Public Roads

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May/June 2017

Connected Vehicles Hit the Road
Filling the Parking Gap
Managing Road Weather

U.S. Department of Transportation
Federal Highway Administration

Public Roads

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

May/June 2017 www.fhwa.dot.gov Vol. 80, No. 6

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Front cover—Motorcycle safety is a key concern for organizers of an annual Memorial Day gathering in Washington, DC. To address the issue, transportation agencies are implementing improvements at high-risk locations across the Nation. Strategies from rider education to debris control can help combat the grim statistics. For more information, see "Slamming on the Brakes on a Mounting Problem" on page 10 in this issue of PUBLIC ROADS. *Photo: © Rena Schild, Shutterstock.*

Back cover—USDOT and FHWA are partnering with transportation organizations and the freight industry to address the critical shortage of safe, accessible parking for semitrailer trucks across the country. The Jason's Law Movement got the ball rolling for an FHWA survey that reveals the extent of the shortage. To learn more, see "Where Can the Big Rigs Park?" on page 18 in this issue of PUBLIC ROADS. *Photo: © Jupiterimages, Getty Images.*

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Federal Highway Administration

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Public Roads (ISSN 0033-3735; USPS 516-690) is published bimonthly by the Office of Research, Development, and Technology, Federal Highway Administration (FHWA), 6300 Georgetown Pike, McLean, VA 22101-2296. The business and editorial office of *Public Roads* is located at the McLean address above. Phone: 202–493–3375. Fax: 202–493–3475. Email: lisa.a.shuler@dot.gov. Application to mail at Periodicals postage prices is pending at McLean, VA, and additional mailing offices (if applicable).

POSTMASTER: Send address changes to *Public Roads*, HRTM-20, FHWA, 6300 Georgetown Pike, McLean, VA 22101-2296.

Public Roads is sold by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. Requests for subscriptions should be sent directly to New Orders, Superintendent of Documents, P.O. Box 979050, St. Louis, MO 63197-9000. Subscriptions are available for 1-year periods. Paid subscribers should send change of address notices to the U.S. Government Printing Office, Claims Office, Washington, DC 20402.

The electronic version of *Public Roads* can be accessed through the Turner-Fairbank Highway Research Center home page (www.fhwa.dot.gov).

The Secretary of Transportation has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this department.

Guest Editorial

After the Celebration

Throughout last year, we joined with our colleagues to celebrate the 50th anniversary of the U.S. Department of Transportation, which opened its doors on April 1, 1967. On that same date, the Nation's road agency—born on October 3, 1893, and known by many previous names—officially became the Federal Highway Administration.

Over FHWA's first half-century, the agency has had many notable accomplishments, such as the completion of the interstate system, leadership in shaping the post-interstate era embodied in the Intermodal Surface Transportation Efficiency Act of 1991, and the thousands of jobs created and sustained by Federal-aid highway projects. FHWA also has led the way in innovation and research, while enhancing partnerships with State departments of transportation, industry, academia, local public agencies, and metropolitan planning organizations.

The vital importance of roads is one key to the agency's longevity. As transportation professionals go through their daily routines—meetings, memos, phone calls, emails, deadlines—it is easy to lose sight of that simple proposition. U.S. highways, roads, bridges, and tunnels are the backbone of the Nation's economy, part of daily life, essential to the national defense network, and an enduring contributor to life, liberty, and the pursuit of happiness.

Such a central role may seem like an exaggeration, but, amidst competition from rail, air, water, and the Internet, vehicles on U.S. roads still topped 3.2 trillion miles (5.1 trillion kilometers) in 2016, the highest total ever. Moreover, demographics tell us that the number of drivers and vehicles will continue to increase for the foreseeable future. People will rely more heavily than ever on the country's roads and bridges. As a result, FHWA is committed to ensuring that the system can handle the challenges ahead.

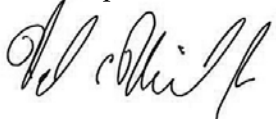
Much has changed since April 1, 1967. At that time, the National Environmental Policy Act did not exist, computers were not on every desk or in most hands, and the World

Wide Web was still two decades away. A highway engineer likely had a slide rule on his belt ("his" being the appropriate pronoun because most engineers were males back then).

As progress since then has proven, FHWA does not rest on its laurels, always confronts challenges head on, and pursues innovations at every opportunity. Over the decades, the agency has applied changes in technology, the economy, and the political world to find solutions.

Today, FHWA continues to face challenges in making roads safer and more efficient. The search for better, more innovative ways to maintain and enhance infrastructure continues. FHWA is working to adapt the road network to the wave of new technology just ahead, such as alternative fuel vehicles, vehicle-to-infrastructure communication, and driverless cars. For an indepth look at just how close connected vehicles are to being road ready, see "Connected Vehicles: Coming Soon to a Road Near You" on page 4 in this issue of PUBLIC ROADS.

Still, many challenges likely lie ahead, for the supply of challenges always exceeds the solutions. That said, if the past 50 years are any indication, FHWA will work successfully with its partners to keep America moving.



Walter C. "Butch" Waidelich, Jr.
Acting Deputy Administrator
Federal Highway Administration

by Michael S. Griffith

Solving the Safety Puzzle

Performance management is evident in all aspects of society, from grade school report cards to workplace reviews. Performance can be measured in subjective and objective ways—and in combination. For example, judges score a gymnast's performance according to both execution (subjective) and difficulty (objective). When it comes to highway safety, the performance measures that matter most are objective: the number of lives lost and serious injuries sustained.

For more than 4 decades, the National Highway Traffic Safety Administration's Fatality Analysis Reporting System has collected data on highway fatalities. "When it comes to data on serious injuries resulting from crashes, no national data system currently exists," says Terry Shelton, the acting executive director of NHTSA. "States collect this information, but not all States define injuries in the same way."

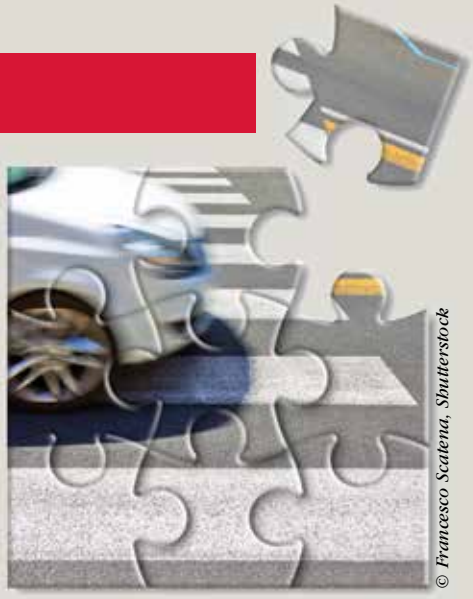
But that is all starting to change. The Federal Highway Administration recently adopted new requirements that place greater focus on the numbers behind highway safety performance. Safety performance management is part of FHWA's overall Transportation Performance Management program—a strategic approach that uses system information to make investment and policy decisions to achieve national performance goals. The recent safety performance management final rule established requirements for safety performance measures that support the Highway Safety Improvement Program (HSIP) and help assess serious injuries, as well as fatalities, on all public roads. (For more on the recent rules regarding the HSIP and safety performance management, see "What Drives Highway Safety Improvements?" in the November/December 2016 issue of PUBLIC ROADS.)

> *"When it comes to data on serious injuries resulting from crashes, no national data system currently exists."*
> —Terry Shelton, NHTSA Acting Executive Director

Filling the Data Gap

To improve the quality and consistency of data, the U.S. Department of Transportation established a national definition for serious injuries in 2016. FHWA's National Performance Management Measures regulation (23 CFR Part 490, Subpart B) and NHTSA's Uniform Procedures for State Highway Safety Grant Programs Interim Final Rule (23 CFR Part 1300) establish a single, national definition for serious injuries, aligned with the definition provided by the fourth edition of the Model Minimum Uniform Crash Criteria (MMUCC).

In 2015, FHWA determined that only 3 out of the 57 jurisdictions—50 States, the District of Columbia, the Indian Nations, and 5 U.S. territories—surveyed were using the definition in the MMUCC fourth edition. The executive committee of USDOT's Traffic Records Coordinating Committee created a subcommittee made up of representatives from FHWA, NHTSA, and the Federal Motor Carrier Safety Administration to assist in implementing the new reporting requirements.



Accurate and consistently reported data on serious injuries is a critical missing piece of the puzzle that transportation professionals need to improve the safety performance of the Nation's roadways.

© Francesco Scatena, Shutterstock

States need to report serious injuries using this definition by April 15, 2019, but "the Department encourages States to begin using it on or before January 1, 2019, to produce a consistent and compliant dataset for the entire year," says Elizabeth Alicandri, associate administrator for safety at FHWA.

USDOT is developing resources to help States obtain and report standard and consistent data on serious injuries. These resources include guidance and technical assistance for stakeholders (primarily State highway safety offices, departments of transportation, and law enforcement agencies), fact sheets, and frequently asked questions to assist States with their compliance efforts.

The Department also is planning outreach timed with the release of the fifth edition of the MMUCC in summer 2017 to highlight the importance of adopting the uniform definition and outline the changes required of States to comply. In addition, USDOT is developing training resources, including a video on classifying suspected serious injuries, to ensure that law enforcement officers have the tools they need to apply the updated definition effectively.

What's Next?

The uniform definition for reporting serious injuries is an important step toward determining the right countermeasures to support the goal of improving safety on the Nation's roadways. In a perfect world, being able to link crash data to hospital data, where medical professionals can share their input on injury severity, would help ensure even more accurate and consistent reporting on injuries. Until then, USDOT stands ready to assist States in compiling the data on serious injuries necessary to help solve the safety puzzle.

Michael S. Griffith is director of FHWA's Office of Safety Technologies and has worked for USDOT for 27 years.

by Rob Ritter

Sharing the Innovation Experience

The Federal Highway Administration's Accelerated Innovation Deployment (AID) Demonstration program is more than just a grant program. It provides an opportunity for award recipients to share their experiences applying proven innovations on highway projects in their own words.

Administered by the Center for Accelerating Innovation, the program provides up to $1 million to support the cost of deploying innovations on any phase of a project. The program allocates up to $10 million per fiscal year. Agencies that receive awards develop reports documenting the processes used and lessons learned, as well as guidance, specifications, and other tools to help others adopt these innovations as standard practices.

Read on for examples of four successful projects and insights from the agencies involved.

Kentucky Roundabout

The Kentucky Transportation Cabinet (KYTC) used an AID Demonstration award to build a roundabout to improve safety and alleviate capacity problems at a four-way stop-controlled intersection in London, KY. The intersection had been a high-crash location for years.

After the roundabout was installed, rush hour queues at the intersection disappeared. "The roundabout has yielded significant improvements in traffic flow at the KY 363 and KY 1006 intersection," the project team concluded in its final report. "It appears that other projects could successfully adopt a roundabout and experience the dramatic safety and operational benefits that London has enjoyed."

One goal of the project was to help KYTC gain the experience necessary to institutionalize the use of roundabouts at safety-critical locations when appropriate. As a result of the project, the agency is revising its roundabout design guidance as part of a revamp of its *Highway Design Manual*.

