared imaging. Other alternatives tested included the more conventional changes in practice such as additional roller compactors, material transfer vehicles, and improvements to asphalt mixture design, material selection, and quality assurance plans.

From all accounts, the demonstration project has been a success. The key finding was that crews could effectively improve in-place density, with 8 of the 10 States achieving increased densities by at least 1 percent on their projects.

Goal Areas in FHWA's Sustainable Pavements Program Road Map

Source: FHWA/APTech.

The methods found to achieve increased density fell into five basic categories that can serve as a checklist for highway agencies to investigate:

1. Improve specifications to either include incentives or increase existing incentives for contractors to achieve higher in-place densities.
2. Adjust mixture designs to obtain slightly higher asphalt contents.
3. Strive for greater consistency in mixture temperatures, paver speeds, and roller patterns.
4. Follow best construction practices.
5. Employ new technologies such as warm-mix asphalt, infrared imaging, rolling density meters, and intelligent compaction.

Workshops on Best Practices

Key to the success of the demonstration projects was the partnership that FHWA established with industry, as well as the State highway agencies and contractors in the participating States. The National Center for Asphalt Technology and the Asphalt Institute provided workshop training, assistance with mixture designs and preconstruction meetings, construction monitoring, and documentation support. The primary goal of the workshops was to present best practices for achieving pavement compaction without resorting to the use of additional compaction equipment or higher cost compaction technology.

The feedback on the 1-day workshop from the participating States was so positive that the workshop was later delivered to an additional 18 States. Together, more than 1,400 participants from Federal and State transportation agencies and industry organizations benefitted from the training.

"The funding and workshop provided by FHWA were instrumental in [the Wisconsin Department of Transportation (WisDOT)] prioritizing an enhanced density demonstration project," says Barry Paye, chief materials engineer at WisDOT, one of the participants in the FHWA demonstration project. "The information gained from this demo enabled WisDOT to update our density specifications for the 2017 construction season, a year or two ahead of what we had originally planned. The 1- to 1.5-percent increase in density will result in 10 percent or greater gains in pavement life. The return on FHWA's $50,000 incentive and workshop will be great for Wisconsin."

For more information on the findings of the demonstration projects, visit http://eng.auburn.edu/research/centers/ncat/files/technical-reports/rep17-05.pdf.

Toward Sustainable Pavements

Another highlight in the AID-PT annual report is FHWA's Sustainable Pavements Program. This program supports highway agencies as they work to meet environmental, social, and economic goals. The program aims to advance the knowledge and practice of designing, constructing, and maintaining more sustainable pavements through stakeholder engagement, education, and the development of guidance and tools.

The program defines a sustainable pavement as one that fits the location and climate, uses locally available materials when possible, and meets an agency's design and performance goals. With the help of a technical working group, FHWA's Sustainable Pavements Program is putting knowledge into action. Here is a closer look at some of the program's major activities.

Engaging the Stakeholders

At the heart of the program is the Sustainable Pavements Technical Working Group. With 20 members representing Federal, State, and local transportation agencies, as well as industry and academia partners, and more than 300 "friends," the working group provides overall technical input for the program and helps raise awareness of sustainability issues among pavement professionals.

The group meets twice a year to share information through technical presentations, reviews of technical documents, and breakout and roundtable discussions. Recent meetings have covered such topics as pavement life-cycle assessment and pavement-vehicle interaction.

According to Leif Wathne, executive vice president of the American Concrete Pavement Association and a member of the working group, "The Sustainable Pavements Program has been exceedingly fruitful in bringing together stakeholders and engaging in meaningful dialogue on all issues related to pavement sustainability."

Defining the Playing Field

To provide best practices and hands-on guidance, FHWA has produced a variety of reference materials and training opportunities. The program's hallmark deliverable is *Towards Sustainable Pavement Systems: A Reference Document* (FHWA-HIF-15-002). The document provides an overview of key concepts and advice on how to make paving practices more sustainable. For example, it encourages agencies to consider the entire life cycle, from mining the materials and transporting them to the site through the design, construction, use phases, and end of the pavement's life. It also advises agencies to recognize that there is no one-size-fits-all approach to pavement sustainability; to embrace tradeoffs between economic, environmental, and societal factors; and to aspire to improve sustainability from project to project over the long term.

The Sustainable Pavements Program also developed a framework

for assessing the life-cycle environmental impacts of pavement systems. *The Pavement Life Cycle Assessment Framework* (FHWA-HIF-16-014) is an important first step in the implementation and adoption of life-cycle assessment principles. Highway agencies and pavement and materials professionals are using this document to help guide the development of life-cycle assessment tools.

For example, Amlan Mukherjee, Ph.D., associate professor of civil and environmental engineering at Michigan Technological University, used the document to prepare a product category rule and environmental product declaration for the asphalt pavement industry. "The life-cycle assessment framework identifies all the interrelated components that are relevant to design, construction, and maintenance of pavements," Mukherjee says. "When conducting the life-cycle assessment for asphalt mixtures, the framework was used to consider all factors relevant to asphalt pavements. This ensures that asphalt environmental product declarations can integrate seamlessly with other pavement life-cycle assessment components and, in the long run, allows them to be used by agencies for pavement design and construction decisionmaking purposes."

A Road Map for the Future

FHWA recently developed a strategic *Sustainable Pavements Program Road Map* (FHWA-HIF-17-029) that provides a focused direction for 2015–2020. The road map highlights topics and deliverables that can have a meaningful effect on advancing sustainability considerations within the pavement community. The contents are organized into four broad goal areas, each of which includes processes and actions that advance the state of the practice toward sustainability. For more information, visit www.fhwa.dot.gov/pavement/sustainability/hif17029.pdf.

Putting Knowledge Into Practice

Adopting more sustainable practices yields a variety of benefits, not just for the environment but also for agencies' bottom lines. For example, in the reconstruction of the Jane Addams Memorial Tollway (I–90), the Illinois Tollway documented the reuse of nearly 1.2 million tons (1.1 million metric tons) of recycled materials, including aggregate and both asphalt and concrete pavements, from the project site. Similarly, the Illinois Department of Transportation documented the recycling of more than 2 million tons (1.8 million metric tons) of materials during the 2015 construction season. Recycling and reusing materials reduces the demand for virgin materials and the related transport and energy costs.

Reusing materials also yields significant environmental benefits and cost savings at the national level. According to a survey conducted by FHWA and the National Asphalt Pavement Association, during the 2016 construction season more than 76.9 million tons (69.7 million metric tons) of reclaimed asphalt pavement and nearly 1.4 million tons (1.3 million metric tons) of recycled asphalt shingles were put to use in new pavements in the United States, saving taxpayers more than $2.1 billion compared to the cost of using traditional paving materials. Further, the American Road & Transportation Builders Association estimates that the use of fly ash—a byproduct of coal-burning power plants—as a replacement for cement in concrete paving mixtures saved $2.3 billion over a 5-year period.

The Sustainable Pavements Program will continue to support highway agencies as they incorporate sustainability considerations in their day-to-day operations. On the horizon, FHWA plans to produce additional guidance documents, create a simple life-cycle assessment calculator, and develop case studies highlighting best practices for sustainable pavements.

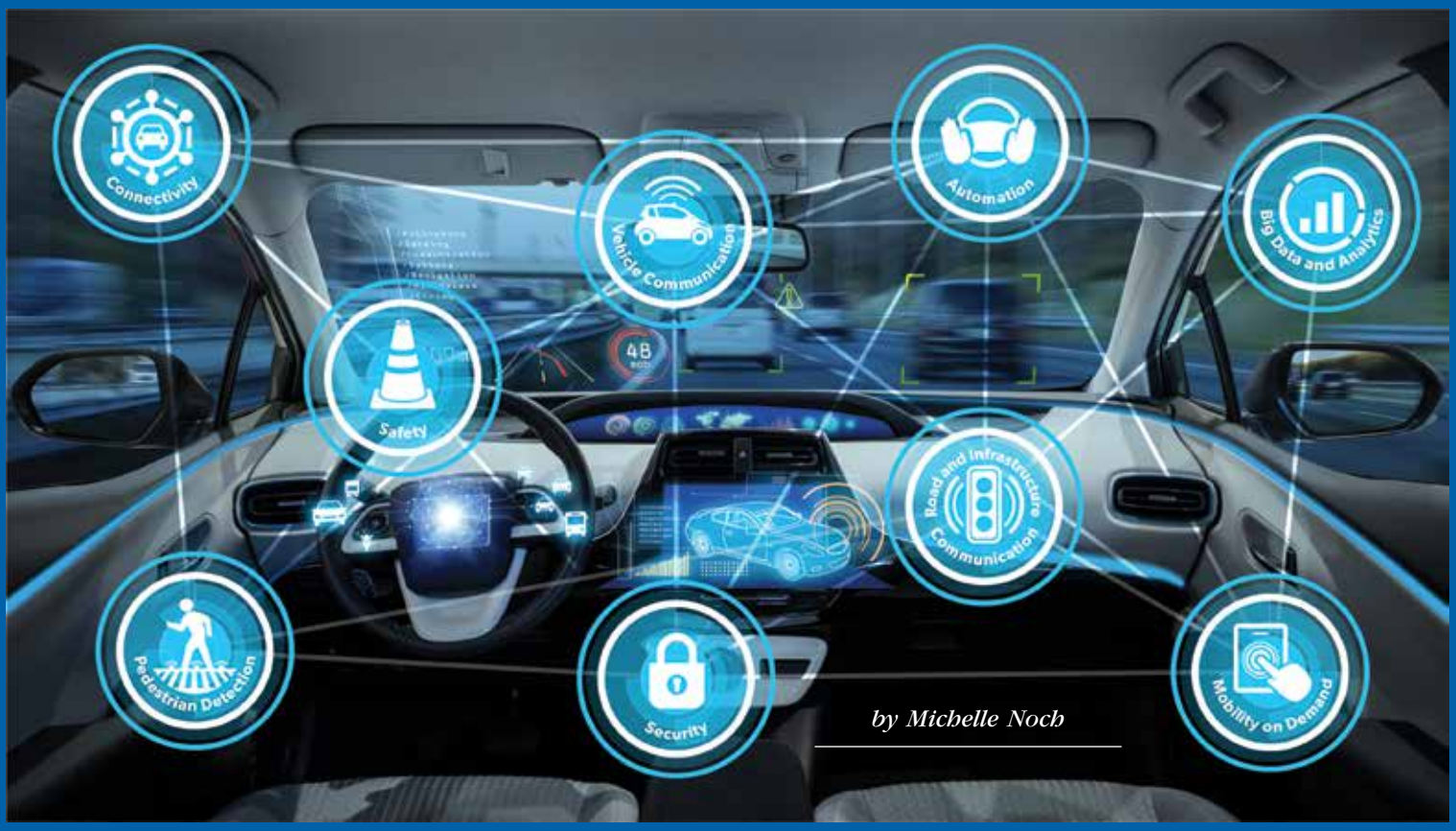
Through strategic partnerships with highway agencies and others across the paving community, FHWA is leveraging Federal investments to maximize the impact of the AID-PT program and amplifying the benefits to the traveling public. The full AID-PT report is available at www.fhwa.dot.gov/Pavement/pubs/hif17047.pdf.

Gina Ahlstrom is the pavement materials team leader at FHWA in Washington, DC. She is responsible for policies, standards, technical and program assistance, and deployment of innovative technologies. She received a B.S. in civil engineering from the Pennsylvania State University and an M.S. in civil engineering from the University of Maryland, College Park.

For more information, visit www.fhwa.dot.gov/pavement or contact Gina Ahlstrom at 202-366-4612 or gina.ahlstrom@dot.gov.

Two-lift concrete paving, as shown here, uses a higher percentage of recycled or marginal aggregate in a thicker bottom layer, while reserving more durable material for the thinner surface layer. This method improves the sustainability of the pavement without compromising performance. *Photo: APTech.*

Are We Ready for Connected and Automated Vehicles?



by Michelle Noch

Through an ITS training program, USDOT is seeing to it that transportation workers are prepared for the new world.

The Nation's transportation system is accelerating toward a trailblazing transformation. Technological advances such as connected and automated vehicles that were once deemed in the realm of science fiction are becoming a tangible reality. Innovative connected and automated vehicles are merging the physical and digital worlds of transportation and yielding new opportunities to improve the safety, mobility, and efficiency of the U.S. transportation system.

"Successful deployment and operation of these new technologies depend largely on a knowledgeable, trained, and skilled workforce to support them," says Egan Smith, managing director of the Intelligent Transportation Systems (ITS) Joint Program Office in the U.S. Department of Transportation. "One cannot advance without the other."

To fully capitalize on the technological innovations and ensure successful deployment, the current and future transportation workforce must advance and evolve. The USDOT staff in the ITS Joint Program Office understands this need. For more than 20 years, the Joint Program Office has led efforts to offer a variety of learning opportunities to the current and emerging workforce to support successful ITS deployments and more efficient operations. The Professional Capacity Building Program, housed within the Joint Program Office, is the Department's primary vehicle for educating transportation professionals about ITS technologies. The vision is to prepare transportation industry professionals for a connected and automated transportation system.

Although some automation technologies can operate without connectivity, higher levels of automation will likely need connected vehicle technology to achieve their full potential. For example, the dashboard of this vehicle indicates that the car is both connected and automated. *Source: USDOT.*

To achieve this vision, the Professional Capacity Building Program has developed a new strategic agenda to guide its path forward over the next 5 years. The program's staff has developed a course plan and core curriculum for those interested in careers in connected automation. Finally, the program has partnered with others within the training industry to expand the slate of course offerings.

Thus, the program is gearing up for what's next in transportation.

Transportation on the Verge of Transformation

The power of wireless communication is already being demonstrated, and its potential to improve the transportation system is tremendous. Connectivity will enable drivers to better navigate roads and allow agencies to manage the transportation system more effectively, thus reducing crashes, lessening congestion, and providing travelers with improved mobility, accessibility, and overall quality of life.

The private sector is piloting connected vehicles on U.S. roads right now. The vehicles use wireless communication technology to talk to each other and operate more safely and efficiently. But racing toward the world of connected vehicles also means moving closer to automating them. Today, many models of passenger cars already include low-level automation features, such as cooperative-adaptive cruise control, automatic emergency braking, and lane-centering assistance. More advanced, higher level automation features, such as driverless operation under certain circumstances (for example, self-parking), also are available on some models. Numerous manufacturers aim to have autonomous driving capabilities that are commercially viable by 2020 in multiple models of vehicles.

The transportation industry is pushing the boundaries of innovation to bring the future of transportation within reach of the average consumer. Now that imagination is becoming reality, the industry must prepare to ensure the safe and efficient deployment of connected and automated vehicles. A crucial part of those preparations includes training the current and emerging workforce to offer support to that deployment.

The ITS Workforce in Flux

Transportation professionals must be able to adapt to the continuous introduction of new and emerging vehicle technologies. The pace at which these technologies are evolving is creating workforce challenges for the transportation industry, as new skills are quickly becoming essential to deploy, operate, and maintain the network of connected and automated vehicles. As the technologies progress, the ITS transportation workforce will need progressive knowledge, skills, and abilities. Therefore, new and modified training opportunities are critical for the ITS workforce to acquire the advanced skill sets needed to support a transportation network populated by emerging technologies.

Within the field of connected and automated vehicles, these skill sets must span across multiple competency areas, including architecture, data management, legal considerations,

Inside a Connected Vehicle

Connected vehicles use advanced wireless technology to communicate with each other and the roadway and to deliver critical safety information to their drivers.
Source: USDOT.