Since 2014, FHWA has awarded AID Demonstration grants to 62 projects across the country.

Michigan Bridge Slide

The Michigan Department of Transportation (MDOT) used AID Demonstration funds to replace the U.S. 131 bridges over 3 Mile Road near Morley using slide-in bridge construction. The agency chose the method to minimize the project's impact on a major route linking cities in southern Michigan to resort areas in the north. The project was MDOT's first use of the technique, in which a new bridge is built on temporary supports then slid into place during a road closure.

According to the agency's final report, "The overall project was deemed a success, and the Michigan DOT has now added this innovative technology to its toolbox." The final report includes lessons learned from the U.S. 131 project and a second bridge slide in Lowell Township.

> *"The overall project was deemed a success, and the Michigan DOT has now added this innovative technology to its toolbox."*
>
> *— Michigan Department of Transportation*

County Pavement Recycling

In another project, MDOT partnered with the Dickinson County Road Commission and the city of Kingsford, MI, to use hot in-place recycling and warm-mix asphalt to rehabilitate a roadway section in Kingsford. Crews recycled and reused 100 percent of the existing pavement on the project.

According to the project report, "The Dickinson County Road Commission determined from the results of our data analysis and [the] sense of satisfaction from the facility users that the [hot in-place recycling] method is a valuable but little-used tool in the road preservation toolbox."

The county now considers hot in-place recycling one of its standard operating procedures. The technology joins warm-mix asphalt as an option for contractors on paving projects.

South Dakota Safety Treatment

The South Dakota Department of Transportation used an AID Demonstration grant to improve driver safety on horizontal curves using high-friction surface treatments. The project, implemented on U.S. 14A near Deadwood and I–229 in Sioux Falls, had a goal to cut roadway departure crashes at the curves by at least 25 percent.

"The real lesson we learned was in the performance of [high-friction surface treatments] in snow- and ice-covered road conditions," agency officials concluded in the final report. In the first winter, the agency "had an overall crash reduction rate of 78 percent." As a result, the agency developed standard specifications and plans to adopt high-friction surface treatments as a standard procedure.

For more information, visit www.fhwa.dot.gov/innovation/grants or contact Ewa Flom at 202-366-2169 or ewa.flom@dot.gov.

Rob Ritter is managing director of FHWA's Office of Innovative Program Delivery.

Connected Vehicles: Coming Soon to a Road Near You

Across the Nation, USDOT is pilot testing vehicles that can communicate with each other and with the roads around them. Welcome to the new world of transportation.

by Egan Smith and Kate Hartman

Downtown Tampa is the site of one of USDOT's connected vehicle pilots. *Photo: © Judy Kennamer, Thinkstock.*

Congestion in many areas of the United States cripples efficient travel. Annually, drivers in the United States waste more than 6.9 billion hours and 3.1 billion gallons (11.7 billion liters) of fuel due to traffic. Moreover, 6.3 million crashes occur on U.S. roads each year, resulting in more than 35,000 deaths. This heavy fatality toll affects the entire country—whether rural or urban, northern or southern. Innovative, universal, and tangible solutions to one of transportation's toughest challenges are critical.

Enter connected vehicles. For more than a decade, the U.S. Department of Transportation has collaborated with some of the world's largest automobile manufacturers, State departments of transportation, and roadside equipment suppliers to conduct research on how vehicles can share critical information about their position, speed, and brake system status through advanced wireless technology. This technology can provide motorists with 360-degree awareness of the driving environment. The resulting data will be the basis for powerful new applications in vehicles and on mobile devices, supporting improved safety and mobility, as well as more efficient use of transportation assets.

Such applications could alert motorists about potentially dangerous situations—impending collisions, icy roads, and dangerous curves—before drivers are aware of the hazards. The National Highway Traffic Safety Administration estimates that just two of many possible vehicle-to-vehicle (V2V) safety applications, such as intersection and left-turn assists, could prevent up to 592,000 crashes and save as many as 1,083 lives annually, once the technology has spread throughout the transportation system.

Connected vehicles also can offer information on recommended speeds and alternative routes, identify nearby travelers participating in ridesharing, and even send requests to bus drivers to delay their departures so that riders can make their connections. All of these benefits can help reduce congestion, save fuel, and improve travel options.

The Department's research studies and tests support the tremendous potential of connected vehicle technology, including a promise to reduce unimpaired vehicle crashes by 80 percent.

"The time is now for transportation to begin capitalizing on years of research and investment in innovative technologies," says Ken Leonard, the director of USDOT's Intelligent Transportation Systems Joint Program Office (ITS JPO). "We must move from the laboratory to the real world and equip our vehicles and our infrastructure with advanced technology that can save lives."

As Leonard indicates, USDOT's connected vehicle effort has expanded from research to pilots and demonstrations. The deployment of a wireless communications network among vehicles, infrastructure, and mobile devices is in fact underway.

Accelerating Deployment

To make connected vehicles a national reality and accelerate their deployment, USDOT launched a pilot deployment program in 2015. As part of the Department's larger initiative to improve the performance of transportation systems by moving toward a more intelligent and connected system, the pilot program focuses on deploying connected vehicle technology at the State and local levels. The Federal Highway Administration is funding the pilots through the ITS JPO.

The goals of the pilot are straightforward—accelerate deployment, measure impacts, and uncover barriers to deployment in a hands-on manner.

In September 2015, USDOT awarded three cooperative agreements—collectively worth more than $45 million—to the New York City Department of Transportation, Tampa Hillsborough Expressway Authority, and Wyoming Department of Transportation. These deployment sites represent diverse geographic regions—from one of the Nation's most densely populated areas (New York City) to one of the least populated rural areas (southern Wyoming).

Transportation professionals at the three agencies that are conducting the pilots are using connected vehicle technologies to improve safe and efficient truck movement along I–80 in Wyoming, exploit V2V and intersection communications to improve vehicle flow and pedestrian safety in New York City, and deploy multiple safety and mobility applications along reversible freeway lanes in Tampa.

"These pilots are helping make the leap to deployment so that the integration of connected vehicle technology has an immediate short-term impact and lays the groundwork for even more dramatic transformations in the long term as other areas follow in their footsteps and begin to implement the technology," Leonard says. "The resulting widespread adoption will transform transportation as we know it."

Each of the connected vehicle pilot sites developed a comprehensive

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This urban street crowded with taxis is typical of New York City's complex and highly congested transportation system.

deployment concept to ensure rapid and efficient introduction of connected vehicle technology into its transportation system. The sites are also building on lessons learned from the Safety Pilot, the connected vehicle deployment that USDOT established in Ann Arbor, MI, in 2012.

In September 2016, the three sites embarked on a 20-month phase to design, build, and test the Nation's most complex and extensive deployment of integrated wireless in-vehicle, mobile device, and roadside technologies.

New York City Pilot

New York City is the most populous metropolitan area in the United States with more than 8 million people. Vehicles and pedestrians alike compete for space. The area also boasts one of the most extensive rapid transit systems in the world, and the city's residents heavily depend on it.

Within this complex and highly congested transportation system, approximately 4,000 people are seriously injured each year in traffic crashes, and more than 250 are killed. Manhattan in particular has high levels of pedestrian traffic, which result in frequent interactions between pedestrians and vehicles. Seventy-three percent of all crash fatalities in the area involved pedestrians, compared to 14 percent nationwide.

Furthermore, senior citizens over the age of 65 comprise 13 percent of the city's population, but they accounted for about 39 percent of all pedestrian fatalities in 2014. In addition, from 2002 through 2011, the primary reason for injury-related deaths of children in the city aged 5 to 14 was from being struck by a vehicle. Transportation has exacted a heavy toll on the safety of New York City's streets.

To combat this challenge, the city's connected vehicle pilot will deploy V2V and vehicle-to-infrastructure (V2I) technologies to improve the safety of travelers and pedestrians. This directly aligns with the city's Vision Zero initiative, which began in 2014, to reduce traffic-related deaths and serious injuries on New York City's streets.

"The connected vehicle environment is ready for primetime deployment in a densely populated area so that future deployers will have answers to the technical questions," says Jonathan Walker, USDOT's ITS JPO program manager overseeing the New York City pilot. "We are at a critical juncture in the connected vehicle environment. The New York City Department of Transportation [NYCDOT] will catalyze USDOT's 10 years of collaboration on this technology with automobile manufacturers, organizations that develop vehicle standards, and various stakeholders. The technology and timing are perfect for a connected vehicle environment."

New York City's deployment provides an ideal opportunity to evaluate connected vehicle technology and applications in the tightly spaced intersections typical in a dense urban transportation system. The pilot is the largest deployment of connected vehicle technologies in the United States to date.

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In the New York City pilot, V2V and V2I technologies are helping improve safety for pedestrians like these waiting to cross an intersection.

USDOT

The Tampa pilot is deploying connected vehicle safety applications that work on pedestrians' smartphones.

NYCDOT is leading the pilot, which encompasses three distinct areas in the boroughs of Manhattan and Brooklyn:

- A 4-mile (6.4-kilometer) segment of Franklin D. Roosevelt (FDR) Drive in the Upper East Side and East Harlem neighborhoods of Manhattan
- Four one-way corridors in Manhattan
- A 1.6-mile (2.6-kilometer) segment of Flatbush Avenue in Brooklyn

The deployment includes approximately 310 signalized intersections instrumented with roadside equipment using dedicated short-range communications to connect with up to 8,000 vehicles equipped with aftermarket safety devices, and at least 100 pedestrians with personal devices that assist them in crossing streets safely. In addition, NYCDOT will deploy approximately 8 roadside units along the higher speed FDR Drive to address challenges such as short-radius curves, a weight limit, and a minimum bridge clearance. The agency will deploy another 36 roadside units at other strategic locations throughout the city to support system management functions.

Tampa Pilot

Tampa is one of Florida's most densely populated areas. It is also heavily car-centric, with a lack of other transportation options apart from buses and streetcars, and has considerable traffic on its streets. The area has no passenger rail system and limited bicycle and pedestrian amenities.

The reversible express lanes on the Lee Roy Selmon Expressway serve as main commuter routes into and out of downtown Tampa. The city's commercial business district contains bus and trolley services, high pedestrian densities, and highly variable traffic demand over the course of a typical day, plus occasional special event trip generators.

Drivers on the reversible express lanes experience significant delays during the morning peak hours, resulting in, and often caused by, a correspondingly large number of rear-end crashes and red-light-running collisions. Because the lanes are reversible, wrong-way entry is possible, which increases the risk of collisions. The Tampa commercial business district also has significant pedestrian activity in areas with high volumes of vehicular traffic.

With its network of connector roads and adjacent surface streets, Tampa was chosen as an ideal deployment site for a connected vehicle pilot.

The Tampa Hillsborough Expressway Authority is leading the deployment of a variety of connected vehicle technologies on the downtown's reversible express lanes and in their vicinity. The goals are to relieve congestion, reduce collisions, and prevent wrong-way entries at the exits of the express lanes. The expressway authority is also using connected vehicle technology to enhance pedestrian safety, improve bus operations, and reduce conflicts between streetcars, pedestrians, and passenger cars at locations with high volumes of mixed traffic. The expressway authority will employ dedicated short-range communications to enable transmission among approximately 1,500 cars, 10 buses, 10 trolleys, and 500 pedestrians with smartphone apps. The authority also will deploy approximately 40 roadside units along city streets.