1. An under-the-hood box (a processor with memory) collects and transmits data between the vehicle's onboard equipment (OBE) and between OBE on nearby connected vehicles and safety devices along the roadside.
2. A display panel, sitting in the vehicle's center console opposite the driver's dashboard, displays audio or visual safety warnings to the driver.
3. A radio and antenna, using wireless communication and a GPS receiver, receive and transmit data about the vehicle's position to other vehicles and to safety devices along the roadway.
4. Sensors collect additional information that improves the accuracy of the data being collected and transmitted by the vehicle.

operations, procurement, standards, systems engineering, system security, and more. In addition, the evolving ITS workforce must acquire a basic understanding of connected and automated vehicle concepts, technologies, and applications.

USDOT's Role in Preparing The ITS Workforce

The USDOT staff in the ITS Joint Program Office has long recognized the need to advance the workforce in parallel with the advancement of the Nation's transportation system. In 1996, the Joint Program Office established the Professional Capacity Building Program to develop a workforce capable of developing, operating, and maintaining innovative ITS technologies.

The 1998 Transportation Equity Act for the 21st Century legislation codified the need for an ongoing program, specifically calling for the development of a capable ITS workforce. The Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users legislation in 2005 further reinforced the charge to USDOT to support the development of a well-prepared current and future ITS workforce.

The Professional Capacity Building Program provides ITS professionals with flexible, accessible learning through a variety of training opportunities and educational resources. They include technical assistance, webinars, workshops, online training modules, classroom courses, educational materials, peer-to-peer exchanges, and academic support—most of which is freely available to the public. For more information, visit www.pcb.its.dot.gov.

Planning a Capacity Building Strategy

The Professional Capacity Building Program recently established a strategic plan for 2017 to 2021. The plan highlights the program's vision, mission, and roles in both the development and delivery of training products and the facilitation of the efficient exchange of knowledge and learning among all necessary stakeholders. Key program stakeholders provided input to the strategic plan to ensure that it reflects the needs and perspectives of others within the training and capacity-building industry.

The ITS Professional Capacity Building Program offers a variety of training opportunities, including classroom, online, and blended learning courses.

The plan emphasizes the program's current focus on coordinating training and educational opportunities for all levels of current and future transportation professionals to accelerate the deployment of connected and automated vehicles. To achieve this vision, the plan identifies four program goals focused on training, partnering, outreach, and evaluation. The plan also provides a framework around which the program's staff will conduct activities to achieve these goals and corresponding objectives—to support the ongoing functions of the staff and prepare for the road ahead.

One of those objectives is implementing a core curriculum with courses that explore how to deploy, operate, and maintain a transportation network of connected and automated vehicles and infrastructure. Public agencies support deployment by investing in infrastructure that enables data transfer between connected vehicles and the infrastructure.

As the technology evolves and deployment of connected and automated vehicles advances, training should be considered in the short- and long-term management of infrastructure assets, including pavements, bridges, pavement markings, and other ITS assets, to ensure the safe and efficient movement of people and goods in the most cost-effective manner.

Plotting Courses For the Road Ahead

The program offers several training opportunities specifically related to connected vehicles, including the following courses in the core curriculum:

- Connected Vehicle (CV) 101 Basics Workshop and eLearning Course
- CV 102 Applications and Planning for Implementation Workshop and eLearning Course
- CV 200 Workshop and Course Series for Developing a Deployment Plan for Implementing CV Projects
- Advanced Transportation and Congestion Management Technologies Deployment Program Solicitation Webinar
- CV Awareness Webinar Series

Thinkstock

In addition, the program offers training modules that focus on the standards needed to support the deployment of communications technology for connected vehicles. The program also has developed an *ITS ePrimer* that serves as both a stand-alone reference document for the practitioner as well as a text for use in educational and training programs. Within this primer are modules dedicated to connected vehicles, automated vehicles, and smart communities.

Despite this variety of resources and course offerings, gaps do exist in currently available training and education, particularly related to connected automation. The program's staff is working aggressively to address the most pressing training needs. One initiative involves promoting a shared vocabulary and universal understanding of ITS and connected and automated vehicle technologies.

"A more comprehensive, shared understanding of these concepts can help accelerate informative conversations, extend the reach of training offerings, and ultimately enable more effective deployments," says David W. Jackson, transportation industry analyst with USDOT's Volpe Center, which works to improve the Nation's transportation system by anticipating emerging issues and advancing innovations.

Other near-term activities of the Professional Capacity Building Program include implementing the core curriculum, modifying

existing courses, and creating new courses focused on cybersecurity, data management, and procurement of systems using methods that facilitate rapid innovation.

In addition to developing the core curriculum, the program's staff is directing the attention of transportation professionals to appropriate courses. Members of all audiences interested in playing a role in the deployment of these technologies should complete the core curriculum to build the knowledge base necessary for productive conversations and ultimately deployment, operation, and maintenance.

The core curriculum narrows the assortment of available connected automation courses to target 21 that collectively cover general training needs. These courses may address one or more competency areas, such as architecture, data management, legal, operations, procurement, standards, systems engineering, and system security. They are best suited for connected and automated vehicle concepts and aim to provide audience segments with an introductory and basic understanding.

Partnering to Achieve Success

The Professional Capacity Building Program also is addressing gaps in training by continuing to partner with organizations such as Federal modal offices, academic institutions, and industry associations. The program and these partners are exchanging information on existing and planned training and are developing and delivering training, both jointly and separately depending on the course.

The ITS Professional Capacity Building Program offers training opportunities specifically related to connected vehicles. *Photo: USDOT.*

The ITS field contains numerous learning providers and educational offerings. A variety of organizations provide courses, including State and local agencies; Federal training partners such as the Federal Highway Administration, National Transit Institute, and National Highway Institute; and universities, professional associations, and private-sector vendors of ITS technologies.

Through outreach, coordination, and instructional products, the Professional Capacity Building Program is aiding these partners in developing new tools and concepts in education and training to deploy the advanced technologies inherent in connected and automated vehicles. These partners play a critical role in helping the program address any gaps in training offerings; coordinate efforts, where possible, to avoid overlap and offer a consistent curriculum in ITS and connected automated technologies; and reach an expanded set of stakeholders.

"Workforce development is the foundational element to advancing the use of ITS technologies focusing organizations on transportation systems management and operations," says Patrick Son, managing director of the National Operations Center of Excellence, a partnership of the American Association of State Highway and Transportation Officials, the Institute of Transportation Engineers, and the Intelligent Transportation Society of America, with support from FHWA. Son adds, "The ITS Professional Capacity Building Program's leadership in cultivating partners to advance a wide range of topics and varied facets of transportation technology is key to lifting up the entire workforce, from secondary education to post-employment training."

In line with this focus on partnering, the program and some of its partners collaborated on a panel session held at the 2018 South by Southwest (SXSW) EDU Conference on March 5–8, 2018, in Austin, TX. The SXSW conference conveners selected the session proposal submitted by the Professional Capacity Building Program out of more than 1,400 submissions. The session, "Smarter Workforce, Smarter Car, Smarter Community," discussed USDOT's vision for what comes next in transportation and the knowledge and skills that students need to be ready for it.

The Road Ahead

Going forward, the program also is working to fill a handful of priority gaps by developing new courses or modified delivery methods, such as virtual/online options for courses currently provided only through in-person/classroom training formats. Likewise, the program's staff will develop new courses in a modular format to facilitate easier updates and use of smaller sections for individualized, user-led trainings.

Automation and connectivity are expected to substantially transform the Nation's transportation system in the very near future. For this transformative technology to be successful, the USDOT program, external training providers, and USDOT and State and local modal agencies must all be key partners in expanding the transportation workforce's knowledge, skills, and abilities in ITS and connected vehicles—so that the entire transportation community is accelerating toward the future of transportation together.

Michelle Noch is the program manager of USDOT's ITS Joint Program Office's Professional Capacity Building Program. She manages program coordination among all modal administrations and disciplines within USDOT. She began her career with FHWA in the southern California office as the primary lead for all Federal, statewide, metropolitan, and tribal planning-related issues. Noch earned bachelor of arts and master's degrees in urban and regional planning from Virginia Commonwealth University and a master's degree in liberal studies from Hollins University.

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HUMAN MOSAICS
Move the Nation

by Jennifer Mayo and Elizabeth Romero

FHWA is paving the way for harnessing diversity in the transportation industry by integrating the values of inclusion and engagement in all of the agency's activities.

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September 26, 2016, started out as any other cloudy and rainy day in Washington, DC. More than 20 Federal Highway Administration employees from around the United States had gathered in a conference room to talk about the value of diversity and inclusion in the workplace. Looking around the room, one could immediately tell that this was a very diverse group in terms of demographics. What became even more apparent as the day went on was how everyone had different

(Above) The Federal Highway Administration is one of the leaders in promoting inclusive diversity in transportation workforces. *Photo: © Digital Vision, Getty Images.*

views on almost everything. There were robust—and sometimes even heated—discussions. There were moments of creativity and moments of intense emotion. There was a sense of connection and a spirit of collaboration. One thing was crystal clear before the end of the day: A diverse workforce can introduce out-of-the-box thinking and produce innovative solutions that improve the Nation's transportation system.

In fact, encouraging diversity at FHWA and elsewhere is crucial to the future of transportation.

By law, the Federal Government's recruitment policies should "endeavor to achieve a workforce from all segments of society," while avoiding discrimination for or against any employee or applicant on the basis of race, color, religion, sex (including pregnancy or gender identity), national origin, age, disability, sexual orientation, or any other prohibited basis. Seeking to attain a diverse, qualified workforce is a cornerstone of the Government's merit-based civil service. As the Nation's largest employer, the Federal Government has an obligation to lead by example.

But adherence to legal requirements alone does not ensure success in developing a diverse, inclusive, and engaged workforce. First, defining, identifying, and attracting a diverse workforce is not always easy because the concept of what constitutes diversity is constantly evolving. People have various ideas of what diversity actually means, and the concept covers a wide range of human attributes and qualities that are not always obvious or evident. In addition, making diversity part of an entity's value system takes a coordinated effort involving everyone in the organization.

The Federal Government, through its Office of Personnel Management (OPM), has defined "workforce diversity" as a collection of individual attributes that together help agencies pursue organizational objectives efficiently and effectively. Similarly, "inclusion" is defined as a set of behaviors (a culture) that encourages employees to feel valued for their unique qualities and experience a sense of belonging. From these definitions, OPM developed the phrase "inclusive diversity" as a set of behaviors that promote collaboration within a diverse group.

The U.S. Department of Transportation and its partners, including State departments of transportation, have been incorporating inclusion and engagement as core values to help knock down barriers; facilitate communication among communities, organizations, and individuals; help ensure knowledge transfer; and expedite project delivery.

For example, in 2016, USDOT awarded $3 million in job training grants throughout the Nation. Included was the creation of FHWA's Center for Transportation Workforce Development, which supports innovative programs for developing highway construction workforces that include women, minorities, and other disadvantaged groups.

In addition, USDOT's Disadvantaged Business Enterprise program aims to provide opportunities for small businesses owned by socially and economically disadvantaged individuals to come for, and participate in, USDOT-assisted contracts led by State DOTs and local transportation agencies in an environment free from unlawful discrimination.

Similarly, FHWA has been a leader in embracing and promoting inclusive diversity. From enforcing legal requirements in its hiring practices and delivery of its programs to partnering with various stakeholders across the country, FHWA has made diversity, engagement, and inclusion part of its very fabric. By effectively advancing initiatives that promote collaboration within its workforce and beyond, FHWA has created an organizational culture of diversity.

The nonprofit Partnership for Public Service produces rankings of Best Places to Work within the Federal Government based on feedback from Federal employees who complete an annual survey. The rankings are based on 10 categories, one of which is support for diversity, inclusion, and employee engagement. In 2017, FHWA ranked 12 out of 148 agencies in that category, which measures the extent to which employees believe that actions and policies of leadership and management promote and respect diversity.

FHWA Executive Director Walter C. "Butch" Waidelich, Jr. says, "FHWA's workforce looks like the people of our country, and all employees feel their contributions are valued and considered in decision making. That's what makes FHWA one of the best government agencies, respected by all people."

On this construction site, a transportation worker demonstrates that being in a wheelchair does not prevent him from doing his job. *Photo: © BartCo, Getty Images.*

Advancing Diversity

Since 1971, FHWA has required State DOTs to establish on-the-job-training and apprenticeship goals on federally assisted contracts, and contractors must use good faith efforts to meet those goals. Although no trainee or apprentice is excluded from participating on contracts, the regulatory requirement is targeted toward increasing participation by women, minorities, and disadvantaged individuals with past and current underrepresentation in the transportation industry. The apprenticeship and training opportunities are intended to help individuals achieve journey-level status in the skilled and semiskilled trades to ensure that an available and competent workforce is ready to meet present and future hiring needs for highway construction.

Other professional and trade organizations in the transportation industry also are doing their part to advance diversity programs. Together, public and private initiatives are not only helping transform workforce recruitment and retention, but are also shaping innovative transportation policies to foster a culture of diversity across the Nation. For example, a number of nonprofit organizations, such as the Transportation Diversity Council, the Conference of Minority Transportation Officials, and WTS International (formerly Women's Transportation Seminar), are dedicated to meeting the growing needs in the transportation and construction industries by engaging and developing a large and diverse workforce.

Other groups and organizations, such as the American Public Transportation Association, the American Association of State Highway and Transportation Officials, and the Transportation Research Board, also are involved in advancing diversity and inclusion through research, scholarships, and other programs and projects directed at attracting and retaining a diverse workforce in transportation.

Finally, State DOTs are continually working to increase diversity and inclusion opportunities for all stakeholders. Examples are Ohio's Division of Opportunity, Diversity & Inclusion and Illinois' Workforce and Business Diversity initiatives.

Understanding Diversity

For those unfamiliar with the modern concept of diversity, the first thing that might come to mind is the need to meet federally mandated equal employment opportunity (EEO) and affirmative action (AA) legal requirements. In fact, the term "diversity" is frequently used interchangeably with EEO/AA regulations, but they are not the same. EEO employment opportunity programs ensure that job applicants and employees have a fair opportunity in the hiring process and competition for promotions, and equal access to training and opportunities for professional development. Similarly, AA programs are in place to address past discrimination. In the most general terms, EEO and AA laws are designed to level the playing field, ensure that a company's human resources policies are not discriminatory, and help keep organizations out of legal trouble.

Therefore, it comes as no surprise that diversity initiatives traditionally have referred to these legally protected categories. It is also fair to say that following these frameworks, insofar as they are not exclusively based on quotas or preferential hiring systems, will result in a workforce composed of a heterogeneous mix of people.

However, if an organization is setting out to build a diverse, inclusive, and engaged workforce, the raw diversity numbers achieved through EEO and AA are only a small piece of the puzzle. Organizations looking to leverage the differences in their human capital also need comprehensive plans and initiatives for diversity management. These plans and initiatives differ from EEO and AA efforts in that they are long term and strategic in focus; strive not only to recruit but also to actively develop, promote, and capitalize on the various skills and perspectives of diverse employees; and involve fundamental organizational change.

Diversity experts are increasingly considering a wider range of factors when it comes to achieving these organizational goals. Organizations focused on long-term achievements are now talking about inclusive and wide-ranging human factors, some of which can be seen, and others that are not apparent at all. These factors can include race, gender, gender identity, age, sexual orientation,

To leverage the skills and creativity of their employees, transportation organizations need comprehensive plans for diversity management.
Photo: © Rawpixel Ltd, Getty Images.

The success of transportation agencies depends on their ability to embrace diversity. *Photo: © Portra, Getty Images.*

social class, physical and mental ability or attributes, religious or ethical value systems, levels of education, national origin, political beliefs, and personality and intelligence types.

By seeking diversity in these human factors, organizations are placing value on achieving diversity of perspective or thought. This shift in focus has resulted in moving the definition of diversity far beyond the categories that have been looked at in the past.

The Business Case For Diversity

Diversity-centric organizations strive to maintain a cadre of employees who are both highly qualified and also highly diverse. Diverse working groups can be more innovative, flexible, and productive. They can offer valuable perspectives on important issues and can appeal to a wide range of stakeholders. In addition, groups made up of diverse personnel do a better job of analyzing and solving problems.

FHWA exemplifies this organizational culture of diversity and innovation, as evidenced by its many inclusive programs geared to solve some of the U.S.'s most prevalent transportation challenges. For example, FHWA researchers have pioneered numerous safety enhancements, such as cutting-edge retroreflective laminates that make highway signs brighter and more visible from greater distances. This innovation helps to address challenges faced by older drivers, which range from declining vision to decreased flexibility and psychomotor performance, and changes in perceptual and cognitive performance. In addition, the agency provides funding support to the Roadway Safety Foundation to operate the Clearinghouse for Older Road User Safety, which offers information for practitioners and for senior drivers as well.

Also, FHWA recently awarded a $4 million Advanced Transportation and Congestion Management Technologies Deployment grant to South Carolina's Greenville County for its automated taxis. These driverless taxis will provide shuttle service to and from employment centers and are expected to improve access to transportation for disadvantaged and mobility-impaired residents.

Not surprisingly, organizations that effectively capitalize on the strengths of all employees and leverage their differences and unique values also have the most engaged employees. This sense of belonging and inclusion can increase the quality of their work. Further, engagement can go beyond human-capital factors to a range of issues as broad as reducing accidents on factory floors to increasing public engagement. An example of the latter is in Portland, OR, where arts-based engagement is helping to build dialogue between local agencies and the community to ensure that a new planned bus rapid transit line serves the residents of ethnically diverse, low-income districts in the eastern part of the city. An organization's success and competitiveness depends in part on its ability to embrace diversity.

Organizations that proactively assess their management of workplace diversity, and develop and implement plans to actively promote a culture of diversity, inclusion, and engagement, could realize a number of benefits:

Increased adaptability. Innovation often requires connecting multiple tasks and ideas in a new way. Diversity breeds creativity and innovation because employees from diverse backgrounds bring myriad talents and experiences, suggesting flexible ideas for adapting to fluctuating markets and customer demands. Bringing together workers with different qualifications, backgrounds, and experiences is key to effective problem-solving on the job. Organizations employing a diverse workforce can supply a greater variety of solutions to problems in service, sourcing, and allocation of resources.

Broader service range. Diverse skills and experiences (for example, languages and cultural understanding) enable an organization to provide service to customers on a wider basis. By bringing together individuals from different backgrounds and experiences, organizations can reach a broader number of stakeholders more effectively.

Variety of viewpoints. A diverse workforce that feels comfortable communicating varying points of view provides a larger pool of ideas and experiences. The organization can draw from that pool to meet strategic needs and the needs of stakeholders more effectively. Diversity of thought can help an organization guard against groupthink and expert overconfidence, make better decisions, complete tasks more successfully because of more careful and creative information processing than typically occurs in homogeneous groups, and increase the scale of new insights.

Diversity Management Committee

More effective execution. Organizations that encourage diversity in the workplace are more likely to inspire their employees to perform to their highest ability, which results in higher productivity, efficiency, and return on investment. A diverse and inclusive workforce also helps organizations avoid the costs of employee turnover. In addition, diversity helps organizations identify the right human capital to tackle their most pressing problems. Organizations that embrace a culture of diversity are able to engage their workforce at a higher level by matching the right people to the right jobs, and assigning individuals to specific teams based on their strengths.

A more qualified workforce. When organizations recruit from a diverse set of potential employees, they are more likely to hire the best and brightest in the labor market. In an increasingly competitive economy where talent is crucial to improving an organization's bottom line, having the largest and most diverse set of candidates is increasingly necessary to succeed in the marketplace.

Public and private transportation sectors in the United States can benefit greatly from initiatives to encourage diversity. Diversity of people and ideas in the transportation workforce promotes innovation, performance, and efficiency in all the ways detailed above. A diverse workforce will help the industry connect with the increasingly diverse constituencies served by transportation agencies. In short, to build a workforce ready to meet the demands of the future, the transportation industry needs to recruit and retain individuals with diverse thoughts and perspectives.

FHWA's Diversity Management Committee

Although FHWA's main concern is keeping the public moving safely, efficiently, and reliably while protecting the country's environmental resources, the agency also recognizes the need to address the changing demographics of U.S. society. To help meet that need, FHWA encourages a diverse workforce by continually fostering a culture of inclusion and creating and maintaining a work environment that welcomes diverse individuals.

A Native American woman is learning to use GPS survey equipment from an FHWA expert, among many who offer technical assistance to tribes.

In addition to the diversity factors cited earlier, FHWA's definition includes national origin, ethnic group, age, personality, cognitive style, tenure, education, and background, to name just a few. Within this context, FHWA's goal is to manage its diverse human capital to function effectively as a cohesive organization that will excel in areas such as communication, adaptability, and change. All FHWA employees have a role in helping the organization reach the ideal of an inclusive work environment where individual differences, unique perspectives, and talents are respected, appreciated, and valued.

To help meet these goals, FHWA established a Diversity Management Committee in 2005. To ensure that the agency's leadership is actively engaged in advancing the benefits of diversity and inclusion, the committee works through and supports FHWA's leadership group, the Strategic Workforce Council.

The aim of the diversity committee is to continue building an inclusive organization characterized by equal access to opportunities, cultural competence, transparent communications, participatory work processes and decision making, constructive conflict management, leadership development, equitable rewards systems, and shared accountability. These inclusion characteristics are key to actualizing the potential of workforce diversity to improve performance. The committee's purpose is to help foster an inclusive organizational environment that will enable all FHWA employees to realize their full potential and maximize their contributions to the agency's mission and service to the public.

Implicit in the committee's efforts is the principle that diversity goes beyond race and gender to include diversity of thought and experience that accompanies human identity. The inextricable link between how people see themselves and how they think makes diversity a potent ingredient in organizational performance.

Through the use of available data analyses and evaluations, the

committee's activities include the following:

- Evaluating organizational performance to attract, promote, and retain the FHWA workforce.
- Recommending strategies and initiatives that contribute to workforce diversity for inclusion in the agency's strategic plan.
- Promoting best practices in diversity and ensuring integration with FHWA's "Learning Highway"—the agency's internal online tool for accessing opportunities for learning and development training.
- Collaborating on equal employment opportunity and diversity initiatives with other offices and committees within FHWA, such as the Office of Civil Rights and Human Resources Management Committee.
- Carrying out special projects, under the direction of the Strategic Workforce Council, that address diversity matters.
- Serving as an advocate for diversity throughout FHWA. Two examples are the creation of a Women's Forum and the establishment of the Diversity Champions.

To ensure full participation of FHWA's diverse workforce in the committee's efforts, its members are drawn from FHWA headquarters, field offices (both Federal-aid and Federal Lands Highway) and the Office of Technical Services. The committee's cochairs include a division administrator or equivalent and an executive at the division director or office director level. Committee membership rotates on a staggered basis, while the director of the Office of Human Resources, the diversity program manager, and a staff member from the Office of Civil Rights are permanent members.

To further advance the implementation of diversity in the agency, FHWA established the Diversity Champions initiative in 2016. This program provides a grassroots opportunity for employees, at all levels of FHWA, to identify and learn about diversity, inclusion, and engagement challenges in the workplace. The initiative relies on a peer-to-peer approach. During the first year after implementation, the champions led 40 activities designed to foster diversity and inclusion. The Diversity Champions currently are developing best practices for employee outreach and interactions to support and deliver diversity and inclusion initiatives.

FHWA does acknowledge that diversity and inclusion are a work in progress. As Gregory K. Murrill, the agency's Maryland Division Administrator, says, "FHWA is keeping pace with the steadily evolving topic of diversity. We must continue our efforts with recognizing that we are more diverse than the obvious [indicated by human resource statistics] and are better as an organization because of our differences. Our efforts do not reflect a finite goal but instead a journey to continuously foster and cultivate a culture where the unique attributes and perspectives that we all bring are valued, respected, celebrated, and leveraged for greater mission success."

FHWA's Avenue For Diversity

Other avenues for diversity and inclusion include FHWA's Federal Lands Highway programs. These programs work with partner agencies that administer programs for Federal roads and bridges while protecting and enhancing the Nation's natural resources and providing needed transportation access for Native Americans. The Federal Lands Highway Divisions, in cooperation with these partners, have been key to providing access to the beauty, history, and legacy of the Nation's Federal and Indian lands. Tribal transportation programs, as the largest of the Federal Lands Highways programs, are an excellent example of how FHWA has been successful in implementing diversified outreach to meet the needs of these significant customers and partners.

Tribal transportation programs are tailored to meet the unique needs of tribal governments that do not follow the form and function of typical State DOTs. FHWA's Federal Lands Tribal Coordinators develop individual relationships with tribal governments to implement projects that meet their transportation needs. These relationships are built on trust and honoring the commitment to preserve and protect tribal lands and sacred places.

Federal Lands has a multifaceted outlook on its unique responsibilities. Sandra Otto, director of the Western Federal Lands Highway Division, says, "We are passionate about our mission—providing access to and through Federal and tribal lands. By caring for these special places, we acknowledge and celebrate the diversity of this country."

Partners in the Transportation Industry

FHWA is just one of many transportation organizations in the United States, including State DOTs and nongovernmental organizations, that are recognizing the benefits of supporting and advancing diversity in their workforces. Through its partnerships, FHWA seeks varied perspectives from a diverse group of individuals and organizations that can offer specific solutions to transportation challenges. This external

Many transportation organizations in the United States, including State departments of transportation and nongovernmental organizations such as the Transportation Research Board, are recognizing the benefits of supporting and advancing diversity in their workforces. *Photo: © kali9, Getty Images.*

FHWA's Utah Division Administrator Ivan Marrero and Oklahoma Division Realty Officer Karen Orton are providing right-of-way technical assistance to local governments in Oklahoma.

collaboration can offer answers and advance transportation programs that would not be available otherwise.

One of the agency's close partnerships is with the Transportation Research Board. TRB's 2016 annual report noted that the board has developed and adopted a management plan for diversity and inclusion, identifying strategies to engage a diverse, inclusive pool of stakeholders representative of the community that TRB serves. Recently, TRB's Executive Director Neil Pedersen expressed the view that "an inclusive environment foster[s] more creative solutions to solve transportation challenges."

In 2016, TRB held a webinar, in partnership with the National Network for Transportation Workforce and the American Public Transportation Association. The partners titled the online event "Diversity in the Transportation Industry: Attracting and Engaging Diverse Groups." The webinar highlighted efforts by various private, Federal, tribal, State, and local government transportation initiatives to promote diversity in the many aspects of deployment of the transportation labor force, from planning and construction to maintenance and implementation.

Other FHWA partnerships that foster diversity include support for staff participation in associations that represent a diverse cross section of the transportation realm, including Blacks in Government, the Conference of Minority Transportation Officials, National Society of Black Engineers, Society of Hispanic Professional Engineers, Society of Women Engineers, and WTS International, among others. Through these organizations, FHWA staff forge partnerships and relationships that enhance their work lives and create opportunities to share varied ideas to explore new avenues and approaches for current and future transportation needs.

Many State DOTs have advanced their efforts to implement diversity and inclusion within their internal civil rights programs and throughout their agencies. The Minnesota Department of Transportation (MnDOT) has recognized the benefits of a workplace environment that values and embraces individual differences, which led to diversity and inclusion being added as one of its six core values as an agency. A result is that MnDOT created the Minnesota Community Partners on Recruitment and Retention Solutions (MnCARRS) to build recruitment partnerships between MnDOT and communities underrepresented in its workforce. During MnDOT's recruitment efforts with MnCARRS in 2009 and 2013, the agency filled 29 percent to 35 percent of targeted positions with diverse candidates. This effort is now managed at a statewide level.

The Maryland Department of Transportation's Office of Diversity and Equity focuses its efforts, through its equal employment program, to develop a model State agency with a diverse and effective workforce.

The Oregon Department of Transportation highlights diversity as one of its seven core values and has established a Council for Diversity and Inclusion. The council establishes employee-led Diversity Action Teams around the State that share information, hold events, and spread awareness about diversity.

FHWA's recent efforts to improve technology deployment have included expansion of its Office of Innovative Program Delivery, which includes the Center for Accelerating Innovation, with its established Every Day Counts and State Transportation Innovation Councils initiatives, and newly developed Center for Local Aid Support and Center for Transportation Workforce Development. Every Day Counts and the State Transportation Innovation Councils enable wide, diverse groups of stakeholders with innovative and diverse perspectives to collaborate to meet the challenges of aging infrastructure, growing traffic volumes, and limited staffing and funding resources. The Center for Local Aid Support works collaboratively with a diverse mix of partners that includes the local and tribal transportation centers. The Center for Transportation Workforce Development directly supports FHWA's diversity initiative with its primary mission to deliver programs and initiatives that build transportation awareness and improve the development, capacity, and diversity of the Nation's transportation workforce.

Two of the programs led by the Center for Transportation Workforce Development place particular emphasis on diversity and inclusion by reaching out to youth, women, minorities, and other disadvantaged groups. The National Summer Transportation Institutes introduce youth to the transportation industry, and the Summer Transportation Internship Program for Diverse Groups provides college and university students with on-the-job

experience while working on current transportation topics and issues.

The center partners with States and local agencies, colleges, and universities to implement the National Summer Transportation Institute, a national workforce development program. FHWA's division offices provide local resources by conducting site visits and providing technical assistance for the institute at each host site.

The Vermont Agency of Transportation has used its Summer Transportation Institute to aid in developing a diverse and robust workforce for the transportation industry by exposing students to transportation careers. Vermont's policy for its summer program is to encourage high school students with diverse backgrounds to apply. This effort leads to a group of participants with a broad range of interests and abilities that can result in an enriched multicultural experience.

Additionally, the Center for Transportation Workforce Development manages activities that aim to increase the number of post-secondary students interested in pursuing transportation-related careers, including the Summer Transportation Internship Program for Diverse Groups. While the program's paid summer internships are open to all qualified applicants, the primary focus is to provide opportunities for qualified women, persons with disabilities, and historically underrepresented members of diverse groups.

These partnerships and initiatives have enabled FHWA to evolve as a transportation organization that clearly recognizes the benefits of attracting, promoting, and retaining a diverse workforce. Its diversity efforts underwrite the agency's core values and will continue to help the agency deliver its primary mission of improving mobility on the Nation's highways through national leadership, innovation, and program delivery.

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Elizabeth Romero is currently the program development team leader in the Oklahoma Division. She has worked for FHWA since 1990, serving as a highway engineer in many field offices and holding various responsibilities, including highway design, environmental compliance, planning, and project development. She received her B.S. in civil engineering from the University of Arkansas.

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High school students with Vermont's Summer Transportation Institute are participating in a demonstration of highway maintenance equipment by an expert with the Vermont Agency of Transportation. *Photo: Morse, Vermont Agency of Transportation.*

by Martha Kenley and Tracy Duval

Ready, Willing & Able

Women and girls are employed in a variety of transportation jobs, and more are poised to join the workforce. It's a matter of training and contracting, and FHWA is helping out.

When people think of working women in U.S. society, what comes to mind? No doubt, many are aware of the growing presence of professional women such as physicians, attorneys, managers, and CEOs. But what about women who have determined that higher education is not the right choice for them, or is simply cost prohibitive? How can they be expected to support themselves, let alone a family, with low-paying jobs in areas such as food service? Do women ever envision themselves as working in a skilled trades industry where, once they learn a trade, they could be earning a good salary—certainly enough to support themselves and a family?