To support this initiative, the expressway authority worked with the city, the Florida Department of Transportation, and Hillsborough Area Regional Transit to create a region-wide task force for connected vehicles. The task force's primary mission is to support the deployment of connected vehicle infrastructure in a uniform manner to ensure interoperability and interagency coordination as these deployments transition from concept to planning to operations.

Govind Vadakpat, the research transportation specialist at the Federal Highway Administration who is overseeing the Tampa pilot, notes, "With the support of Federal, State, and local agencies, the expressway authority is at the forefront of deploying connected vehicle technologies to help address mobility and safety-related issues in downtown Tampa. We hope the lessons learned from this targeted and timely pilot deployment will be readily transferrable to communities throughout the United States and beyond."

Wyoming Pilot

Wyoming highways constitute an important freight corridor that plays a critical role in the movement of goods across the country and between the United States, Canada, and Mexico. In southern Wyoming, I–80—which reaches its highest elevation at 8,640 feet (2,633 meters)—is a major corridor for east/west freight movement with more than 32 million tons (29 million metric tons) of freight transported per year.

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Freight movement on highways during winter months creates safety challenges in the Wyoming pilot area.

"Approximately 13,000 vehicles travel this corridor every day, and by using V2V and V2I, the Wyoming Department of Transportation [WYDOT] will collect information from vehicles equipped with the new technologies and disseminate information to those that are not equipped," says USDOT's Leonard.

During winter seasons when wind speeds exceed 30 miles per hour (mi/h) (48 kilometers, km/h) and when wind gusts hit 65 mi/h (105 km/h), crash rates on I–80 have been three to five times higher than the summer rates. This resulted in more than 200 truck blowovers within 4 years and often led to road closures.

The WYDOT connected vehicle pilot focuses on the needs of commercial vehicle operators in the State. The agency is developing applications that use V2I and V2V connectivity to support a flexible range of services, including roadside alerts, parking notifications, and dynamic travel guidance.

In all, WYDOT is developing systems that support the use of connected vehicle technology along the 402 miles (647 kilometers) of I–80. The agency has deployed approximately 75 roadside units along various sections of I–80 that can receive and broadcast messages using dedicated short-range communications. In addition, WYDOT has equipped around 400 fleet vehicles and commercial trucks with onboard units. Of these vehicles, at least 150 are heavy trucks that are regular users of I–80. The 400 vehicles also include 100 WYDOT fleet vehicles, snowplows, and highway patrol vehicles equipped with onboard units and mobile weather sensors.

Connecting Communities

The potential of advanced wireless communication technology extends beyond transportation itself. The technology enables transportation systems to join the growing environment of connectivity and shared intelligence that is the "Internet of Things"—the network that collects and exchanges data from connected mobile devices, vehicles, and smart infrastructure, such as traffic and parking sensors, smart streetlights, noise and environmental sensors, and shipping containers equipped with RFID (radio-frequency identification) tags.

The tremendous sources of data from interconnected systems can come together to enable cities to reduce congestion, keep travelers safe, improve mobility, protect the environment, connect underserved rural and urban communities, and support economic vitality. Smart cities and communities are emerging as a next-generation approach for city management.

To demonstrate the true power of such intelligent communities, USDOT launched its Smart City Challenge—a national competition to implement bold, data-driven ideas that demonstrate the use of advanced data systems and intelligent transportation systems to make transportation safer, easier, and more reliable. In the summer of 2016, Columbus, OH, won the Smart City Challenge, receiving $40 million from USDOT and $10 million from Paul G. Allen's Vulcan, Inc. to demonstrate innovative ways to use technology to connect the city's vehicles, infrastructure, and people. Columbus will work to reshape its transportation system to become part of a fully integrated community that harnesses the power and potential of data, technology, and creativity.

With USDOT's support, Columbus will help define what it means to be the country's first community to fully integrate innovative technologies—self-driving cars, connected vehicles,

The pilot in southern Wyoming is taking place along the State's segments of I–80.
Photo: © cosmonaut, Thinkstock.

Applications in Deployment

The three pilot sites are deploying many applications with some overlap, attesting to the versatility and universal applicability of connected vehicle technology. Some of the overlapping applications include the following:

Emergency Electronic Brake Lights (New York City, Tampa) alert drivers if a vehicle ahead is hard braking, providing them with additional reaction time.

Intersection Movement Assist (New York City, Tampa) warns drivers when it is not safe to enter an intersection due to a high probability of a collision with other vehicles.

Pedestrian in Signalized Crosswalk Warning (New York City, Tampa) warns drivers when a pedestrian is walking within the crosswalk of a signalized intersection and is in the intended path of the vehicle.

Mobile Accessible Pedestrian Signal System (New York City, Tampa) allows for an automated call from the smartphone of a visually impaired pedestrian to a traffic signal, as well as provides audio cues to assist the pedestrian in safely navigating the crosswalk.

Forward Crash/Collision Warning (New York City, Tampa) alerts drivers if there is a direct and imminent threat of a collision ahead, helping them to avoid or mitigate the severity of rear-end crashes with the upstream vehicle.

Work Zone Warnings (New York City, Wyoming) provide approaching vehicles with information about work zone activities, such as travel lane obstructions, lane closures, lane shifts, speed reductions, or vehicles entering or exiting the work zone.

Vehicle Turning Right in Front of Bus Warning (New York City, Tampa) alerts transit vehicle drivers at stops when nearby vehicles are pulling in front of a transit vehicle in order to make a right turn.

Intelligent Traffic Signal System (New York City, Tampa) adjusts signal timing and grants priority and preemption to improve traffic flow and pedestrian safety.

and smart sensors—into its transportation system network.

Automated low-speed shuttles will be deployed to support first mile/last mile (a phrase used to describe travel to and from public transportation hubs) connectivity to a new bus rapid transit system. A multimodal trip-planning application with a common payment system will deliver enhanced human services to residents and visitors. Real-time parking information will help drivers reduce time spent looking for parking, and smart streetlights equipped with free public Wi-Fi will improve safety and enable people living in underserved communities to have access to the Internet. The city expects to finish deployment by mid-2019.

The city plans to equip 200 traffic signals and 3,000 vehicles with connected vehicle technologies that will support a variety of mobility and safety applications. Finally, the city's approach includes an integrated data exchange consisting of a set of data repositories that will be created to support data discovery, analytics, ad hoc investigations, and reporting.

The challenge will extend far beyond this one community. Columbus will provide a foundation that others can build on to develop their own smarter, safer, and more efficient communities.

USDOT is hoping to spur development of connected vehicle technology, and interested communities are getting help from Congress. The 2015 Fixing America's Surface Transportation (FAST) Act established the Advanced Transportation and Congestion Management Technologies Deployment Program to make competitive grants available for the development of model deployment sites for large-scale installation and operation of advanced transportation technologies to improve safety, efficiency, system performance, and infrastructure return on investment.

More Technology Deployment Grants

In addition, USDOT is building on the connected vehicle effort and expanding its scope to include a broader connectivity between research and pilot deployment. The recent award of grants under the Advanced Transportation and Congestion Management Technologies Deployment initiative provides an opportunity to expand the connected/automated vehicle environment to rural and urban communities across the country.

For example, Pittsburgh, PA, will receive nearly $11 million to execute elements of the vision it developed in its Smart City Challenge application, including deployment of smart traffic signal technology—which has been proven to reduce vehicle wait time at traffic lights by up to 40 percent—along major travel corridors. In addition, Denver, CO, will receive approximately $6 million to implement connected vehicle technology to help alleviate the congestion caused by the influx of 200,000 commuters each workday.

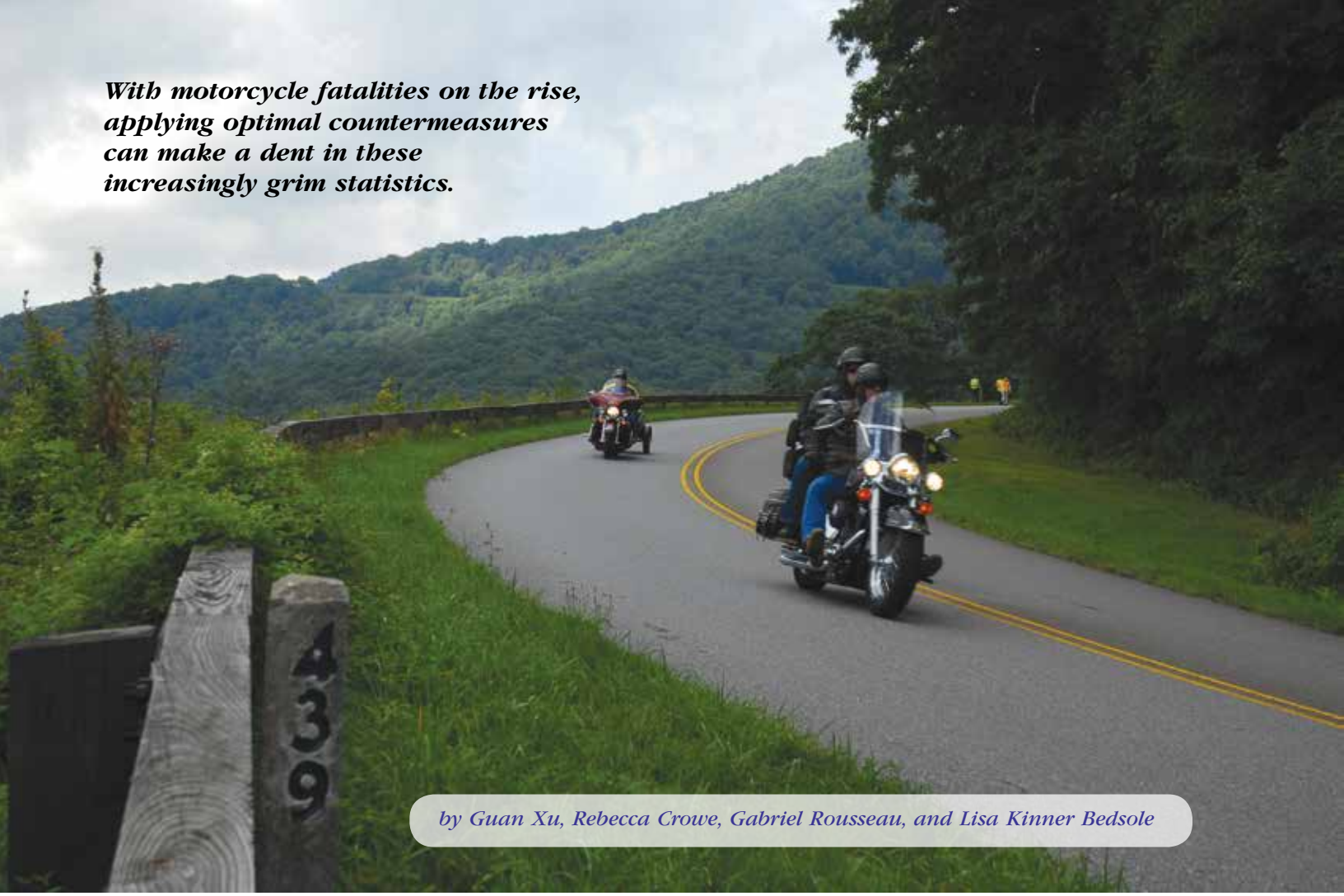
The grants will enable cities and rural communities to harness new technologies to reduce congestion, improve mobility, connect people to mass transit, and enhance safety.

"The Advanced Transportation and Congestion Management Technologies Deployment grant program will provide $300 million over 5 years to help communities deploy intelligent transportation systems around the Nation," says Leonard, "and accelerate the deployment of life-saving and mobility-enhancing new technologies."

Egan Smith, P.E., PTP, PTOE is managing director of the USDOT ITS JPO and has decades of professional experience in ITS, transportation program management, and transportation planning. Smith has a bachelor of science degree in civil engineering, a master of engineering in traffic engineering and operations research, and a master of science in technology management.

Kate Hartman has more than 15 years of experience at USDOT and serves as chief of research, evaluation, and management for the ITS JPO. She has worked in connected vehicle technology research for a number of years and currently manages the Connected Vehicle Pilot Deployment Program. She has a B.A. in economics, an M.B.A., and a Project Management Professional® certification.

For more information on USDOT's connected vehicle deployment, visit www.its.dot.gov/pilots/index.htm. Or contact Mike Pina at 202-366-3700 or mike.pina@dot.gov.



With motorcycle fatalities on the rise, applying optimal countermeasures can make a dent in these increasingly grim statistics.

by Guan Xu, Rebecca Crowe, Gabriel Rousseau, and Lisa Kinner Bedsole

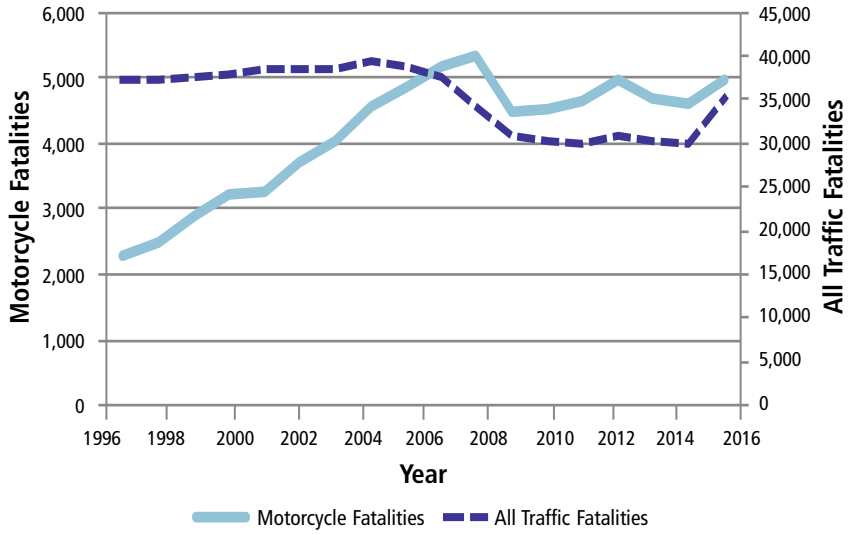
Slamming on the Brakes on a Mounting Problem

(Above) Motorcyclists are at a greater risk for injuries and fatalities than many other roadway users because they do not have the protection of an automobile's frame to lessen crash impacts.

Ten years ago, motorcycles were involved in 1 out of every 10 vehicle fatalities. By 2014, despite making up only 3 percent of registered motor vehicles, motorcycles were involved in 1 out of 7 fatal crashes. Although total traffic-related deaths have trended downward until recently, the number of motorcycle-related fatalities has increased significantly, from 2,116 in 1997 to 4,576 in 2005 and then to 4,976 in 2015, an overall increase of 174 percent.

Many factors contribute to the rise in motorcycle-related fatalities, including roadway geometry, statutory and advisory speeds, and the behavioral characteristics of motorcyclists. Established engineering practices may not adequately consider the unique characteristics

Trends in Traffic- and Motorcycle-Related Fatalities, 1997–2015



Source: FHWA, Motorcycle Road Safety Audit Case Studies, *FHWA-SA-16-026 (Washington, DC: May 2016). Available at: http://safety.fhwa.dot.gov/rsa/resources/docs/fhwasa16026.pdf. Data for 2015 was derived from FARS.*

of motorcycles, as is the case with advisory speeds at horizontal curves, where the conventional approach to setting speeds was developed with the automobile in mind. Furthermore, roadside and median barriers have been largely designed to contain and redirect passenger vehicles. Similar barriers that could reduce the severity of motorcycle impacts have not been tested for use in the United States, and FHWA does not advocate their use at this time, although barrier modifications have been tested and installed in Europe to reduce the severity of motorcycle impacts with guardrails.

Motorcyclists and their behaviors also must be taken into account. In 2006, the average age of motorcycle riders killed in motor vehicle traffic crashes was 39, and in 2015 the average was 42. These data suggest that age does not always translate to experience or ability. Impaired riding is also a significant factor in fatal motorcycle crashes: 42 percent of motorcycle riders who died in single-vehicle crashes in 2015 were alcohol impaired.

A number of approaches are needed to help put the brakes on these statistics. The first step is identifying the road segments where motorcycle crashes are overrepresented and applying appropriate countermeasures where they are needed most. Motorcycle road safety audits (RSAs) offer an effective and methodical approach to identifying and applying these countermeasures.

Conducting a Motorcycle RSA

The factors that affect the safety of motorcyclists often differ from those that affect the safety of automobile users. Selecting the right set of solutions to address overrepresented motorcycle crashes on a specific road segment is therefore challenging. Many different types of safety strategies and countermeasures can reduce crashes and fatalities among motorcyclists when applied appropriately.

A motorcycle RSA can help practitioners identify the most appropriate countermeasures for specific locations that will lead to crash reductions. This safety assessment is specifically tailored to address motorcycle safety concerns, differing slightly from the standard RSA, which addresses safety issues that affect a broader set of road users.

An RSA is the formal safety performance examination of an existing or future road or intersection by an independent, multidisciplinary team. The audit team qualitatively estimates and reports on potential road safety issues and identifies opportunities for improvements in safety for all road users. A motorcycle RSA generally follows the same step-by-step procedure as a standard RSA.

RSA teams typically consist of persons with expertise in road safety, traffic operations, road design, and law enforcement. It is advisable for the law enforcement officers selected to serve on the RSA team to have riding experience, or to be actively conducting motorcycle

Typical 8-Step Road Safety Audit Process

Source: FHWA.

patrols. RSA organizers also should select team members with expertise critical to understanding the conditions affecting motorcyclists, such as representatives of licensing authorities, motorcycle safety clubs, and other groups and organizations with an interest in motorcycle safety.

Jim Compton, a motorcycle safety instructor for the Motorcycle Safety Foundation, was on the RSA team that reviewed North Carolina (NC) Route 28 (known as a "Tail of the Dragon" for its extensive horizontal and vertical curvature) as well as NC–43, both of which are in Graham County, NC, near the Tennessee border. "We had an extremely diverse team that involved engineers, law enforcement, and safety staff," he says. "As a rider with more than 30 years of experience, and a Motorcycle Safety Foundation instructor since 1999, I was pleased to explain how a motorcycle has to maneuver and react to different highway designs."

Once selected, the RSA team reviews and discusses crash data, as well as the anecdotal experiences of motorcyclists from local clubs and organizations, during the startup meeting. At that meeting, those familiar with riding describe and interpret the data to help determine factors contributing to crashes and their potential effect. These individuals provide details concerning critical conditions or locations that other team members may not be aware of.

An RSA should be conducted on existing facilities based on crash frequency. The RSA team should review the critical conditions in the field at those locations. Furthermore, team members who are licensed motorcyclists should ride the locations under investigation and convey their knowledge and experience to the RSA team.

Once the field review is complete, the team conducts an RSA workshop in which they compare the experiences and observations of the riders to the field condition review. Based on this analysis, the RSA team identifies any conditions critical to the safety of motorcyclists and suggests measures that may reduce the risks.

In 2016, the Federal Highway Administration published *Motorcycle Road Safety Audit Case Studies* (FHWA-SA-16-026) to help Federal, State, tribal, and local agencies understand conditions that affect the safety of motorcyclists so that these agencies, too, can learn how to address safety issues and identify opportunities for improvement through the RSA process. This report examines three sets of RSAs that were sponsored by FHWA to demonstrate the benefits of using this process to reduce motorcycle-related fatalities, injuries, and crashes. An effective motorcycle RSA will identify countermeasures across the 3Es of safety—engineering, enforcement, and education.

Conducting RSAs to Select Engineering Countermeasures

Data from the National Highway Traffic Safety Administration's Fatality Analysis Reporting System (FARS) show that, in 2015, the most harmful event for 54 percent of motorcyclists involved in fatal crashes was a collision with another vehicle on the roadway. To a lesser degree, motorcyclists also are frequently involved in fatal collisions with fixed objects. About a quarter of the cyclists involved in fatal crashes in 2015 collided with fixed objects, compared to 17 percent for passenger cars, 13 percent for light trucks, and 4 percent for large trucks.

In two-vehicle crashes in 2015, 74 percent of those that involved motorcycles were frontal collision crashes. Of two-vehicle crashes between a motorcycle and another type of vehicle, 41 percent occurred when the other vehicle was turning left across the motorcyclist's path, was involved in passing, or was attempting to overtake other vehicles.

When it comes to motorcycle safety, transportation agencies can apply engineering strategies to mitigate specific environmental or roadway characteristics that lead to the types of crashes most frequently responsible for motorcycle-related fatalities and injuries. A wide variety of safety strategies using engineering countermeasures can be specifically targeted to combat motorcycle crashes. Unique site characteristics, however, may mean that some countermeasures will have greater positive impact than others.

For example, a motorcycle RSA conducted in North Carolina on NC–28 and NC–143—routes characterized by a winding alignment; numerous driveways, commercial entrances, and intersections; and a dense tree canopy—determined that motorcyclists were crossing the center line. Crash data also demonstrated a prevalence of head-on and sideswipe opposite-direction crashes.

The RSA team determined that several countermeasures would improve safety on the routes, including clearing vegetation to improve sightlines around curves and the addition of warning signs for intersecting roadways. Some motorcycle-specific recommendations included paving

Engineering Strategies for Motorcycle Safety

Engineering strategies targeted to motorcycle crashes include the following:

- Provide full paved shoulders to accommodate roadside motorcycle breakdowns.
- Consider motorcycles in the selection of roadside barriers.
- Identify pavement markings, surface materials, and other treatments that reduce traction for motorcycles, and replace those with high-friction surface treatments.
- Maintain the roadway to minimize surface irregularities and discontinuities.
- Reduce roadway debris—such as gravel, shorn treads, snow and ice control treatments (sand/salt), and detritus resulting from uncovered loads—from the roadway and roadside to help avoid motorcyclists losing control and entering the opposing lane.
- Provide advance warning signs to alert motorcyclists of reduced traction and irregular roadway surfaces.
- Incorporate motorcycle safety considerations into routine roadway inspections.
- Provide a mechanism for notifying highway agencies of roadway conditions that present a potential problem for motorcyclists.