Or are young women taught to believe that those jobs are an option only for their male counterparts?

Many researchers refer to work in the skilled trades as "middle-skill jobs" with "family-sustaining wages." Middle-skill jobs typically do not require a bachelor's degree but do require education and training in various skills.

According to Ariane Hegewisch and Heidi Hartmann in a report titled *Occupational Segregation and the Gender Wage Gap: A Job Half Done*, published by the Institute for Women's Policy Research in January 2014, women represent 83 percent of workers in middle-skill, female-dominated occupations that pay less than $30,000 per year. The majority of anticipated job openings, however, are in middle-skill, male-dominated occupations with median annual earnings of at least $35,000 and opportunities for regular increases. In male-dominated occupations in fields such as transportation, women currently make up less than 10 percent of the workforce.

Data collected by the Federal Highway Administration's Office of Civil Rights also show a dearth of women participating in federally assisted contracts in construction. Each year, FHWA requires prime contractors on federally assisted contracts to submit "Federal-aid Highway Construction Summary of Employment Data," known as the FHWA 1391/1392 report (contractors submit a 1391 report to the State departments of transportation, which then compile these into a 1392 report submitted to FHWA). This report is an annual snapshot of the demographics of each prime contractor's construction workforce as of the last payroll period preceding the end of July. FHWA uses the report to identify patterns and trends of employment in the highway construction industry, and to determine the adequacy and impact of contractors' equal employment opportunity efforts and on-the-job training requirements.

In 2017, during the relevant July timeframe, the 1392 data showed 13,511 active construction projects with a total workforce of 227,609 journey-level men and women. (Men and women are considered "journeymen," or reach "journey-level" status, when they have successfully completed an official apprenticeship and are qualified to work in a skilled trade.) In 2016, the 1392 data showed 11,852 active construction projects with a total workforce of 160,831. Data for both 2016 and

(Left) FHWA is helping women enter, train for, and advance in jobs throughout the transportation sector. *Photo: © Getty Images, sturti.*

Wearing a hardhat and a safety vest, Hannah Carmical poses onsite at the Governor Mario M. Cuomo Bridge project in New York. *Photo: Mark MacDonald, Tappan Zee Constructors, LLC.*

2017 showed that within the several job categories identified during the reporting periods, males led in all work areas. The combined data showed that women comprised 6.39 percent of the workforce. Although women were present in all categories, they were represented primarily in clerical categories, equipment operators, and unskilled and semi-skilled laborers. When apprentices and trainees were included in the data, the percentage of women participants rose to 6.72 percent.

The U.S. Department of Labor projects that employment in highway, street, and bridge construction will increase by 23 percent through 2022, with 67,500 jobs added across the United States. These numbers are above and beyond the job openings created by retiring workers. According to a 2013 article in Forbes Magazine, "America's Skilled Trades Dilemma: Shortages Loom as Most-In-Demand Group of Workers Age," almost one in five skilled construction workers were 55 years or older in 2012, and more than half were 45 years and older. Employers are finding it difficult to fill vacancies in these middle-skill occupations. Women are a key labor pool that can help this sector of the economy meet its hiring needs.

Section 22(a) of the Federal-Aid Highway Act of 1968, codified under 23 USC 140 (a) and (b), provides the authority for FHWA to administer an on-the-job training program. The purpose of the program is to move women, minorities, and disadvantaged individuals into journey-level positions, in order to ensure that a competent workforce is available to meet the hiring needs in transportation construction, and to address the historical underrepresentation of these groups in skilled crafts in highway construction. FHWA's on-the-job training program requires State departments of transportation to set training goals that prime contractors on federally assisted contracts must meet. State DOTs require contractors to use good faith efforts to hire women and minorities. The U.S. Department of Labor's Office of Federal Contract Compliance also has goals for minorities and women workers on federally assisted contracts (the goal for women is 6.9 percent nationwide). Together, the FHWA and Department of Labor programs make it necessary for prime contractors to make sufficient efforts to recruit women and minorities as trainees and apprentices.

"Although these target middle-skill occupations currently employ only a small minority of women, there is little to suggest that there are not many women who could successfully train for these occupations," according to *Pathways to Equity*, a report from the Institute for Women's Policy Research. The report notes that many women already work in occupations that have similar skills to the occupations employers are seeking to fill, but are paid less. "Recruiting more women to fill skills gaps in growing middle-skill occupations is a viable, if not a necessary, strategy for employers, while for women such occupations present pathways to higher earnings and economic security."

Challenges and Barriers

Although increasing the number of women in transportation occupations seems an obvious solution to overcoming current and anticipated workforce shortages, as well as providing women with family-sustaining income, it's not that simple. Women face a number of barriers to success and career advancement in the construction industry, both internal and external. The barriers include fewer opportunities than men have to learn how to use tools while growing up; lack of information about careers in the skilled trades; less access to social networks that facilitate successful applications to apprenticeship programs; and harassment and discrimination in hiring, assignments, and on-the-job training during apprenticeships.

Ariane Hegewisch, program director for employment and earnings at the Institute for Women's Policy Research, says, "Gender exclusion in certain industries is not rational." She stresses that both women and employers should focus on skill sets and not traditional gender roles. "Many women work in female-dominated occupations that are very similar to male-dominated occupations in terms of the amount of instruction needed to learn the job; the use of deductive and inductive reasoning; the need to be able to visualize physical arrangements; required command of the English language; the extent to which the occupation satisfies a worker's 'enterprising' occupational interest; the extent to which the work is paced by the speed of equipment; the frequency of exposure to physical hazards; and the extent to which the job involves administrative 'paperwork.'"

Roxanne Neilson, currently an outreach coordinator for a Los Angeles-based firm and president and owner of a projects management firm in

New York, believes that women who doubt they have the skills necessary to succeed in apprenticeship programs should consider what skills they already possess. For example, women who have fine-motor and abstract visualization skills demonstrated in activities such as knitting and sewing from complex patterns might find these skills translate well into the area of low-voltage communication wiring such as fiber optics cabling and testing. Neilson notes, "These girls can navigate smartphone applications, so there should be no question that they can learn how to configure controls on digital testing equipment."

Women Who Are Paving the Way

The women quoted in this article all have current or past experience working in skilled construction trades, and all had the same message for women, "You have to really want it."

Neilson benefitted from FHWA's on-the-job training and the workforce requirements from the Department of Labor's Office of Federal Contract Compliance. How she found herself working in heavy highway construction is an unusual story. She graduated with a liberal arts degree from Swarthmore College in Pennsylvania, then moved to Honolulu, HI, in the 1980s, where she worked at a YWCA as a program director managing an infant and toddler care program. However, even with her college education, Neilson was barely making ends meet.

The YWCA was spearheading programs for low-income mothers of children in the daycare program. During the outreach, Neilson noted that local trade unions were looking for women to join their apprenticeship programs to help contractors achieve their Federal workforce goals. Neilson soon learned that a union apprentice earns more than she made as a program director.

Going outside her comfort zone, she attended pre-apprenticeship training courses. The courses introduced her to the expectations for workers in construction and strengthened her skills with hand tools. Although she lacked any previous technical training, after finishing the pre-apprenticeship program, Neilson was hired as a union apprentice. By the end of the apprenticeship, she had received enough training hours to become a certified welder and the first female African-American locally union-trained journeyman in the State of Hawaii.

"You've got to persevere; you have to really want to do it, and you must keep your eyes on the long-term benefits of sticking it out no matter what," Neilson says. She tells a story about working at a job at Pearl Harbor when a superintendent asked her to go into a dumpster and separate the garbage from the lumber. At that moment, she told herself, "He's trying to humiliate me to make me quit; but I'm not a quitter." To keep going every day, she focused on the money and long-term benefits of belonging to a union.

Hannah Carmical is the manager of human resources and administration for a company that is part of the Tappan Zee Constructors

Julie Savitt, president of a disadvantaged business enterprise in Chicago, says, "Nothing should stop a woman from being a trucker." *Photo: AMS Elite Solutions, Inc.*

Two women conduct an inspection of a bulletin board at a jobsite in Florida using an electronic tablet device. *Photo: Marla Nance.*

consortium, which is the design builder of the new Governor Mario M. Cuomo Bridge just north of New York City. Among other things, Carmical manages union labor relations, hiring and firing, and compliance with equal employment opportunity requirements. Carmical often hears from new engineering graduates wondering why they spent so much on a college education when an apprentice can start earning a combined salary and benefit package of $50 to $60 per hour (with built-in increases) as soon as they finish their apprenticeship. Carmical often reminds them that the tradeoff, of course, is unless they work full-time for a company, they often have time on the bench in between jobs.

Carmical believes that women with long-term success in construction "want to make it happen." She recognizes a shift toward the acceptance of women in construction, although she notices differences in projects from city to city. Carmical's job involves recruiting women workers to meet New York State's 6.9 percent goal for female hires. So far, women make up approximately 2.8 percent of the bridge project's workforce.

Women-Owned Small Businesses

What about women-owned small businesses in the transportation industry? Responding to successful grassroots lobbying, Congress added women as a presumed disadvantaged class to the USDOT's disadvantaged business enterprise (DBE) program in 1987. In addition to women, the disadvantaged groups include African Americans, Hispanic Americans, Native Americans, Asian-Pacific Americans, and Subcontinent-Asian Americans.

Joann Payne, president of Women First, a national legislative committee that advocates for women-owned small businesses, led the grassroots effort to include women in the DBE program as a presumed disadvantaged class. She explains that even after the legislation passed through Congress in 1987, certain State DOTs refused to include women into their DBE programs. State officials apparently were convinced that not only were women unqualified, but including women would lead to the establishment of "front" companies, that is, companies owned by women on paper only while actually controlled by their nonminority husbands or other males.

Payne testified at various hearings in which she provided data on women-owned construction companies to show that they were, in fact, legitimate, qualified companies. It was only after the publication of a scathing report by the Government Accountability Office in 2001, however, that women began to receive contracting opportunities as DBEs. Although the road to inclusion was not easy, women-owned firms now have the greatest percentage of participation on federally assisted contracts among all the DBE program's disadvantaged classes. Despite this success story, women-owned small businesses continue to face challenges and barriers in the male-dominated construction industry.

Over the years, Julie Savitt, who is president and owner of a DBE business in Chicago, has been frequently called "honey" or "sweetie" by her male counterparts. When she enters a jobsite, often she is asked whether she is looking for her husband. She believes that as a woman, she has had to haggle twice as hard to be paid half as much, and if a prime contractor hires her firm, it is as if the company is doing her a favor.

Savitt began her career as an assistant principal in a small day school. Then, at age 40, she started a company with a single truck that she leased to other companies. She is self-taught in the nuances of the construction industry and has had mentors help her learn business concepts such as cost perspective versus profit perspective.

Today, her company has 15 employees and owns 13 trucks. Now when she hires drivers, she requires approximately 10 years of trucking experience, and at least 5 years in construction. She kept at it and finally found a niche area of trucking in which the competition is not quite as fierce. She believes that she is successful because her company is expert at what it does.

What made her continue? "You have to love it," she says. What Savitt truly loves about her job is that it provides the opportunity to break down barriers for women and to be a mentor to help minorities and women grow their businesses. Her goal is to make the industry culture more appealing in order to attract a new generation of women who value education and working hard but working smart. Her daughter is interested in following in her mother's footsteps; although this succession plan excites Savitt, it also concerns her. "I told my daughter to take a year off, and if she's still interested in trucking when she comes back, I'm okay with it," she says.

One last example: Marla Nance owns a small certified DBE business that provides equal employment opportunity and DBE compliance oversight services for State DOTs and local public agencies, primarily in Florida. She started her career as a Florida DOT employee working for 2 years in the co-op program in the Right of Way Unit. She then left FDOT to work with Florida's Auditor General conducting financial audits.

Having grown up in a family with a strong entrepreneurial spirit, Nance then opened her own business. Her firm has been certified as a DBE for 13 years and averages 22 employees. As a small business

owner, she had to learn how to market her company. Nance advises young women who are considering careers in the transportation industry or who aspire to open their own business to pursue some type of higher degree such as a B.A. and consider obtaining a specialized license or certification that will distinguish them. From there, she, like Savitt and Neilson, advises women to get "really good" at what you do and your reputation will grow. Nance is a licensed certified public accountant in Florida and has a B.A. and M.A. in accounting, and she believes these credentials gave her credibility from the start. She, like Savitt and Neilson, also advises finding a niche market. Her background in government auditing led her to her current business of providing equal employment opportunity compliance and auditing certified payrolls.

Changing the Current Dynamic

How does the transportation industry convince young women that working in male-dominated, middle-skill jobs is a viable option? According to the Hegewisch and Hartmann report, "College degrees do not come more cheaply in female-dominated fields, and the gender wage gap together with the penalty for working in a female-dominated occupation leave women graduating in these fields with many fewer resources and lower future earnings potential than women who choose nontraditional fields. Therefore, improved information about the differences in prospective earnings in different fields at different educational levels would be especially useful to women." Hegewisch and Hartman define "nontraditional fields" as occupations or fields of work where individuals of one gender comprise less than 25 percent of the workforce. For more information on women in nontraditional careers, see www.womenandgoodjobs.org.

Although education and training are key, how else can women continue to break down barriers and increase the numbers who find and retain middle-skill, male-dominated jobs? Françoise Jacobsohn, cofounder and former cochair of the National Task Force on Tradeswomen's Issues and a former Ford Foundation Public Voices Fellow with the OpEd Project, notes that across the country, more women are available to work on federally assisted contracts but are often frustrated at their inability to get hired, get equitable work assignments, and stay working. The OpEd Project is a nonprofit that trains underrepresented experts how to write op-eds and get them published.

Research indicates that outreach is critical and must start as early as elementary school to spark interest and expose young women to the increasing opportunities in transportation. Barriers to women acquiring jobs in male-dominated fields with family-sustaining wages are not insurmountable and are not a reflection on women's capacity to succeed in those jobs.

Hegewisch says that the transportation community needs to change the conversation. Many are of the belief that women cannot be successful in a construction career because of the long hours. Hegewisch disagrees with that argument, saying "Nurses often work 'round the clock, and no one says, 'Oh, that's no job for women!'"

Françoise Jacobsohn is the cofounder of the National Task Force on Tradeswomen's Issues. *Photo: Françoise Jacobsohn.*

USDOT Efforts

Efforts are ongoing nationwide to attract more women to transportation, as well as to fields related to science, technology, engineering, and mathematics (STEM). Michelle Harris, of the U.S. Department of Transportation's Office of Small and Disadvantaged Business Utilization, is manager of the office's Women and Girls in Transportation Initiative (WITI). The initiative's mission is to increase the participation of women in the transportation industry through internships, strategic partnerships, and education.

WITI is based on a USDOT initiative, the Pilot Entrepreneurial Training and Technical Assistance Women and Girls Program, which began in 2009 as a partnership with Spelman College in Atlanta, GA. USDOT created the program to encourage girls to pursue careers in STEM-focused fields and to help women in those fields achieve their goals. The program provided internships and mentoring for young women, as well as entrepreneurial training for female owners of small businesses in the region.

As a result of the success of the Spelman initiative, USDOT expanded the internship program by creating WITI. This program provides transportation internships for young women across the Nation. Each summer, WITI places 26 women ages 19 and 20 in paid internships in different areas of the country. Recently,

In addition to USDOT's Women and Girls in Transportation Initiative, FHWA participated in the Take Your Sons and Daughters to Work Day in 2016, a fun day of scientific discovery to encourage children to consider careers in science, technology, engineering, and mathematics (STEM).