Source: NCHRP Report 500: Guidance for Implementation of the AASHTO Strategic Highway Safety Plan, Volume 22: A Guide for Addressing Collisions Involving Motorcycles. *www.trb.org/Publications/Public/Blurbs/A_Guide_for_Addressing_Collisions_Involving_Motorc_160626.aspx*

Speed-reduction pavement markings installed by the North Carolina Department of Transportation (NCDOT) give road users the illusion that they are going faster than they are to encourage motorcyclists to slow down as they traverse tight curves. The wide apron installed on the inside of the curve serves to collect gravel that washes down from the hillside, keeping this hazard off the roadway. *Photo: NCDOT.*

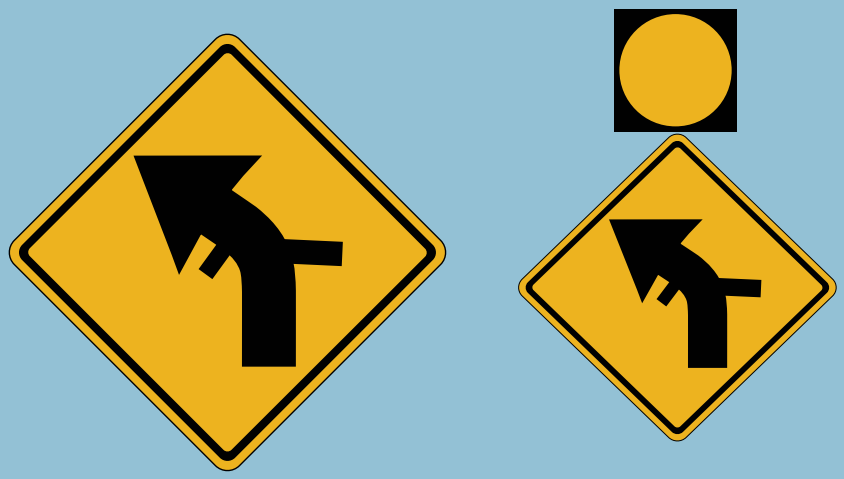
shoulders on the inside of curves, especially gravel shoulders, as motorcyclists may try to steer away from these to avoid debris. Repainting center lines and adding center line pavement markings through intersections would help motorcyclists maintain visual focus. In addition, the RSA team believed that adding motorcyclist-specific signage or lane pavement markings at critical locations, such as at vertical (sag or crest) curves that also have horizontal curvature, would reduce crashes.

Another team conducted an RSA on a segment of the Blue Ridge Parkway in North Carolina, which is also characterized by a winding roadway with significant variations in alignment and multiple spiral curves. The data indicated that motorcycle crashes were by far the most common type of crash along curve segments in the study area. One factor might be that motorcyclists are largely a visitor population unfamiliar with the parkway's attributes.

In this study area, recommendations included implementing a program to install the SafetyEdge[SM] countermeasure along the parkway roadside. The SafetyEdge is an effective solution for reducing run-off-road crashes because it makes the transition back onto the pavement easier. It involves shaping the edge of the pavement to a 30-degree angle using a commercially available device (called a shoe) that can be attached to the paver. The asphalt is extruded under the shoe, resulting in a durable edge that resists edge raveling.

An FHWA evaluation of the SafetyEdge indicates that application of the measure has led to an estimated reduction of nearly 6 percent in total crashes on two-lane highways. Because of the low cost of the device, FHWA found the benefit-cost ratio for installation on two-lane roads ranged from 4 to 63. The RSA team members in North Carolina suggested that this countermeasure might be particularly effective in areas with higher traffic volumes, along curves, or at locations where data suggest motorcycles run off the road.

This enhanced curve warning sign on NC–143 targets motorcyclists. *Photo: North Carolina Department of Transportation.*



Shown here are examples of warning signs that depict the locations of intersections along a curve. Signs like these could be used in Washington on SR–7, where intersections on curves present sight-distance challenges.

Washington State conducted an RSA on State Route (SR) 7 from milepost 16 to 59. The study area was divided into three focus areas: one urban segment and two rural segments. The study of the urban focus area, from the intersection of SR–7 and 182nd Street to the intersection with Interstate 5, revealed numerous driveways that make it possible for drivers to turn onto both directions of SR–7, creating many conflict points. Also, because turning drivers have to cross many lanes of traffic, their ability to judge acceptable gaps in traffic is reduced, which may have made it difficult for drivers to see oncoming motorcyclists.

The RSA team suggested that, in the medium term, turns into and out of driveways onto both directions of SR–7 should be restricted using signage, pavement markings, and physical barriers to prevent left turns except in select locations. In the long term, the team suggested developing a revised corridor access management plan that would take into account the needs of motorcyclists.

Carefully maintaining the brightness and retroreflectivity of a 6-inch (15-centimeter) white edge line like the one shown along this roadway can provide positive guidance to help motorists navigate tight horizontal curves more safely.

In addition, the RSA team suggested some short-range actions for other RSA sites on the SR–7 corridor to improve motorcycle safety, such as installing intersection warning signs that indicate an upcoming intersection, installing reflective post-mounted delineators that are evenly spaced throughout both sides of curves, applying wider edge lines and center lines, and installing shoulder rumble strips.

Selecting Education And Enforcement Countermeasures

Education and enforcement, the other two elements of the 3Es, often go hand in hand with engineering countermeasures. For example, collisions with fixed objects represent

Enforcement Strategies for Motorcycle Safety

Enforcement strategies that can help reduce motorcycle crashes and fatalities include the following:

- Target law enforcement to specific motorcycle rider impairment behaviors that have been shown to contribute to crashes. Specifically, 17 cues have been identified to help law enforcement officers discriminate between impaired and normal operation of a motorcycle. Highway agencies should consider partnering with enforcement officials to support officer training in detecting these cues.
- Expand existing impaired driving prevention programs to include motorcycle riders and specific motorcycle events.
- Increase awareness of the causes of crashes due to unlicensed or untrained motorcycle riders.
- Ensure that licensing and rider training programs adequately teach and measure skills and behaviors required for crash avoidance.
- Identify and remove barriers to obtaining a motorcycle endorsement.

Source: NCHRP Report 500: Guidance for Implementation of the AASHTO Strategic Highway Safety Plan, Volume 22: A Guide for Addressing Collisions Involving Motorcycles. *www.trb.org/Publications/Public/Blurbs/A_Guide_for_Addressing_Collisions_Involving_Motorc_160626.aspx*

a significant factor in motorcycle crash fatalities, accounting for more than 25 percent of fatal motorcycle crashes in 2014, and motorcycles are more likely to be involved in such crashes than any other vehicle type.

Part of the reason for this might be that more than a quarter of the motorcyclists who are fatally injured each year do not have a valid motorcycle license. This statistic possibly indicates a connection between lack of adequate training and an inability to maneuver the vehicle well enough to avoid fixed-object collisions in the event of a roadway departure.

During another motorcycle RSA conducted on SR–7 in Washington State—this one on an 11-mile (18-kilometer) segment of the highway—the Washington State Department of Licensing (WSDOL) provided data indicating that 30 percent of those killed in motorcycle fatalities on State roadways did not have the appropriate licensure or training to operate a motorcycle. The WSDOL data also showed a clear link between riding experience and fatalities: One-third of all motorcyclist fatalities involved motorcyclists with 2 years of riding experience or less.

The RSA team suggested several actions to improve the competence of riders and, by extension, their ability to navigate the SR–7 study site. The team suggested that safety courses that offer training in advanced riding techniques could help reduce the prevalence of collisions with fixed objects. In addition, transportation and enforcement agencies should place increased emphasis on the education and training opportunities provided through WSDOL's motorcycle safety program. As part of this effort, these agencies were encouraged to reach out to a nearby military base and work with base staff to publicize and encourage motorcycle training and education to service members.

The RSA team also suggested that increasing the level of active enforcement of motorcycle licensing laws at locations with high crash rates is another approach that can prove effective in reducing crashes.

On the other side of the country, the North Carolina RSA suggested a somewhat different approach. There, some segments of the study sites were famous among motorcyclist communities for their challenging horizontal and vertical curvature and attracted motorcyclists of all experience levels, many from out of State. In fact, data from the North Carolina Department of Transportation (NCDOT) suggested that only about 15 percent of motorcycle fatalities involved motorcyclists from within the State. Because there are no national standards in terms of motorcyclist training and licensure, there are broad inconsistencies in skill level among motorcyclists who travel the studied corridors on NC–28 and NC–143.

In this case, the RSA team emphasized education, suggesting that NCDOT and law enforcement begin to collaborate with riding clubs, the division of motor vehicles, safety groups, and emergency medical services to provide riding safety education. The team also suggested creating and posting online safety information that will rank highly in Internet search engines. It is easy to find information on the Internet that emphasizes the more "thrilling" aspects of riding a motorcycle on these roads in North Carolina, but not so easy to locate safety information.

Educational Strategies for Motorcycle Safety

Educational strategies that involve partnering with the public and conducting public outreach include the following:

- Increase awareness of the benefits of high-visibility clothing.
- Identify and promote other methods and technologies to enhance rider visibility, such as auxiliary brake lights and daytime headlights.
- Form strategic alliances with the motorcycle user community to foster and promote safety and training in advanced riding techniques.
- Increase awareness of the consequences of aggressive riding, riding while fatigued or impaired, unsafe riding, and poor traffic strategies.
- Educate operators of other vehicles to be more conscious of the presence of motorcyclists.
- Increase the use of helmets compliant with Federal Motor Vehicle Safety Standard 218.

Source: NCHRP Report 500: Guidance for Implementation of the AASHTO Strategic Highway Safety Plan, Volume 22: A Guide for Addressing Collisions Involving Motorcycles. *www.trb.org/Publications/Public/Blurbs/A_Guide_for_Addressing_Collisions_Involving_Motorc_160626.aspx*

Motorcycle Crashes from the North Carolina Perspective

The terrain in North Carolina varies from broad coastal plains in the east to scenic mountain ranges in the west. The mountains draw motorcyclists from all over the country who see them as a place to test their skills.

"That creates some challenges for us," says Brian Murphy, P.E., a safety planning engineer at NCDOT. "We want these riders to come and enjoy themselves, but we also want them to be able to drive back home."

Murphy adds, "We've learned that just because motorcycle crashes often involve speed and other driver behavioral factors, there are still treatments that can help."

A series of motorcycle safety reviews that NCDOT has conducted since 2011 has created a new perspective in the agency about identifying countermeasures targeted to motorcycle crashes.

"I would definitely recommend that a motorcycle expert be part of the RSA team," Murphy says. "We had a motorcycle driving instructor [at the last RSA we conducted], and he was really looking at the site from the perspective of the motorcycle rider. His input was invaluable. It has been a real learning experience."

At many of the sites NCDOT looked at, a large majority of the crashes involved motorcycles (more than 90 percent in some cases). Although other types of vehicles also travel through these sites, crash levels for those were much lower. As a result, NCDOT has implemented a variety of safety countermeasures that have been specifically targeted to motorcycle riders.

One effort involves adding plaques below standard roadside advisory signs that are specifically targeted to motorcyclists. Another countermeasure is applying speed-reduction pavement markings that begin in advance of specific curves and run through them. The markings give drivers the illusion that they are going faster than they are, influencing them to slow down as they enter the curve.

Beginning in 2015, the agency also has implemented dynamic sequential curve warning signs in two locations. Although it is too soon for the agency to have crash data, staff hope that those will have positive crash-reduction benefits as well.

Addressing the fact that many motorcyclists come from outside the State, NCDOT is constructing informational pulloffs in scenic areas where advisories and information specifically for motorcyclists can be posted so that riders can be prepared to navigate the road ahead.

An important but perhaps overlooked factor that the NCDOT safety staff learned from the motorcycle RSAs was about gravel on the roadway as a safety issue. In response to RSAs that identified areas where gravel washes down from the mountains onto the roadway, the agency installed large paved aprons to keep it off to the side and out of the roadway.

Perhaps the biggest takeaway from the North Carolina experience with motorcycle RSAs is that many of these countermeasures are transferrable to other sites.

"We couldn't conduct an RSA at every site with higher-than-expected motorcycle crashes," says Murphy, "but a lot of the recommendations from the safety reviews we did complete are being implemented at other sites throughout the State that have similar issues."

Many of the countermeasures that North Carolina has implemented have been installed within the past 2 years, so not enough data are available regarding how effective the treatments have been. However, NCDOT is planning to begin conducting before and after analyses in 2017–2018 to determine which countermeasures have proven to be the most effective.

A pulloff in North Carolina features motorcycle advisory information on a white sign targeted to motorcyclists to prepare them for the challenges of the road ahead. *Photo: North Carolina Department of Transportation.*

In addition, the team suggested working with the Tennessee DOT, which also hosts a segment of the Blue Ridge Parkway, to focus joint education efforts on the most vulnerable riders, including those with the least experience. Finally, the team suggested that posting signage at key locations to communicate motorcycle crash statistics on high-crash segments might induce motorcyclists to drive more carefully, while signs that indicate the fine for speeding might induce them to drive more slowly.

Research Efforts to Advance Motorcycle Safety

From a broader perspective, important gaps exist between what we know and what we need to know to make motorcyclists safer. A recently completed analysis by FHWA assessed the lack of available average annual daily traffic (AADT) data for motorcycles and described the impact of this gap on practitioners' ability to perform evaluations aimed at developing motorcycle-specific crash modification factors. Existing advanced safety analysis tools, namely the American Association of State Highway and Transportation Officials' (AASHTO) *Highway Safety Manual*, rely on the availability of roadway AADT data; however, the data are seldom disaggregated to show motorcycle-specific AADT.

Additional gaps in the types of crash data collected and in the availability of roadway inventory data, especially on low-volume roadways, exacerbate the challenge of increasing the transportation community's understanding of what is happening when motorcycles crash and why. Furthermore, very little information is known about the impacts of roadway geometric and traffic control features on motorcycle crash frequency and severity.

A recently completed FHWA study will help to better define these and other existing gaps and form the basis for a roadmap that will lead to more information. FHWA's Motorcycle Crash Causation Study, the most comprehensive research into the causes of motorcycle crashes in the United States in more than 30 years, concluded in 2016, although its findings are not available as of the writing of this article. The dataset collected in the study includes data from 350 or more crash investigations and 700 interviews with control riders, who were not involved in crashes but were exposed to similar riding environments. Partners from Federal agencies, State DOTs, local police jurisdictions, and the motorcycle industry support the effort and are optimistic that the data will offer significant insight into countermeasures.

Another effort, the FHWA Office of Safety's Intersection Safety Program, once complete, is intended to leverage the data from the Motorcycle Crash Causation Study to develop additional insights. The researchers will use this new dataset to inform a study currently underway that is exploring the risk characteristics of intersections relative to motorcycle-involved fatal crashes and infrastructure strategies that could address those risks. Program staff are optimistic that a great deal will be learned, as roughly two-thirds of the investigated cases in the Motorcycle Crash Causation Study occurred at intersections.

Moving Forward

Motorcycle safety is increasingly relevant as the number of motorcyclists on the Nation's roadways increases. While several important studies are underway to improve the ability to identify and mitigate safety risks to this vulnerable user group, the tools available today, including motorcycle RSAs and the implementation of innovative countermeasures such as those being applied in North Carolina and Washington State, can be effective in treating areas where motorcycle crashes are a concern. Motorcycle RSAs are an important tool for identifying specific crash treatments that will be most effective in improving safety on segments where motorcycle fatality and injury crashes are overrepresented. To date, 40 States are addressing motorcycle safety with 184 strategies across 53 emphasis areas. Several States also have created motorcycle safety coalitions to address motorcyclists' concerns.

At the Federal level, increasing crash rates among motorcyclists have sharpened the focus on their safety. The Fixing America's Surface Transportation (FAST) Act, signed into law in December 2015, reinstated a Motorcyclist Advisory Council to advise the FHWA administrator on ways to improve the roadway infrastructure for motorcycle safety, specifically with regard to barrier and road design, construction, maintenance, intelligent transportation systems architecture, and implementation.

"We are looking forward to the new [council] helping us to identify innovative ways to improve roadways for motorcycle safety," says Michael Griffith, director of the FHWA Office of Safety Technologies.

In the meantime, FHWA encourages agencies to use RSAs to identify the most pressing problems that contribute to overrepresentation of motorcycle crashes on local roads. As shown in the RSAs highlighted in *Motorcycle Road Safety Audit Case Studies* (FHWA-SA-16-026), the multidisciplinary perspectives that team members bring, coupled with the inclusion of experienced motorcyclists, can be critical factors in defining effective methods to improve motorcycle safety using RSAs and the 3E approach.

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Where Can the Big Rigs Park?

by Tretha Chromey and Jeff Purdy

Through partnerships, continued education, and effective planning, FHWA and others are implementing strategies to help solve the national shortage of parking spaces for semitrailer trucks.

Why should a person care about another driver on the road? Specifically, would it matter if that other driver was carrying the new computer you want? Or the food you are going to eat in a couple of days? What if that driver's vehicle is transporting up to 46,000 pounds (20,865 kilograms) of the kinds of things you need every day? Wouldn't you want to do everything you could to help that other driver?

That is what the U.S. Department of Transportation is doing—helping those drivers—and one of the ways is by addressing the issue of parking for big rigs, that is, semitrailer trucks.

The lack of safe, adequate parking for commercial motor vehicles continues to be a crucial concern for the industry. The problem is not insignificant. According to the Federal Highway Administration, there are more than 2.6 million registered tractor-trailer trucks traveling on U.S. roads every day. But when truckers are going from one town to the next and driving long hours, they often need to pull over to rest. But where? For those 2.6 million tractor-trailers, parking is available for only about 12 percent of them at any given time.

In addition, industry relies on just-in-time deliveries, which result in truckers needing parking for staging so that they can make their deliveries at the designated times.

As a result, truck drivers are sometimes forced to stop along highway onramps, or in dark, abandoned commercial lots for rest. Truckers sometimes drive an hour or more out of their way looking for a safe, legal place to park. This search can cause delays, which add to the cost of goods. The quest for parking also puts truckers at great personal risk if they are unable to find a safe place to stop because they might become overtired or out of their hours of service.

The semitrailer trucks shown here are stopped at a parking facility. Nationwide, there is a critical shortage of spaces for truckers to rest. *Photo: © Jupiterimages, Getty Images.*

With truck traffic projected by USDOT to grow from 11.5 billion tons (10.4 billion metric tons) in 2015 to 16.5 billion tons (15 billion metric tons) in 2045, the demand for truck parking will continue to outpace the supply of public and private parking facilities and will only exacerbate the problems experienced in many regions.

What Is Being Done?

With the passage of the Moving Ahead for Progress in the 21st Century (MAP-21) Act in 2012, Congress established what is called "Jason's Law," which provides a "national priority to address . . . the shortage of long-term parking for commercial motor vehicles on the National Highway System to improve the safety of motorized and nonmotorized users and for commercial motor vehicle operators."

Specifically, Jason's Law requires USDOT to conduct a survey and comparative assessment in consultation with relevant representatives of motor carriers to evaluate the capability of each State to provide adequate parking for commercial motor vehicles engaged in interstate transportation. The law also requires assessment of the volume of that traffic in each State and the development of a system of metrics to measure the adequacy of the parking facilities in each State.

This topic is not new to FHWA. Since 2015, in particular, FHWA has been working with its partners to raise awareness of the need for parking for semitrailer trucks and providing resources about the subject. To address the issue, FHWA has conducted a survey and developed written guidance for programs specifically related to funding for truck parking.

What Is the Jason's Law Movement?

Jason's Law was named in honor of Jason Rivenburg. On March 4, 2009, Rivenburg stopped for his first delivery in Virginia and then headed toward another delivery destination in South Carolina. When only 12 miles (19 kilometers) from the delivery location, Rivenburg needed to find parking to rest through the night because his arrival location was not yet open to receive deliveries. He decided to park at an abandoned gas station described as "safe" by other truckers. Tragically, while he slept in his cab, he was attacked and murdered.

Since his death, Rivenburg's wife, Hope, has worked diligently to bring attention to the shortage of truck parking nationally. In 2013, as part of her effort to found the Jason's Law movement, Hope Rivenburg released the results of her own Safe Truck Parking Survey. The survey found that 39 percent of the nearly 4,000 drivers who responded take 1 hour or longer to find parking when they are mandated to take a rest. Fifty-three percent of respondents regularly use a commercial truck stop for rest, and 20 percent habitually use a rest area. The truckers indicated that if parking was not found by midafternoon or early evening in either a rest area or private truck stop, the next suitable option is a well-lit shopping area, due to safety concerns. However, the respondents stated that they worried during their rest period that they would be asked to leave or given a citation by law enforcement.

Other parking options regularly include the shipper/receiver's location (20 percent), an onramp or offramp (8 percent), an abandoned lot or other isolated area (10 percent), or behind a shopping center (11 percent).

During the 12 months prior to taking the survey, 88 percent of drivers felt unsafe while parked for mandatory rest or waiting for pickup or delivery of a load. Thirty-six percent of respondents reported that they felt safe parked at a shipper or receiver location.

The efforts of Hope Rivenburg, along with those of family members, friends, and representatives from the trucking industry, helped push forth the legislation that focused national attention on the issue.