WITI participated in a pilot program with Florida Memorial University in which nine interns received college credits as part of their internships. Harris says that one intern now works as a traffic controller with the Federal Aviation Administration, and two others are working at private airports. Other graduates of the WITI program work in private engineering firms, as community planners, and as a manager at Ford Motor Company. For more information, visit the WITI website at www.transportation.gov/osdbu/women-and-girls.

The USDOT's Office of Small and Disadvantaged Business Utilization provides funding and oversight for 13 Small Business Transportation Resource Centers across the country. The centers provide free technical and financial assistance for small businesses and DBEs to better prepare them to compete for work on federally assisted contracts. The centers' services include business analyses, market research and procurement assistance, general management and technical assistance, and business counseling and coaching. For information about locations of the centers, visit www.transportation.gov/osdbu/SBTRCs. The USDOT office also administers a short-term lending program and a bonding education program for small businesses.

A NEW Approach

Carmical works with Nontraditional Employment for Women (NEW), a nonprofit in New York City that administers a 7- to 8-week women-only pre-apprenticeship program, offered during the day and on evenings and Saturdays. The program's purpose is to prepare women for long-term success in skilled trade careers and to teach them what is expected of them on construction jobsites. The program also teaches women the math and reading skills necessary for success in the construction industry and evaluates individuals to determine their unique strengths and talents.

The program then matches graduates with specific opportunities in construction and transportation industries. Erik Antokal, NEW's workforce development officer, says that careers in the construction trades are "not presented as options" for women by educational institutions, or the media.

NEW offers access to apprenticeships and training. The training involves exercises such as practicing lifting and carrying 63-pound (29-kilogram) buckets and other construction materials. Participants graduate from the program with OSHA 10 certification, which refers to the Occupational Safety and Health Administration's 10-hour training—a requirement for union apprenticeships. Of 400 women per year trained by NEW, approximately 300 will graduate from the program. Of those 300, 150 are placed in union apprenticeship programs within 1 year.

Neilson wholeheartedly concurs that support is necessary to retain women in the construction industry. She notes that many women in apprenticeship programs quit, usually because they are not prepared either technically or emotionally to survive the culture of the industry. Neilson admits that being a woman on the jobsite can sometimes be humiliating if women enter the industry with no skills or support system, unlike some of their male counterparts. She says that young men often get a pass because they are known as "Robert's son" or "Tom's nephew."

Neilson adds that when new female apprentices began work, she and the other women on the job would quickly approach and warn them not to use their sexuality to be accepted on the jobsite. She explains that sometimes flirtation may be the natural fallback response when a woman feels insecure in her lack of experience with tools and equipment. Neilson stresses that by so doing, however, women take a dangerous step. Although they may experience an immediate positive response, they are less likely to be taken seriously or given meaningful work in the long run. Instead, she advises women to perfect a certain set of skills, as this knowledge and talent will be a valuable asset in the workforce now and in the future.

To help those women, Neilson recognizes that they need support, both emotional and technical. She and other women apprentices created a tradeswomen's leadership and supportive services program called "*Na Wahine Hana*," which is Hawaiian for "Women Working

Together." The support group offers after-hours skills training, such as opportunities for hands-on work with tools while building homes for Habitat for Humanity. But primarily the group provides mentorship and support to women without families or friends in the industry to pave the way. Currently, Neilson is coaching the developer of a program in Los Angeles based on the same model. This pilot program seeks to provide resources and referrals for women in the trades to "focus on the skills they need to hone now, for the future they envision and must tailor for themselves."

A Hopeful Future

The transportation industry is ripe to provide a groundswell of well-paying job opportunities. Women who have an interest in applying their problem-solving skills and earning family-sustaining wages may need to think outside traditional female roles. Introducing young women to the possibility of pursuing nontraditional job options is the first step. The next step is for each woman to identify her individual strengths and determine how they can translate into skills needed in the transportation trades.

Overcoming the challenge of working in a traditionally male-dominated industry should not be a deterrent. Women who are breaking into these industries want to help those who follow in their footsteps with a hunger to prove themselves.

There are laws that require employers to recruit women. There are organizations that provide women and small business owners with opportunities for internships and training. There are people, like the ground-breaking women above, who thrive on supporting other women who enter the industry. There are female business owners who are eager to support young women interested in starting their own transportation-related businesses. And, most of all, there are opportunities to work in the transportation industry.

To fill those positions, more women must become ready, willing, and able to receive training, get work, and excel in the transportation industry.

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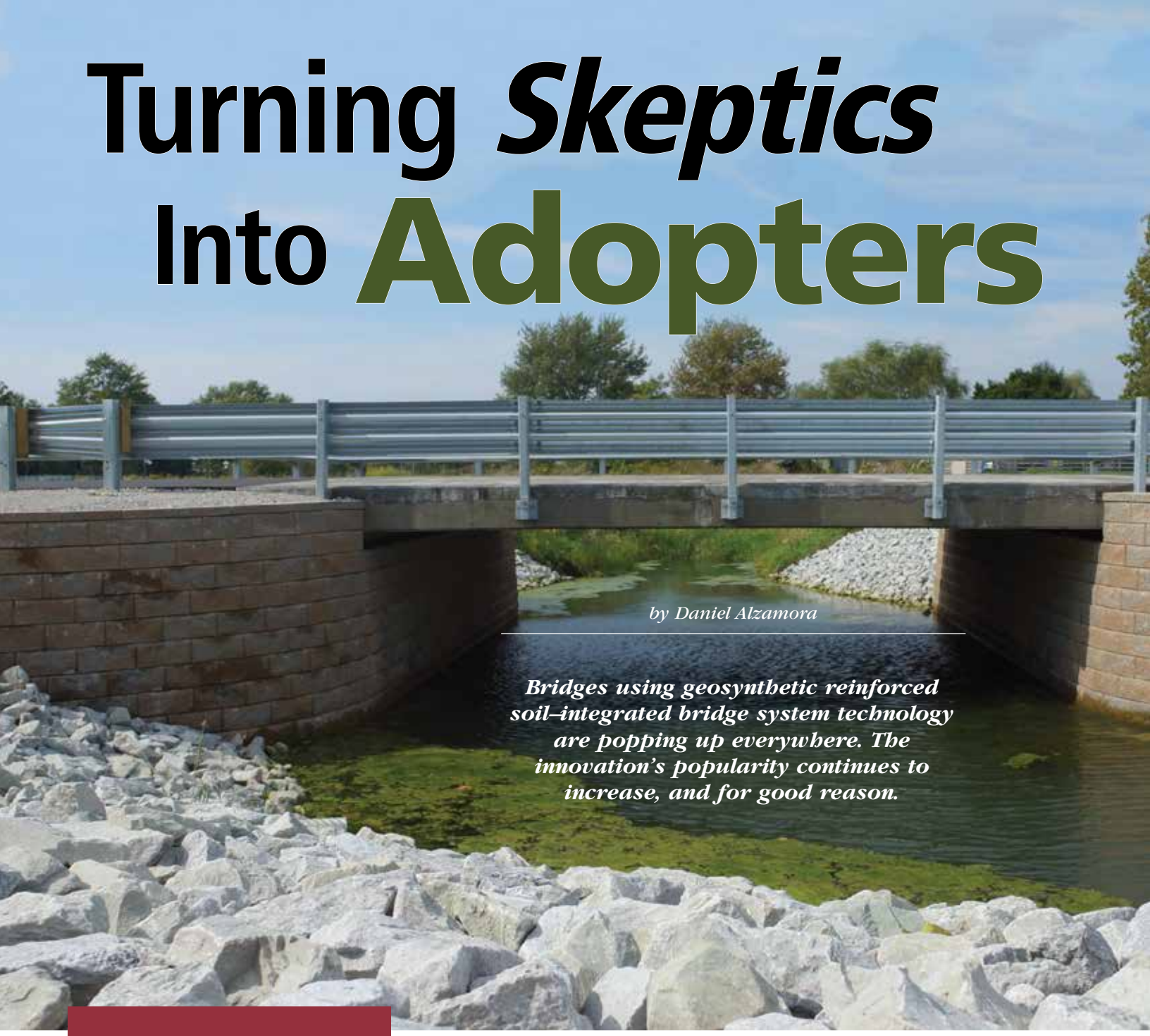
The transportation sector offers women the opportunity to apply a variety of skills in an in-demand industry. *Photo: © Getty Images, sturti.*

Turning *Skeptics* Into Adopters



by Daniel Alzamora

Bridges using geosynthetic reinforced soil–integrated bridge system technology are popping up everywhere. The innovation's popularity continues to increase, and for good reason.

(Above) The flexibilities of geosynthetic reinforced soil–integrated bridge system (GRS-IBS) technology can reduce bridge construction time considerably compared to traditional construction methods. In Indiana, for example, the Hamilton County Highway Department constructed the abutments on this GRS-IBS bridge in Hamilton County, IN, with rounded corners to save even more time and reduce material waste from cutting corner blocks. *Photo: Hamilton County Highway Department.*

Geosynthetic reinforced soil–integrated bridge system (GRS-IBS) technology enables transportation agencies to build durable structures quickly and cost effectively. However, before the Federal Highway Administration's Every Day Counts (EDC) program began promoting the innovation in 2011, only a few projects employed the technology. Cautious about the novel design, some engineers dismissed it at first because there was a general feeling of "that's not the way we build bridges."

EDC and other champions shined a spotlight on GRS-IBS, providing opportunities for the transportation community to learn about the benefits and expanding its use to more than 200 known bridges. Deployment through EDC also demonstrated the technology's versatility and applicability to a range of types of bridge structures, project sites, and construction materials.

GRS-IBS technology can reduce construction time from months to weeks, cutting work zone congestion, saving motorists time, and

enhancing safety. Construction costs can be 25 to 60 percent lower than for conventional bridges, enabling agencies to stretch limited resources while building and replacing the Nation's bridge infrastructure.

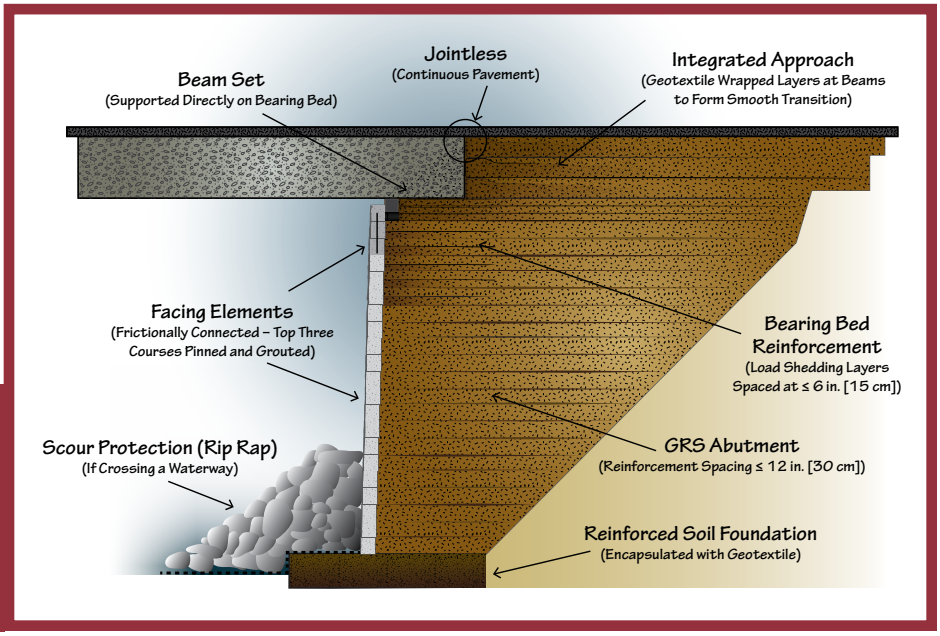
An Established Innovation

Developed by FHWA's Turner-Fairbank Highway Research Center, GRS-IBS is a rapid-construction, high-quality method of bridge support that blends the roadway into the superstructure. The technology consists of three primary components: the reinforced soil foundation, the abutment, and the integrated approach. Alternating layers of compacted granular fill and geosynthetic reinforcement create a composite material with predictable properties that can provide support for the superstructure, which rests directly on the GRS-IBS substructure to create a smooth, seamless transition. More information on design and construction is available in the *Geosynthetic Reinforced Soil Integrated Bridge System Interim Implementation Guide* (FHWA-HRT-11-026). An updated manual, *Design and Construction Guidelines for Geosynthetic Reinforced Soil Abutments and Integrated Bridge Systems* (FHWA-HRT-17-080), is slated for release in mid-2018.

Time and cost savings from the technology result from the simple design and construction procedures and materials, compared to traditional concrete abutments on deep foundations. GRS-IBS uses standard, readily available materials such as geosynthetic reinforcements and facing blocks to build a structure to support bridge loads. Construction crews can place fill with minimal effort while achieving the required strength and stiffness when using the recommended open-graded fill (a uniformly graded durable coarse aggregate) material. The properties of recommended reinforcement materials enable the efficient use of a single product, reducing material waste and complexity.

Because of the many benefits, FHWA selected the technology for promotion through EDC. FHWA supported deployment by providing technical assistance through EDC and funding projects and implementation activities through the Accelerated Innovation Deployment (AID) Demonstration and State Transportation Innovation Council (STIC) Incentive programs. The multidisciplinary EDC team leading the deployment collaborated with States, localities, tribes, and the FHWA Office of Federal Lands Highway to generate awareness through demonstration projects, presentations, webinars, videos, reports, and case studies.

Those efforts proved effective. By the end of the third round of EDC in December 2016, more than 200 bridges were built in 44 States in a variety of environments, demonstrating that GRS-IBS is a practical, cost-effective solution to replacing the Nation's aging infrastructure. Eleven States had adopted the technology as a standard practice. An additional 25 States, the District of Columbia, Puerto Rico, and Federal Lands Highway were demonstrating or assessing the technology for deployment in their bridge programs.



GRS-IBS technology consists of the reinforced soil foundation, the abutment, and the integrated approach, all of which use geosynthetic reinforced soil technology to create a bridge support that blends the roadway into the superstructure. *Source: FHWA.*

The prefabricated, prestressed concrete box girder, used on the Sand Creek Road bridge project in Wyoming shown here, is the most common superstructure type for GRS-IBS projects.

"EDC is a great tool to thoroughly educate bridge owners on the benefits of this technology. It allows the experts to have an open dialogue with owners who may be skeptical," says Michael P. Culmo, chief technical officer at CME Engineering, which helps the Connecticut Department of Transportation manage its bridge program and has designed GRS-IBS structures for the agency. "You really need to dig into the technology and give it careful thought. The more you look at it, the better it looks."

Success Stories

Deployment of GRS-IBS through EDC has produced many success stories that demonstrate the technology's flexibility and value for widespread use. In addition to accommodating various combinations of materials and bridge elements, GRS-IBS is applicable for a range of site conditions and geometries. For example, these bridges have been built on low- and high-volume roadways and across streams and railroads. In addition, these structures have been used in seismically active regions.

Promotion through EDC broadened understanding of the technology among transportation stakeholders. Many of those who deployed GRS-IBS continue the information exchange by discussing their experiences and lessons learned at project showcases, workshops, conferences, and professional society meetings. What follows is a closer look at the innovation's flexibility and current uses across the country.

Materials and Superstructure Types

GRS-IBS can use a variety of abutment materials to satisfy project design criteria. Wall facings can consist of concrete masonry units, segmental retaining wall units, precast panels, or sheet piles. Backfill types may vary based on factors such as drainage, strength requirements, and availability. Geosynthetic reinforcements are specified based on the requirements of the project design. With reinforcement spacing of 12 inches (30 centimeters) or less, many geosynthetic reinforcement products meet the material specifications, providing flexibility and reducing project cost. More information on design criteria and material selection is available in FHWA's *Interim Implementation Guide* and *Design and Construction Guidelines.*

This technology can support several superstructure types. The most common is prefabricated, prestressed concrete box girders, which Federal Lands Highway and Crook County, WY, used on four of the six Sand Creek Road bridges replaced in the Black Hills National Forest. The project used GRS-IBS technology because of its cost-effectiveness, rapid construction, and suitability for the site conditions. FHWA organized an EDC showcase in July 2016 at which transportation professionals from 10 States observed the GRS-IBS construction at the Sand Creek site.

Use on Low-Volume Roads

The Nation's first GRS-IBS bridge was built in Defiance County, OH, in 2005. The technology enabled Defiance County to cut costs on replacement of the Bowman Road Bridge by about 25 percent compared to costs using traditional techniques. Defiance County now has 36 GRS-IBS bridges—10 percent of the county's bridge inventory—built mostly with its own workers and local funds.

As Defiance County engineers built more GRS-IBS bridges and gained experience with the innovation, they shared their knowledge at EDC events and conferences, and with neighboring counties. Engineers in Hamilton County, IN, sought more information and guidance from Defiance County and FHWA in replicating the

The Mount Pleasant Road Bridge, shown here, was built by a county workforce in Huston Township, PA. *Photo: Pennsylvania Department of Transportation.*

The Utah Department of Transportation built twin bridges, one shown here, on I–84 near Salt Lake City, UT—the first GRS-IBS bridges designed for high average daily traffic and a high volume of truck traffic. *Photo: Utah DOT.*

successful application. Hamilton County built its first four GRS-IBS structures in 2015 and 2016.

"We were interested in GRS-IBS because of its flexibility to adapt to any project site and blend into the environment's aesthetic," says Faraz Khan, Hamilton County Highway Department engineer. "Construction knowledge and expertise can be easily infused into [a] skilled or unskilled workforce in minimum time, and [a] limited amount of construction equipment is needed onsite."

Hamilton County also chose the innovation to speed up construction and reduce costs, applying the savings from each project—about $55,000 to $75,000 per bridge on the county's first four projects—to future bridge projects. Among the solutions engineers developed to lower costs was using locally available, segmental retaining wall units for constructing abutments. On two bridges, crews built the abutment walls with rounded corners instead of 90-degree corners, which eliminated the need to cut blocks to fit the corners, reduced construction time, and minimized material waste.

"Approximately 20 to 30 minutes were being spent on custom fitting corner blocks on each GRS-IBS layer," says Khan. "Our onsite solution expedited construction time [on erection of] the GRS-IBS abutment wall and eliminated any cutting of the blocks."

Huston Township, PA, used its own crews and equipment and economical materials to construct Pennsylvania's first State-funded GRS-IBS bridge on Mount Pleasant Road in 2011. Interest spread among other Pennsylvania municipalities and resulted in the construction of an additional 24 GRS-IBS bridges on low-volume State and local roads. To help municipalities plan and build projects, the Pennsylvania Department of Transportation (PennDOT) developed design guidance. The guidance has been instrumental in deploying the technology throughout Pennsylvania.

"The process was placed into a specification for low-volume roads after the first couple of projects were completed," says G. Randy Albert, supervisor of PennDOT's municipal services. "It was then adapted for PennDOT use, and we are refining the specification to allow it to be used on more bridges. As more projects are completed and the process proves its merit, I believe it will be more widely adopted as a viable alternative for bridge construction."

On the National Highway System

After early deployment on low-volume local roads, use of the technology expanded to the National Highway System (NHS). The I–84 bridges over Echo Frontage Road near Salt Lake City, UT, were the first GRS-IBS structures constructed for higher average daily traffic (ADT)—8,300 vehicles, including 40 percent trucks. The project also was the first to combine the innovative technology with slide-in bridge construction, an accelerated method in which a construction team builds the new bridge on temporary supports next to the existing bridge and then slides it into place during a road closure.

From 2013 to 2015, 20 GRS-IBS bridges were built on NHS roads including interstates with ADTs ranging from 2,000 to 34,000. The early performance of these structures demonstrates how well the system manages traffic loads.

Every Day Counts showcases, like this one during the construction of two bridges in Dodge County, WI, enable transportation professionals to observe GRS-IBS construction in person.

Over Streams and Railroads

A project in Dodge County, WI, to replace two bridges over streams was one of several that demonstrated the feasibility of the technology for water crossings. The project highlighted the resilience of the system when flooding of a cofferdam during abutment construction immersed the half-finished abutment on one bridge. No damage occurred to the constructed section, and construction resumed quickly.

During an EDC showcase on the project, participants observed the construction of the wall facing at one bridge site and placement of the pavement overlay on top of the concrete girders at the other bridge.

As of early 2018, two States have built GRS-IBS bridges over railroads, which typically require taller walls and longer spans to accommodate trains passing beneath. The Minnesota Department of Transportation coordinated with the Rock County Highway Department to build their first on County Route 55 over Minnesota Southern Railway tracks in Rock County, MN, in 2013. The project included abutment walls up to 26 feet (8 meters) high built with concrete masonry blocks and a 78-foot (24-meter) span with precast concrete girders as the superstructure. A unique feature was the 5.3-percent grade required to provide clearance for passing trains.

The second was the State Route 7A Bridge over the Housatonic Railroad in Sheffield, MA, which featured the maximum skew for a GRS-IBS bridge at the time of the 2014 project. The bridge required a single 105-foot (32-meter)-long span with a 30-degree skew and abutments that provide clearance up to 28 feet (8.5 meters) in height to accommodate passing trains. FHWA instrumented and monitored the bridge for 36 months after construction to determine the effect of the skew and found that the bridge performed as intended. The project, which was featured in an EDC demonstration showcase and earned several national awards for its innovative techniques, is one of the largest constructed with GRS-IBS and cost nearly 50 percent less to build than the alternative design.

In Seismically Active Areas

Several implementers have designed and constructed GRS-IBS structures for seismic loads, including the I–84 bridge over Echo Frontage Road in Utah and the PR–2 Bridge in Yauco, Puerto Rico. Federal Lands Highway also has used the technology on projects in more active seismic regions, including the Disney Bridge in Sequoia National Park and a bridge on Beckwourth Genesee Road over Crocker Creek in Plumas National Forest, both in California.

The Daniel K. Inouye Highway GRS-IBS underpass on the Big Island of Hawaii was the first GRS-IBS bridge designed for a relatively high (0.58g) peak ground acceleration (PGA), the horizontal acceleration represented as a fraction of Earth's gravity. Because guidance did not exist at the time for seismic design of GRS abutments subjected to 0.58g PGA, the design team developed the procedures, advancing design guidance for future GRS-IBS structures in seismic zones.

Minnesota's first GRS-IBS bridge, shown here, was built on County Route 55 over Minnesota Southern Railway in Rock County. The bridge has abutment walls up to 26 feet (8 meters) high and a 78-foot (24-meter) span to accommodate trains passing underneath. *Photo: Minnesota Department of Transportation.*

The design team for the Daniel K. Inouye Highway GRS-IBS underpass in Hawaii developed guidance for seismic design of geosynthetic reinforced soil abutments in a seismically active location.

Analyzing the Cost Benefits

Lower cost is one of the chief reasons the technology is succeeding as a bridge construction method. In many cases, agencies select the technology because of limited funds. Across the country, States and localities report that using the innovation can save 25 to 60 percent on projects, enabling agencies to build and replace more bridges with available funds using their own labor forces.

PennDOT collected and analyzed the costs of its GRS-IBS bridges, comparing them to conventional bridge projects with similar geometry and site conditions. The comparisons showed that GRS-IBS technology generated savings of as much as 50 percent. Communicating the results of the cost analysis to transportation stakeholders contributed to the spread of the technology in Pennsylvania. By the end of 2017, Pennsylvania municipalities, PennDOT, and the Pennsylvania Department of Conservation and Natural Resources had built nearly 30 of these structures.

"In my experience, with a well-planned, well-executed, and closely monitored project, there is no reason that up to 50 percent savings cannot be achieved," says PennDOT's Albert.

The St. Lawrence County Department of Highways in New York also found that using GRS-IBS reduced bridge costs by about 50 percent compared to conventional construction methods. In addition, the technology shortened average project duration by 5 or 6 weeks. The department, which designs and builds most of the county's bridges, attributes its ongoing success with the innovation to applying lessons learned from past projects. Between 2009 and 2016, the department built 19 of these bridges and 2 bridge-style culverts in St. Lawrence County at a rate of 3 per year. In addition, the county has identified about half of the 194 bridges it owns as eligible candidates for replacement with the innovative technology. Plans are in place to replace those structures using GRS-IBS.

A Versatile Solution For Bridges

GRS-IBS technology is one solution among many to support bridge projects. When used on appropriate projects, the technology can save time and money. Bridge owners should review the specific site conditions—including hydraulic, environmental, and geotechnical—when considering the technology for a project.

Shining the EDC spotlight on this innovation proved to be an effective way to promote the technology and broaden its use. The EDC deployment team's efforts exposed transportation practitioners to the advantages of GRS-IBS and its many applications, significantly increasing the number of projects implemented across the country. With each deployment, increased knowledge about the technology highlighted its versatility and applicability to various project types and site conditions. As a result, GRS-IBS is helping agencies stretch limited resources and build and replace more bridges at lower costs, which will continue to benefit transportation agencies and the taxpayers they serve.

Daniel Alzamora, P.E., is a senior geotechnical engineer at the FHWA Resource Center. He led the EDC team promoting deployment of GRS-IBS technology. Alzamora earned a master's degree in civil/geotechnical engineering from the University of Colorado and a bachelor's degree in civil engineering from the University of Connecticut.

For more information, see www.fhwa.dot.gov/innovation/everydaycounts/edc-3/grs-ibs.cfm or Deployment of the Geosynthetic Reinforced Soil–Integrated Bridge System From 2011 to 2017 Synthesis Report (FHWA-HIF-17-043)*, which is slated for release in mid-2018. Or contact Daniel Alzamora at 720-963-3214 or daniel.alzamora@dot.gov.*

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Technical News

Secretary Chao Announces Drone Program

U.S. Secretary of Transportation Elaine L. Chao recently launched an initiative to safely test and validate advanced operations for drones in partnership with State and local governments in select jurisdictions. USDOT will use the results of the Unmanned Aircraft Systems (UAS) Integration Pilot Program to accelerate the safe integration of UAS into the national airspace and to realize the benefits of unmanned technology in the Nation's economy.

Highway agencies use unmanned aerial systems—or drones—like this one for surveying, inspections, and monitoring.

The program will help USDOT and the Federal Aviation Administration develop a regulatory framework that will allow more complex low-altitude operations and identify ways to balance local and national interests. The framework also will improve communications with local, State, and tribal jurisdictions; address security and privacy risks; and accelerate the approval of operations that currently require special authorizations.

The pilot program will evaluate a variety of operational concepts, including night operations, flights over people, flights beyond the pilot's line of sight, package delivery, detect-and-avoid technologies, counter-UAS security operations, and the reliability and security of data links between pilot and aircraft.

Industries that could see immediate opportunities from the program include infrastructure inspections and monitoring, emergency management, precision agriculture, commerce, and photography.

For more information, visit www.faa.gov/uas/programs_partnerships/uas_integration_pilot_program/splash.

FHWA Demonstrates Truck Platoons on I–66

In fall 2017, the Federal Highway Administration hosted a demonstration of three-truck platoons on I–66 in Centreville, VA. The demonstration was the culmination of a 4-year FHWA Exploratory Advanced Research (EAR) project to test the effectiveness of state-of-the-art driving and communications technologies. Event attendees had the opportunity to ride inside the trucks and experience these technologies firsthand.

Transportation researchers have studied various aspects of truck platooning for years. FHWA's EAR program has added cooperative adaptive cruise control technology and incorporated a third truck into the platoon. Cooperative adaptive cruise control adds vehicle-to-vehicle communications to the adaptive cruise control capability now available in new vehicles. This connectivity enables trucks to operate more smoothly as a unit, reducing and controlling the gaps between vehicles.

The demonstration involved partially automated trucks (which are not driverless) and used professional drivers. The drivers continued to steer the trucks while the system controlled the throttles and brakes. The advanced technology that makes platooning possible is meant to supplement, not replace, the Nation's commercial motor vehicle operators.

Truck platooning offers key benefits, including reduced fuel costs and increased road efficiency while maintaining safety. FHWA conducted the demonstration with EAR project partners as well as local partners, including the Virginia Department of Transportation, the Fairfax County Park Authority, and State and county police.

For more information, contact Osman Altan at 202-493-3391 or osman.altan@dot.gov.

Colorado Introduces Self-Driving Work Zone Vehicle

The Colorado Department of Transportation (CDOT) recently unveiled a first-of-its-kind work zone vehicle designed to advance safety for roadway maintenance crews. This self-driving truck, known as the Autonomous Impact Protection Vehicle (AIPV), is designed to withstand hits from vehicles and is customarily positioned

CDOT

Colorado's Autonomous Impact Protection Vehicle increases work zone safety by removing the driver from a vehicle designed to provide a buffer between traffic and roadway workers.

behind road construction crews to protect workers from the traveling public.

CDOT and a host of partners showcased the AIPV in action without a driver during a live roadway striping operation in Fort Collins, CO. As part of its RoadX program, CDOT and its partners adapted military technology for the AIPV, which uses a rear-mounted attenuator (or crash cushion) to absorb or deflect vehicles that cross into work zones. RoadX represents CDOT's vision and commitment to being a national leader in using innovative technology to create travel in Colorado that is free of crashes, injuries, and delays.

Between 2000 and 2014, Colorado had 21,898 crashes and 171 fatalities in work zones. According to FHWA, in 2015, there were 70 crash-related injuries every day and 12 crash-related fatalities every week in work zones. The AIPV is designed to reduce these numbers by using technology to mimic the position, speed, and direction of a lead vehicle that transmits a signal to the trailing driverless vehicle, ensuring the AIPV is always correctly positioned between roadway workers and live traffic.

Prior to the live roadway operation, CDOT conducted extensive testing of the AIPV's emergency stopping and obstacle detection systems. Testing also confirmed the vehicle's ability to stay in its lane and make tight turns.

For more information, visit www.codot.gov /programs/roadx.

CDOT

Public Information and Information Exchange

Driver Statistics Continue to Set Records

In November 2017, FHWA published data showing that the United States had a record-high 221.7 million licensed drivers in 2016. All but five States saw increases among licensed drivers in 2016 compared to the previous year.

The data show that 41.7 million—or almost one in five—drivers are 65 years or older and that this age group is growing faster than any other. The largest single-year percentage increase in licensed drivers in 2016 was among those who are between 75 and 79 years old, increasing by 4.98 percent over the previous year. Drivers aged 85 or older increased by more than 161,000 people—or 4.62 percent—since the previous year, making them the Nation's second-fastest growing demographic group in 2016.

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U.S. drivers between 75 and 79 years old were the fastest growing demographic in 2016, followed by drivers aged 85 or older.

Drivers 20 to 34 years old account for nearly one in four U.S. drivers, increasing slightly to 57 million drivers from the 56.1 million reported in 2015. Teen drivers continued to increase slightly for the third year in a row, rising to 8.8 million—the highest level since 2013, but remaining at among the lowest levels since the Federal Government began compiling driver license data in 1963.

FHWA collects license data from all 50 States and Washington, DC. Published in FHWA's *Highway Statistics*, an annual compilation of information about drivers, vehicles, and roads, the data reflect the growing demands on the U.S. highway system and inform decisions by transportation policymakers, researchers, and academia.

For more information, visit www.fhwa.dot.gov /policyinformation/statistics.cfm.