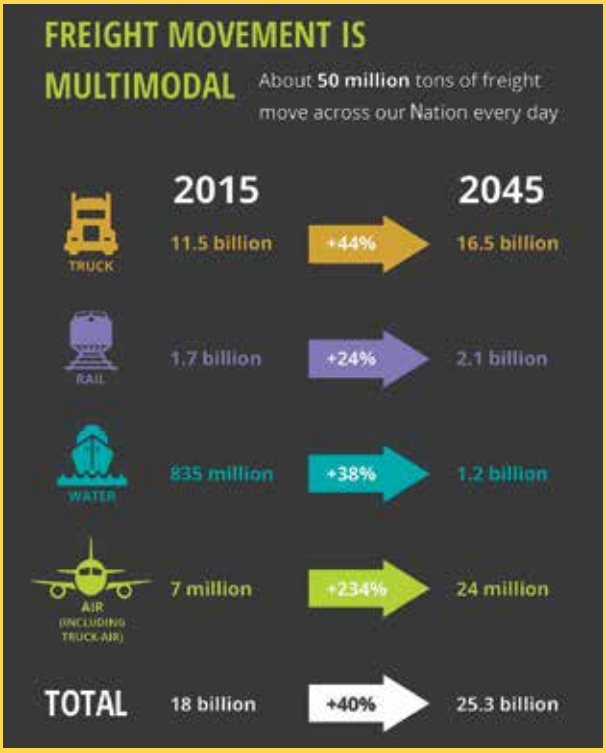
Conclusions from The FHWA Survey

A survey conducted by FHWA in 2014 found similar results. According to FHWA's Jason's Law Truck Parking Survey, more than 75 percent of truck drivers said they "regularly" experienced "problems with finding safe parking locations when rest was needed." And 90 percent reported struggling to find safe parking at night.

FHWA sought input from key partners in identifying metrics and completing the survey activities. The partners included the American Association of State Highway and Transportation Officials, American Trucking Associations, Owner-Operator Independent Drivers Association, NATSO (formerly the National Association of Truck Stop Operators), and the Commercial Vehicle Safety Alliance.

The *Jason's Law Truck Parking Survey Results and Comparative Analysis* report issued by FHWA documents more than 308,000 truck parking spaces, including 36,000 at public rest areas and nearly 273,000 at private truck stops. With 5.6 million commercial motor vehicle drivers in the United States, according

Projected Increases in U.S. Commercial Traffic



Source: Beyond Traffic 2045, *USDOT.*

Parking Spaces Relative to Truck Traffic Volumes

The documentation used to assess truck volumes in FHWA's report, *Jason's Law Truck Parking Survey Results and Comparative Analysis*, is based on an annual survey of State data provided to FHWA predominantly for the purpose of administering the Federal-Aid Highway Program. The data provide an understanding of the level of annual commercial truck activity, as measured by daily combination truck vehicle miles of travel (VMT) on the National Highway System.

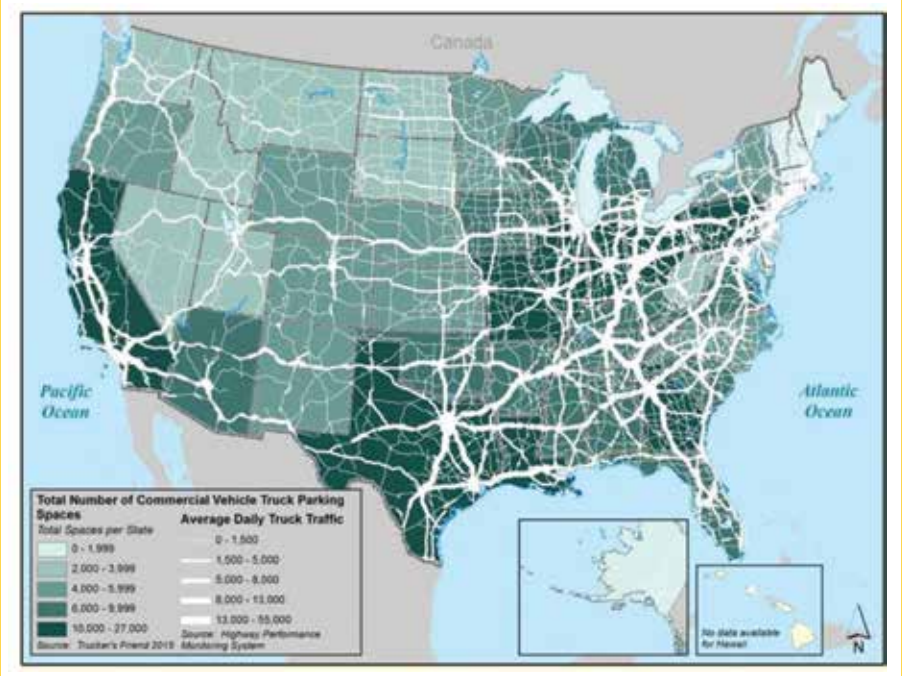
To enhance this assessment of traffic volumes, FHWA mapped the assessment of volumes together with the parking supply in order to characterize the spatial distribution of parking patterns, both within States and across the Nation. The report also includes maps for each State that identify truck volumes and parking facilities.

The report's researchers analyzed commercial motor vehicle truck parking spaces per 100,000 miles (161,000 kilometers) of daily combination truck VMT for each State. The highest number of parking spaces relative to combination truck VMT occur in Missouri, Montana, and Wyoming. The lowest number of parking spaces relative to combination truck VMT occur in California, Rhode Island, and Tennessee (excluding Hawaii, which does not have any public or private truck parking spaces).

Truck Traffic Volumes on the National Highway System

Source: Freight Analysis Framework version 3.4 (2013)

Truck Traffic Volumes in Relation to Parking Spaces



to the Federal Motor Carrier Safety Administration, and the fact that trucks carry by far the largest share (70 percent) and value (64 percent) of the Nation's freight, the 308,000 parking spaces are inadequate.

The FHWA survey found that truck parking capacity is a problem in all States, with the greatest problems more evident on major freight corridors and in large metropolitan areas. Truck parking is an important component of the freight plans of State departments of transportation and metropolitan planning organizations, as well as regional and corridor-based freight planning groups.

Continued evaluation is important for understanding dynamic truck parking needs, as well as providing data. For example, analysis of the supply chains of key industries and commodities is needed in order to better anticipate and plan for parking needs. In addition, local regulations and zoning often create challenges for developing truck parking facilities due to resistance to the externalities of truck stops, such as truck traffic, noise, and emissions. It is for these reasons that coordination of the public and private sectors at every level is critical to addressing the long-term parking needs of commercial motor vehicles.

National Truck Parking Coalition

In response to the survey's release, interested parties formed the National Truck Parking Coalition in November 2015. The coalition brings together stakeholders from transportation organizations, the freight industry, and other groups to advance safe truck parking. The goals are to collaborate regionally and nationally to identify solutions for truck parking needs, share data and new analyses developed by stakeholders to understand trends in truck parking, encourage partnerships to implement solutions, and identify opportunities to use existing and new programs to support the provision of additional truck parking.

The coalition's first meeting took place in November 2015, and the most recent meeting was in December 2016.

During this same time period, USDOT conducted a series of four regional meetings (Dallas, TX; Grain Valley, MO; Hanover, MD; and Salt Lake City, UT) to further the

dialogue on the shortage of truck parking. The meetings brought together stakeholders to share input on strategies and approaches.

Participants found that to address the national concern, there are four target areas for the partnership and the public to work on together: parking capacity; technology and data; funding, finance, and regulations; and coordination of State, regional, and local governments.

Opportunities to Become Involved

The Jason's Law provision of MAP-21 mandates detailed analysis and measurement of the truck parking problem and offers increased opportunity and flexibility to fund truck parking projects. Through this process, public and private entities can identify innovative ways to provide additional parking capacity, the technology to provide real-time information on available parking and locations, innovative means of funding parking construction and maintenance, and truck parking planning by State, regional, and local governments.

Among the potential solutions is a greater emphasis on developing technology, such as a geographic information system (GIS)-based platform that identifies available truck parking nationally. Another solution would be to use existing intelligent transportation systems to help identify truck parking and variable messaging signs to communicate with truckers about areas that have available spaces.

Truck parking is a complex problem that has many elements and requires partnerships to work together to find solutions. Understanding the dynamics of truck parking and the movement of freight is needed in order to make strategic investments in the right applications and the right types of solutions in locations that provide the greatest benefit.

Why Learn More?

Trucking helps keep the U.S. economy moving forward, and truckers work tirelessly to see that the Nation's businesses run smoothly. That is why this responsibility needs to be shouldered through a cooperative partnership between the public and private sectors from the national level down to the local level.

Truck drivers deserve a safe place to park when they need to pull over to rest. This is a problem that affects all Americans, and the solution will involve everyone—FHWA, State departments of transportation, elected officials, trade associations, and members of the public.

And it's a problem that will not go away by itself. Seventy percent of all freight transported in the United States is delivered by trucks. By 2045, the volume of delivered goods by trucks is expected to grow by almost 45 percent.

Think about that the next time you see a trucker on the highway.

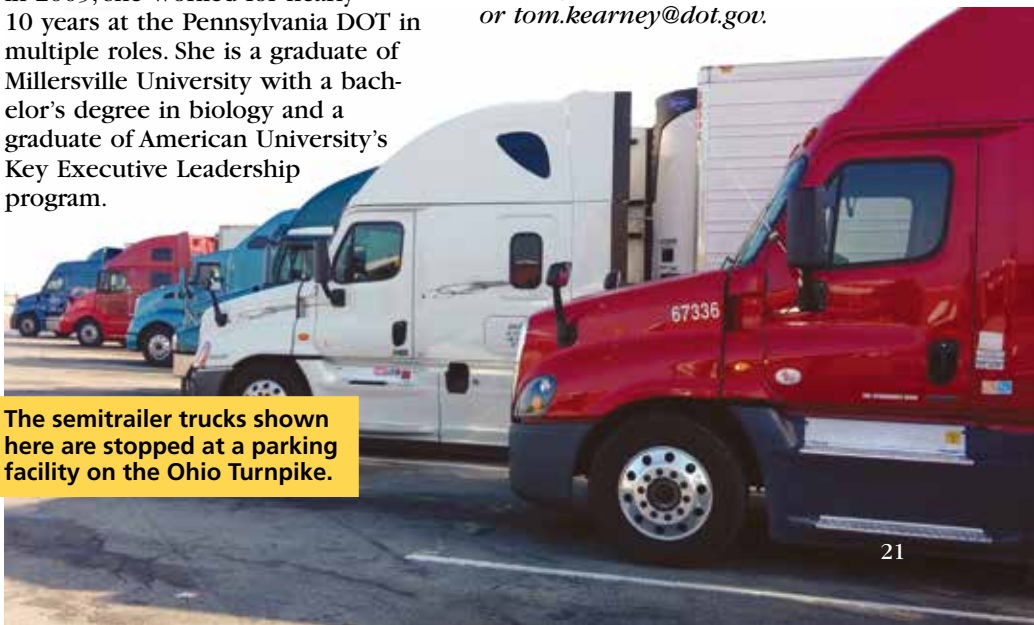
Michigan DOT and HNTB

This dynamic highway signage in Michigan provides advance information for truckers on the location and real-time availability of parking spaces.