New Publication Available for Accessible Shared Streets

Shared streets are streets in which pedestrians, bicyclists, and motor vehicles are intended to mix in the same space. Communities across the United States are implementing shared streets for a variety of reasons, including to foster economic development, improve safety, provide more flexible public space, and accommodate demand for more walking and bicycling opportunities. As the shared street concept gains momentum, it is important to ensure that the designs for shared streets meet the needs of all users. To help, FHWA recently published *Accessible Shared Streets: Notable Practices and Considerations for Accommodating Pedestrians with Vision Disabilities* (FHWA-HEP-17-096).

The publication includes a description of shared streets, an overview of vision disabilities, and the strategies that people with vision disabilities use to navigate in the public right-of-way. It goes on to discuss the specific challenges faced by pedestrians with vision disabilities when they are navigating shared streets. In addition, *Accessible Shared Streets* provides an overview of relevant U.S. guidance, a toolbox of strategies for designing shared streets that improve accessibility for pedestrians with vision disabilities, and ideas on how accessibility for those pedestrians can be addressed in the planning and design process.

Accessible Shared Streets provides information from case studies that highlight accessibility features and lessons learned, as well as a bibliography that includes sources referenced in the publication and other sources that inspired its content and may be useful for the designers of shared streets.

For more information, visit www.fhwa.dot.gov /environment/bicycle_pedestrian/publications /accessible_shared_streets/fhwahep17096.pdf.

Arizona Launches Website for Responders

The Arizona Department of Transportation (ADOT) recently unveiled a new website to help make responses to traffic incidents more efficient and vehicle travel safer for motorists in Arizona. Developed by ADOT and the State's Department of Public Safety, the Arizona Traffic Incident Management (TIM) site aims to be the go-to resource for training that targets Arizona TIM responders.

"Effective traffic incident management keeps the public safe, emergency responders safe, and traffic moving," says Derek Arnson, manager of ADOT's Traffic Management Group. "It's important that everyone who responds to a traffic incident, from law enforcement to tow truck operators, [is] working together and following the same practices."

TIM is the coordinated practices, responsibilities, and cooperation of emergency responders, which includes law enforcement, fire departments, medical services, transportation crews, and tow truck operators, at traffic incidents. Coordinated efforts help keep crash victims and emergency responders safe, while restoring traffic flow.

Although the website is geared toward emergency responders, it also offers tips for the public, including videos and infographics related to Arizona's Move Over law, quick clearance, and work zone safety.

For more information, visit https://tim.az.gov.

TRB Signs Memoranda of Understanding With Partners

The Transportation Research Board (TRB) recently signed memoranda of understanding with the Conference of Minority Transportation Officials (COMTO), the International Road Federation (IRF), and WTS International (formerly Women's Transportation Seminar).

"In order to conduct exemplary research, TRB relies on domestic and international partnerships with other transportation organizations," says Neil Pedersen, executive director of TRB. "Through memoranda of understanding with IRF, COMTO, and WTS, TRB will continue to foster collaboration within the transportation research community."

On November 15, 2017, Pedersen signed a memorandum of understanding with Kiran K. Kapila, chairman of IRF, and Susanna Zammataro, executive director of IRF. Headquartered in Geneva, Switzerland, IRF is a nongovernmental, nonprofit organization with the mission to promote the development of roads and road networks that enable access and sustainable mobility for all. The agreement was signed at the IRF World Road Meeting 2017 in New Delhi, India.

In January 2018, Pedersen signed memoranda with Diane Woodend Jones, WTS International's board chair, and A. Bradley Mims, president and chief executive officer of COMTO. WTS is an international organization dedicated to building the future of transportation through the global advancement of women, and COMTO provides a forum for minority professionals in the transportation industry. Both agreements were formalized during the 2018 TRB Annual Meeting in Washington, DC.

TRB

Risdon Photography

TRB's Neil Pedersen and IRF's Susanna Zammataro sign the memorandum creating a partnership between the two organizations.

Personnel

TIM Program Reaches Training Milestone

U.S. Transportation Secretary Elaine Chao joined officials representing first responders at an event in November 2017 to announce that 300,000 emergency responders have completed FHWA's training for traffic incident management responders. The 5-year-old TIM training program is a national effort to improve the safety of first responders on the scene of highway crashes.

"The courage and dedication of America's emergency responders is inspiring as well as life-saving," says Secretary Chao. "Traffic incident management training helps save the lives of first responders, who put their own safety at risk every day when they go to work and respond to. . . highway crashes."

The event, held during National Traffic Incident Response Awareness Week, highlighted the commitment of first responders. To assist their efforts and to ensure their safety, FHWA developed the TIM course. Designed by and for responders, the course helps build teams of well-trained police, firefighters, highway workers, and emergency medical and towing personnel. Together, they learn a common set of practices, including quick clearance techniques that improve communications and reduce the amount of time needed on scene. The training will remain available along with a refresher course.

The 300,000 emergency responders who have completed the training represent all 50 States; Washington, DC; and Puerto Rico.

To read Secretary Chao's full remarks, visit www.transportation.gov/briefing-room/national -traffic-incident-response-awareness-week.

Reporting Changes of Address

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Internet Watch

by Abdul Zineddin

Improving IHSDM to Increase Roadway Safety

Safety is at the forefront of all stages of project development, from planning, analysis of alternatives, and design to construction and operations. To help practitioners improve safety in their projects, the Federal Highway Administration has developed a variety of advanced analysis methods and tools. One of these is the Interactive Highway Safety Design Model (IHSDM), a suite of software analysis tools for evaluating the safety and operational effects of decisions related to geometric design.

IHSDM supports data-driven safety analysis, one of the innovations FHWA is championing under round four of its Every Day Counts initiative. Typical applications of the model include evaluating the safety impact of highway improvements, comparing the relative safety performance of design alternatives, and assessing the cost-effectiveness of design decisions in relation to the safety results. IHSDM helps users implement the American Association of State Highway and Transportation Officials' *Highway Safety Manual* Part C: Predictive Method. The tool also can be an integral part of road safety audits.

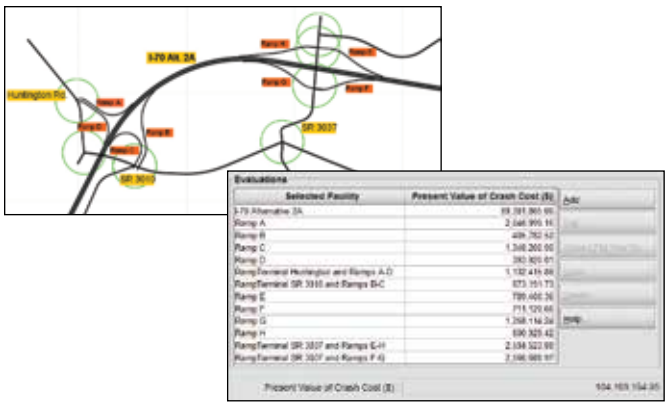
The software includes six evaluation modules, which provide quantitative information on the expected safety and operational performance of a highway design: Crash Prediction, Policy Review, Design Consistency, Traffic Analysis, Intersection Review, and Driver/Vehicle. In fall 2017, FHWA released version 13.0.0 of IHSDM. The latest version adds the Economic Analyses Tool, enabling users to conduct benefit-cost assessments within IHSDM using evaluation results (crash frequencies and severities) from the Crash Prediction module.

Adding New Analytic Capability

The initial version of the Economic Analyses Tool applied to freeways and was expanded in March 2018 to include all facility types covered by Part C of the *Highway Safety Manual*. These include rural two-lane and multilane highways, urban and suburban arterials, and freeway segments and interchange components (such as ramps).

The Economic Analyses Tool supports benefit-cost analyses, including comparisons of crash cost reductions of alternative designs compared to construction and maintenance costs. The tool provides default values for crash unit costs—the costs per crash for different severities—as well as discount rate and crash cost index, used to determine the "present value" of benefits and costs. Users also may enter their own values by using the IHSDM Administration Tool.

In November 2017, FHWA hosted a webinar titled "IHSDM 2017 and the New IHSDM Economic Analyses Tool." A recording of the webinar, as well as presentation slides are available at www.ihsdm.org/wiki/IHSDM_2017_Web_Conference. The developers also added a tutorial and user guide for the Economic Analyses Tool into the software itself, which includes a sample project when downloaded.



These screenshots show alternative 2A for Pennsylvania's interchange project on I–70 as illustrated in the IHSDM Highway Viewer (above) and the interface of the IHSDM Economic Analyses Tool (below) with the calculated present value of crash costs for 2018–2038.

Applying the Economic Analyses Tool

To illustrate the capabilities of the tool, FHWA performed an economic analysis on a project that had previously used the IHSDM for a safety evaluation.

In 2015, the Pennsylvania Department of Transportation (PennDOT) identified a need to modify an existing set of closely spaced interchanges on I–70 in western Pennsylvania. A request submitted by PennDOT to the FHWA Pennsylvania Division Office focused primarily on two alternatives. The first, alternative 2A, retained the two closely spaced interchanges with some mainline improvements. The second, alternative 3, removed one of the interchanges and added a new connector road and local roadway network improvements.

FHWA's Geometric Design Lab used the IHSDM Crash Prediction Module to perform a safety evaluation of the two alternatives for the period of 2018–2038. The results showed that alternative 2A was superior in terms of expected safety performance (587 expected total crashes compared to 652 for alternative 3).

In 2017, to provide an example for using the new IHSDM Economic Analyses Tool, the Geometric Design Lab performed an economic analysis using the results of the I–70 Crash Prediction Module evaluation for the freeway components. As part of a benefit-cost analysis, the researchers estimated the present value of crash costs for 2018–2038 at $104 million for alternative 2A.

Monique Evans, director of FHWA's Office of Safety Research and Development, says, "The IHSDM Economic Analyses Tool will assist State and local highway agencies in making sound investment decisions by quantifying safety-related benefits and costs of project alternatives."

Download the IHSDM software for free at www.ihsdm.org.

For more information, contact Abdul Zineddin at 202-493-3288 or abdul.zineddin@dot.gov.

Abdul Zineddin is a transportation specialist in FHWA's Office of Safety Research and Development.

by Judy Francis and Vanessa Almony

Support for Successful Transportation Asset Management

Managing transportation assets—for example, roads and bridges—is essential to maintaining the Nation's vitality. Transportation asset management is a strategic approach for managing physical transportation infrastructure, which results in effective management and greater cost-effectiveness. Using quality data is key to driving decision making that focuses on achieving and sustaining a desired state of good repair over the life cycle of assets.

To help transportation agencies provide reliable and transparent management practices and excellent customer services with a diminishing pool of resources, the National Highway Institute (NHI) offers an array of training solutions. Recently, NHI made updates and additions to its series of trainings on transportation asset management. Whether an agency is focusing on meeting current requirements or planning for future enhancements and implementation, NHI has a new or recently updated course to help.

Tools for Effective Management

NHI updated two instructor-led courses in late 2017 to reflect the asset management rule (23 CFR part 515). The new rule established the process and minimum requirements to develop a State's asset management plan.

Introduction to Transportation Asset Management with Workshop (course number 136106A), is a basic course that covers the principles of transportation asset management in 1.5 days. Participants explore the core questions every agency should be able to answer about its assets. Course content includes a summary of specific provisions related to asset management and a tool for agencies to use to identify gaps between their desired and actual use of the principles of transportation asset management.

The other 1.5-day training in this series is Developing a Transportation Asset Management Plan (course number 136106B). Participants learn to use the transportation asset management plan as an effective planning, communication, and accountability tool. The course includes the latest guidance from the Federal Highway Administration on risk management, life-cycle planning, and financial planning. Course content focuses on core areas of financial management, strategic life-cycle management, and risk assessment. (This course requires completion of course number 136106C as a prerequisite and completion or equivalent knowledge of material covered in 136106A.)

Throughout both courses, participants apply what they have learned by working through real-life scenarios that enhance their ability to support and implement transportation asset management in their agencies.

Both trainings are intended for mid-level and senior-level managers from State departments of transportation and other transportation agencies that are responsible for decision making in one or more areas addressed by transportation asset management. Personnel who manage individual assets or provide critical information to senior managers, or who have direct responsibility for meeting specific condition targets for highway infrastructure assets, will find these trainings applicable as well. Members of an agency's asset management steering committee (if available) also would be candidates for these training events.

The courses are most beneficial to an agency when participants represent a broad range of organizational units, such as planning, engineering (facility management, design, and construction), capital programming, maintenance and operations, financial management, traffic and safety engineering, system operation and management, and information technology.

Supplementing the updated instructor-led courses is a free, 1-hour, Web-based training that explains the basics of a transportation asset management plan, Introduction to a Transportation Asset Management Plan (136106C). The course offers foundational information, such as how a transportation agency uses a transportation asset management plan and what kind of information is included in one. This course is available on its own, and it also serves as the prerequisite for instructor-led course 136106B.

Drafting a Financial Plan

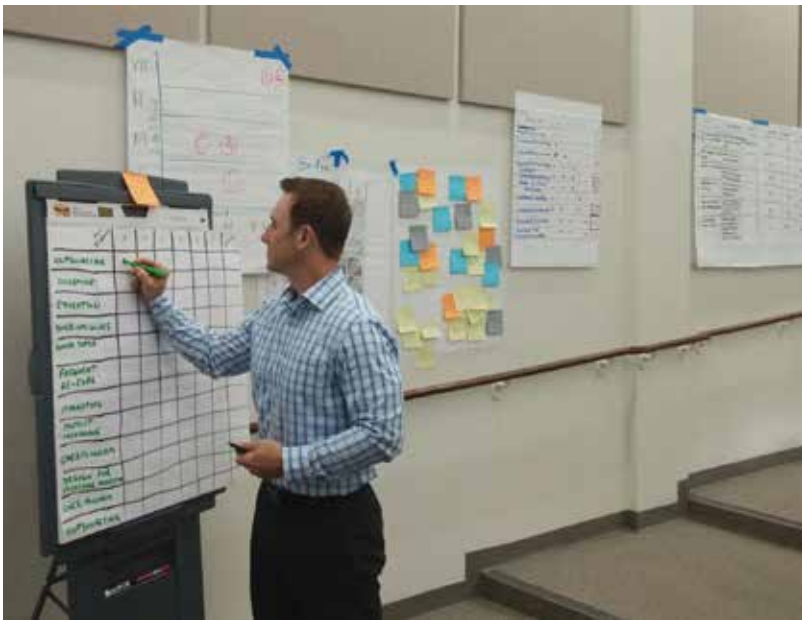
NHI added two new courses to its asset management catalog in 2017: Introduction to Financial Planning for Transportation Asset Management (Web-based course number 136002A) and Financial Planning for Transportation Asset Management (instructor-led course number 136002). In the free, hour-long introductory course,

Vanessa Almony, contractor for NHI

Participants in Financial Planning for Transportation Asset Management break into small groups to craft content for an agency-specific financial plan outline and to identify gaps in their agency's readiness.

135002A, participants build foundational knowledge by exploring financial planning in the context of transportation asset management and by reviewing common vocabulary and background information. This Web-based training is recommended for transportation professionals who are involved with, or interested in, developing a financial plan. The Web-based training also serves as a prerequisite to the in-depth, application-based instructor-led course, Financial Planning for Transportation Asset Management (course number 136002).

"Financial plans provide an excellent opportunity for agencies to demonstrate to constituents that they are responsibly managing their transportation assets," says Nastaran Saadatmand, FHWA's asset management expert and technical leader during the course development. "Agencies with a mature asset management program also can use the financial plan to demonstrate how current and future funding gaps or inadequate funding to support a strong preventive maintenance program could negatively influence the value of transportation assets and long-term asset performance."



Vanessa Almony, contractor for NHI

A Risk Management participant captures his team's input in one of the many learning activities that identify, prioritize, propose responses to, and plan for monitoring risk.

A facilitator leads the Financial Planning for Transportation Asset Management class (136002) through the key content areas of a financial plan. Over the course of 1.5 days, small groups explore approaches to developing a financial plan and generate a plan outline that includes each content area. The groups identify gaps that could reduce the plan's effectiveness and identify the next steps their agency must take to fully develop the financial plan. The instructor evaluates the teams' financial plan outlines. Participants leave the classroom with a useful work product that they can further develop and use in their agency's financial planning process.

This training is recommended for anyone involved with developing the financial plan, including chief financial officers, asset managers, program managers, financial managers, maintenance directors, planners, and their staff. While titles and roles vary from agency to agency, staff involved in developing a financial plan generally consist of engineers, planners, analysts, accountants, auditors, and data managers. Participants may include staff from one transportation agency or could include a blend of State and regional participants from metropolitan planning organizations or rural planning organizations.

Identifying and Managing Risk

Managing transportation networks—including agency management, program development, and project delivery—is extremely complex and fraught with uncertainty. Any agency can use risk management as FHWA does: to focus limited resources, to strengthen its ability to prioritize, to improve communication, and to foster transparent leadership.

Risk Management (136065) is a course for agency professionals who direct or manage any aspect of highway-related programs and projects, such as planning, environment, project development, design, construction, operations, maintenance, and finance. Asset management practitioners will find the Risk Management course content helpful as they develop asset management plans. No previous risk management experience is required to enroll in or benefit from this course. This recently updated 2-day, instructor-led training delves into the principles, tools, and techniques used to identify, prioritize, respond to, and monitor risk at any level of an organization (enterprise, program, project, or activity).

This training is based on FHWA's generally accepted risk management principles and practices. It combines limited instructor presentations with robust group discussions and multiple realistic, job-relevant exercises that help participants identify risk, develop risk response strategies, and apply the risk management process to their own level of decision making within the organization. Assigned teams work on agency-specified objectives and leave class with tools for identifying, prioritizing, and responding to risk, including a partially completed risk register template that they can use as a basis for risk management in their current positions.

For more information on these courses, to register for a session, or to sign up to receive alerts when sessions are scheduled, visit www.nhi.fhwa.dot.gov and search by course number.

Judy Francis is a contracted marketing analyst for NHI.

Vanessa Almony is a contracted instructional designer 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 website 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
Website: www.ntis.gov
Email: customerservice@ntis.gov

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

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Szanca Solutions/FHWA PDC
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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 website at www.fhwa.dot.gov, the FHWA Research Library at www.fhwa.dot.gov/research/library (or email fhwalibrary@dot.gov), or the National Transportation Library at ntl.bts.gov (or email library@dot.gov).

Behavior of a Steel Girder Bolted Splice Connection (Report) Publication Number: FHWA-HRT-17-042

This report compares two design methods for bolted field splice connections on steel bridges. Using computer models, researchers created a hypothetical three-span steel bridge. They designed the connections using both a traditional method and a new method that makes conservative assumptions resulting in a simpler, streamlined procedure.

The researchers found that the design methods resulted in no difference in the numbers of bolts required for the flange splices. However, the models showed a significant difference in the number of bolts required for the web splices, with the new method requiring only two columns of bolts at a much larger spacing. Overall, the new method required 104 fewer bolts than the traditional method, making the connection more economical. The new method proved successful because it did not result in overstressing the girder or bolts at the strength limit state.

Partly because of this work, in June 2016, the American Association of State Highway and Transportation Officials voted to adopt a new method for the design of bolted connections for steel bridges.

The document is available at www.fhwa.dot.gov/publications/research/infrastructure/structures/bridge/17042/index.cfm.

Advanced Methodology to Assess Riprap Rock Stability at Bridge Piers and Abutments (Report) Publication Number: FHWA-HRT-17-054

Riprap is one of the most common materials used to protect bridge abutment and pier foundations from scour, or the removal of sediment by moving water. A key element of the design of riprap countermeasures is rock sizing, which is based on equations generally derived from simplified laboratory experiments. This report describes an advanced, numerical modeling procedure for analyzing the stability of riprap at bridge abutments and piers.

Researchers developed a new, advanced computational methodology for assessing the failure risk of geometrically complex riprap installations. They demonstrated that detailed fluid-structure interaction modeling can inform the evaluation of rock riprap movement for both the analysis of existing riprap aprons and for the design of new riprap aprons. The approach combined software for computational fluid dynamics and for computational structural mechanics.

Researchers computed the flow threshold for the onset of motion of a set of representative riprap rocks for both simplified laboratory and complex field conditions. They used physical laboratory experiments to validate the numerical procedures. Researchers also tested the methodology on a complex field case study of a riprap installation at a pier for a bridge over the Middle Fork of the Feather River in California. Although the case study application was successful, the approach is constrained

by its high costs and limited availability. Consequently, good candidate applications for using the analysis to assess new or retrofit riprap installations are those with significant project costs or catastrophic failure risks.

This report also includes various recommendations for improving the design, installation, and monitoring of riprap apron installations at bridge piers and abutments, where feasible. Designers and engineers responsible for protecting bridge foundations will likely find this report useful.

The document is available at www.fhwa.dot.gov/publications/research/infrastructure/structures/bridge/17054/index.cfm.

Safety Evaluation of Edge Line Rumble Stripes (ELRSs) on Rural, Two-Lane Horizontal Curves (TechBrief) Publication Number: FHWA-HRT-17-068

Several research studies have examined the use of shoulder rumble strips, but research into the performance of edge line rumble stripes (ELRSs) is rare. Rumble stripes are rumble strips created by placing edge line pavement markings over rumble strips. ELRSs are a variation of the common shoulder rumble strips used to alert drowsy or distracted drivers when they leave the travel lane to the right. Both target run-off-road crashes.

Shoulder rumble strips are located on the shoulder between the pavement marking and the outside edge of the pavement and are offset from the edge line pavement marking. In contrast, ELRSs are installed where the edge line pavement marking would normally be placed, and the pavement marking is installed directly over the rumble strip. In this way, the rumble stripes are closer to the travel lane than common shoulder rumble strips.

In addition, milled rumble strips generally are installed on roadway segments consisting of both horizontal tangents and horizontal curves. Installations on only horizontal curves are uncommon and, therefore, safety evaluations have not focused specifically on the effectiveness of horizontal curves. In addition, vertical faces are created within the milled rumble strip to which pavement markings are applied, thereby enhancing the visibility of the edge line during nighttime and wet-weather conditions.

This technical brief discusses research focused on the safety effectiveness of ELRSs on rural, two-lane horizontal curves in Kentucky and Ohio. Researchers aimed to estimate the safety effectiveness of ELRSs as measured by crash frequency. A further objective was to conduct a disaggregate analysis to investigate whether the safety effects vary by factors such as traffic volumes, the frequency of crashes before treatment, posted speed limit, and shoulder width. The evaluation of overall effectiveness included a benefit-cost ratio that considered the installation costs and crash savings.

The document is available at www.fhwa.dot.gov/publications/research/safety/17068/index.cfm.

Safety Evaluation of Red Light Indicator Lights (RLILs) at Intersections (Report) Publication Number: FHWA-HRT-17-077

This report covers research conducted as part of FHWA's Evaluation of Low-Cost Safety Improvements Pooled Fund Study. The document details a study that evaluated the safety effectiveness of red light indicator lights, which are auxiliary lights mounted on signal heads, mast arms, or poles directly connected to a traffic-control signal.

The red light indicator light activates at the onset of the red phase and enables an enforcement officer to observe red-light running from downstream of the intersection. This strategy is intended to reduce the frequency of crashes resulting from drivers disobeying traffic signals by providing a safer and more efficient means for police to enforce the red interval.

Researchers obtained geometric, traffic, and crash data at treated, four-legged signalized intersections in Florida. To account for potential selection bias and regression to the mean, they conducted an empirical before-after analysis using reference groups of untreated, four-legged signalized intersections with characteristics similar to those of the treated sites. The analysis also controlled for changes in traffic volumes over time and time trends in crash counts unrelated to the treatment.

Results indicate statistically significant crash reductions for most crash types, including disobeyed signal crashes, fatal and injury crashes, right-angle crashes, and left-turn crashes. Researchers estimated that the benefit-cost ratio with conservative cost and service life assumptions was 92:1 for four-legged signalized intersections. The results suggest that the treatment, even with conservative assumptions on cost, service life, and the value of a statistical life, can be cost effective.

In addition to the crash-related benefits, red light indicator lights can improve the efficiency and safety of enforcement of red-light running. Although the study did not evaluate the efficiency and safety impacts with respect to enforcement, it is important to recognize that red light indicator lights do enable police to observe violators from a downstream position, eliminating the need for a second observer (upstream) and the need to pursue a violator through the red light.

This report is available at www.fhwa.dot.gov/publications/research/safety/17077/index.cfm.

NATIONAL WORK ZONE AWARENESS WEEK

2018 WORK ZONE SAFETY: EVERYBODY'S RESPONSIBILITY

U.S. Department of Transportation Federal Highway Administration
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ATSSA
VDOT Virginia Department of Transportation
workzonesafety.org
U.S. Department of Transportation Federal Motor Carrier Safety Administration
alliance
American Association of State Highway and Transportation Officials AASHTO
AGC of America
MDOT Maryland Department of Transportation State Highway Administration
d. District Department of Transportation
NHTSA
ARTBA American Road & Transportation Builders Association

Celebrating Lifesaving Achievements

Congratulations to the recipients of the 2017 National Roadway Safety Awards!

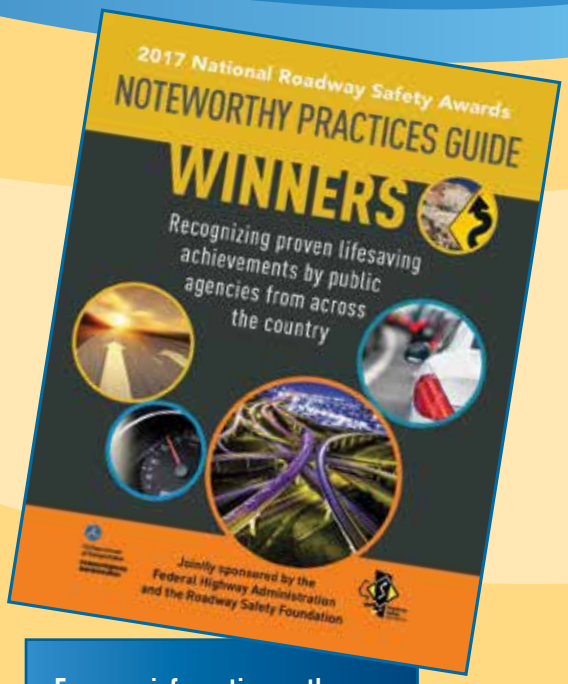
On November 15, 2017, the National Roadway Safety Awards Program recognized nine innovative, lifesaving projects by agencies that have demonstrated outstanding achievements in road safety. The Federal Highway Administration and the Roadway Safety Foundation conferred awards in two categories.

Infrastructure and Operational Improvements

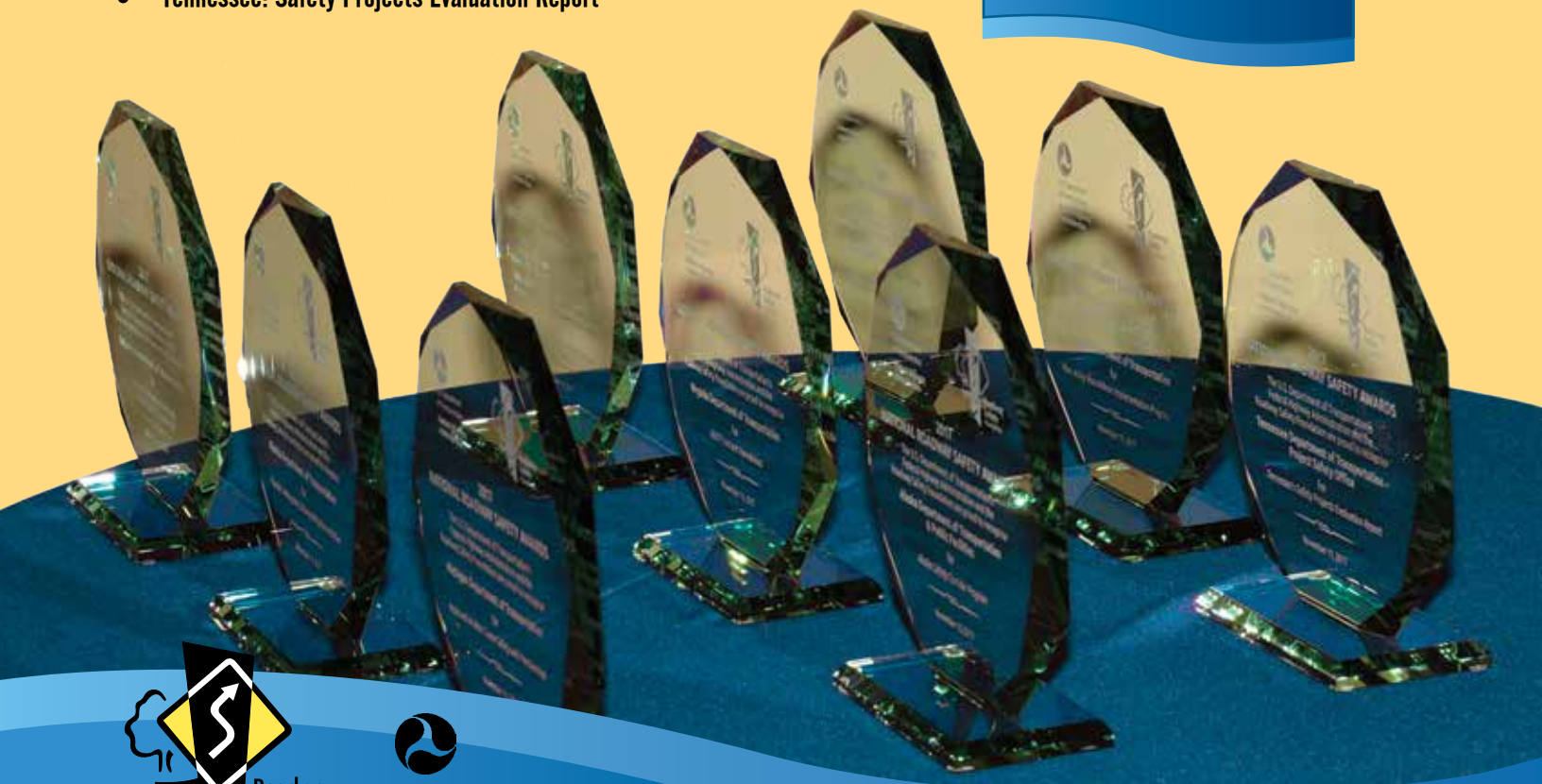
- Delaware: Systemic Safety Improvements Using High-Friction Surface Treatment
- Florida: Wrong Way Driving Mitigation Initiative
- Michigan: Improved Incident Scene Safety with Partnerships
- Minnesota: Implementation of Data-Driven Safety Solutions
- Virginia: Virginia DOT's Instant Roundabout

Program Planning, Development, and Evaluation

- Alaska: Alaska Safety Corridor Program
- Missouri: "Road to Saving Lives" Design-Build Project
- New Jersey: New Jersey Roundabout Implementation Program
- Tennessee: Safety Projects Evaluation Report



For more information on the award-winning projects, see the 2017 *Noteworthy Practices Guide* at https://safety.fhwa.dot.gov/roadwaysafetyawards/2017.



Roadway Safety FOUNDATION

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Federal Highway Administration

U.S. Department
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Federal Highway Administration
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