Tretha Chromey is now the senior advisor for strategic communications in FHWA's Office of Policy and Governmental Affairs and formerly was a freight program specialist in the Office of Operations. Before joining FHWA, she held several senior-level positions in multiple agencies within USDOT, including the Federal Motor Carrier Safety Administration, Maritime Administration, Federal Railroad Administration, and the Office of Policy within the Office of the Secretary. Prior to coming to USDOT in 2005, she worked for nearly 10 years at the Pennsylvania DOT in multiple roles. She is a graduate of Millersville University with a bachelor's degree in biology and a graduate of American University's Key Executive Leadership program.

Jeff Purdy is a transportation specialist in FHWA's Office of Freight Management and Operations. He has worked on a variety of transportation planning projects at the local, State, and Federal levels. Prior to moving to FHWA headquarters, Purdy served as the transportation planner for FHWA's Wyoming Division and at a community and transportation planning consulting firm in Michigan. He has a master's degree in urban planning from Michigan State University.

The Jason's Law Truck Parking Survey, along with other information on truck parking, is available at www.ops.fhwa.dot.gov/freight/infrastructure/truck_parking. For more information on freight economy issues, visit www.fhwa.dot.gov/freighteconomy. Or contact Jeff Purdy at 202-366-6993 or jeffrey.purdy@dot.gov, or Tom Kearney at 518-431-8890 or tom.kearney@dot.gov.



The semitrailer trucks shown here are stopped at a parking facility on the Ohio Turnpike.

Riding Out the Storm

by Roemer M. Alfelor

FHWA is partnering with transportation agencies to develop and implement effective traffic management strategies during adverse weather.

(Above) Snowy roads slow down traffic and increase the incidence of crashes. *Photo: © Lya_Cattel, Getty Images.*

Every year, adverse road weather results in about 6,000 fatalities nationwide and costs more than 32 billion hours of delay among commercial vehicle operators. Improved traffic management strategies during weather events can reduce crashes and resulting delays, but limitations in data coverage and quality have constrained their effectiveness. Specifically, sparsely located road weather sensor stations have prevented agencies from gathering the site-specific information on road weather conditions needed to make informed decisions regarding traffic management and maintenance.

With support from the Federal Highway Administration's Road Weather Management Program, transportation agencies are adopting new technologies that enable road weather data to be easily and automatically collected from the field. The agencies are using this information for various applications in traffic management, including road weather alerts, setting of variable speed limits, and vehicle routing.

In addition to providing more frequent and timely data, technologies like mobile devices and connected vehicle instruments generate location-specific road weather information. Such information helps transportation agencies make more accurate assessments of conditions and leads to more effective decision-making during inclement weather.

To assist agencies in adopting and implementing these technologies, the Road Weather Management

to implement both maintenance and traffic management strategies to improve the safety and mobility of the travelers during these conditions. The benefits that result from these actions are significant, whether the responses to weather events are made proactively or reactively.

Weather Responsive Traffic Management Program

The Weather Responsive Traffic Management Program is one of the major focus areas of FHWA's Road Weather Management Program. It is involved in research, development, and deployment of strategies and tools for traffic management in inclement weather. The program brings together technologies, data and models, human factors, and system performance in a logical framework for identifying and evaluating appropriate traffic management strategies under various types of weather conditions. These strategies can lead to more informed decisionmaking by the agency and motorists; availability of real-time weather and traffic information; and improved mobility, safety, and reliability of the transportation system during inclement weather.

Since 2004, the Weather Responsive Traffic Management Program has worked with public agencies and the private sector (including weather service providers, researchers, and the academic community) to advance the knowledge, capabilities, and tools used for weather responsive traffic management. Program activities have included determining the state of the practice; identifying best practices; conducting research; providing guidance on integrating weather in traffic management centers; disseminating road weather messages; modeling traffic flow on the transportation system during various weather conditions; and evaluating system performance, including the costs and benefits of traffic management strategies.

The program partnered with a number of transportation agencies in developing, implementing, and evaluating reporting systems for road conditions; weather responsive variable speed limits; traffic signal timing; and advanced traveler information systems, including dynamic message signs, Web sites, weather alerts on mobile devices, and 511 traveler information services. More recently, the program has focused on utilizing mobile and connected vehicle technologies to support improved traffic management strategies in adverse weather.

Existing Strategies

Many transportation agencies in the United States already are incorporating road weather information, both current and predicted, into their traffic operations and management strategies. Current strategies for weather responsive traffic management range from advisory (alert and warning) systems to traffic signal control, all of which are used to facilitate travel in inclement weather.

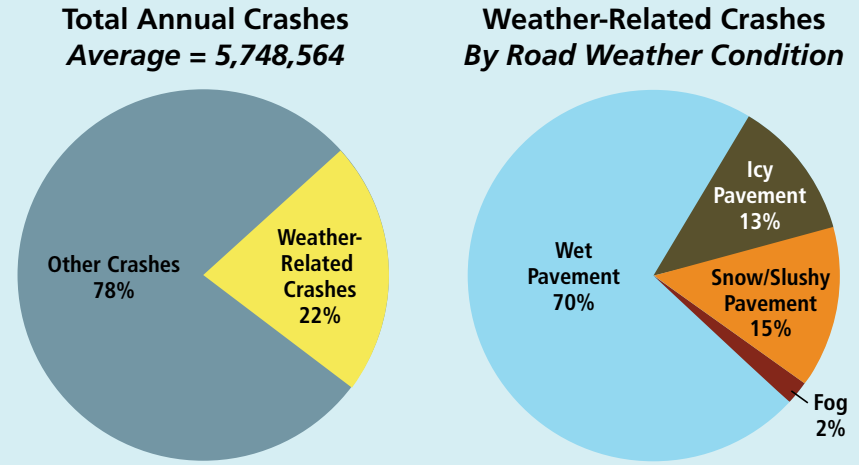
Program recently developed guidelines for deploying applications for connected vehicle-enabled weather responsive traffic management.

Impacts on Transportation and Traffic

The effects of weather on the performance of the highway system are well documented. Of the more than 5.7 million crashes that occur each year on U.S. roads, approximately 22 percent, or roughly 1.26 million, occur in inclement weather. Likewise, weather is the cause of an estimated 23 percent of nonrecurring delays on the highways.

Although roads and drivers are not exposed to bad weather every day, the staggering impacts compel transportation agencies

Percent Share and Types of Weather-Related Crashes



Source: FHWA Road Weather Management Program.

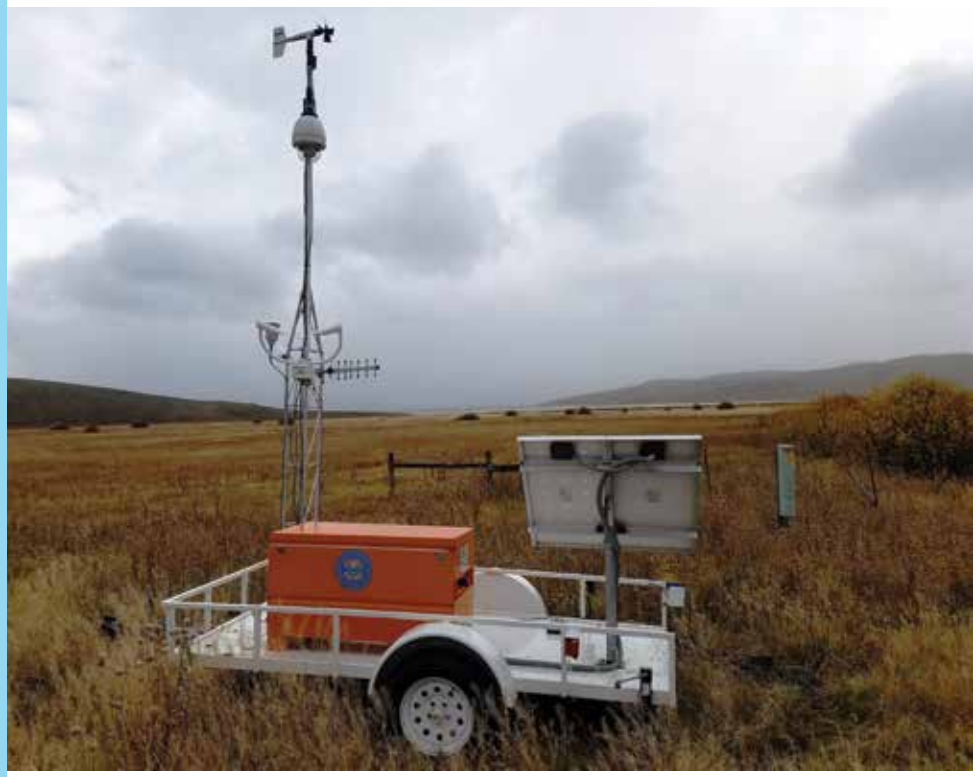
This dynamic message sign displays a wind warning and vehicle restriction to drivers in Wyoming. *Photo: Jeff Garmon, National Oceanic and Atmospheric Administration Forecast Office, Cheyenne, WY.*

Advisory systems make drivers aware of current and impending weather and roadway conditions through passive and active warning systems, en route weather alerts, pretrip road condition information, and pavement condition information.

With control strategies, traffic control devices—including traffic lights and signals, ramp meters, and dynamic message signs—are modified during inclement weather by changing the interaction between detection systems and traffic control systems, implementing weather-specific traffic signal timing plans, or programming timing parameters for weather responsive ramp metering. Traffic operations and management strategies that incorporate models and tools for weather responsive traffic analyses provide greater operational benefits.

In 2011, FHWA prepared a comprehensive description of existing and potential strategies for weather responsive traffic management. The report, *Developments in Weather Responsive Traffic Management Strategies*, details the strategies, where they have been used, the benefits realized, and how to implement and evaluate them. For more information, download the report at https://ntl.bts.gov/lib/42000/42900/42965/wrtm_final_report_06302011.pdf.

Portable road weather sensors, such as these in Utah, enable departments of transportation to gather site-specific observations. *Photo: Cody Opperman, Utah DOT.*



Mobile Data Collection

Recent advances in mobile sensing and data collection technologies for traffic and weather, including those coming from the Intelligent Transportation Systems (ITS) and the Connected Vehicles programs at the U.S. Department of Transportation, have helped researchers and practitioners use more accurate, real-time, and location-specific data.

Portable road weather information system (RWIS) sensors are now available to supplement fixed RWIS stations and are an attractive solution for many transportation agencies because of their mobility and ease of relocation. The portable systems are cost-effective and agencies can use them to monitor specific road weather conditions on the sites where deployed.

Electronic tablets and personal mobile devices have become more accessible, powerful, and affordable, and they enable the collection, processing, and dissemination of road weather information from road weather service providers (including transportation agencies) to the public and vice versa.

Many transportation agencies also equip their vehicles with automatic vehicle location (AVL) systems. The agency or owner can track vehicles' whereabouts by GPS in order to manage the deployment of their fleets during weather events.

Finally, transportation agencies are now using vehicles instrumented with mobile sensors—originally for collecting road weather information and transmitting this data to a traffic management center, a roadside unit, or directly to other vehicles on the road—to support road condition assessment, forecasting, traveler information systems, traffic control, and maintenance operations, among other applications.

Using Mobile Observations

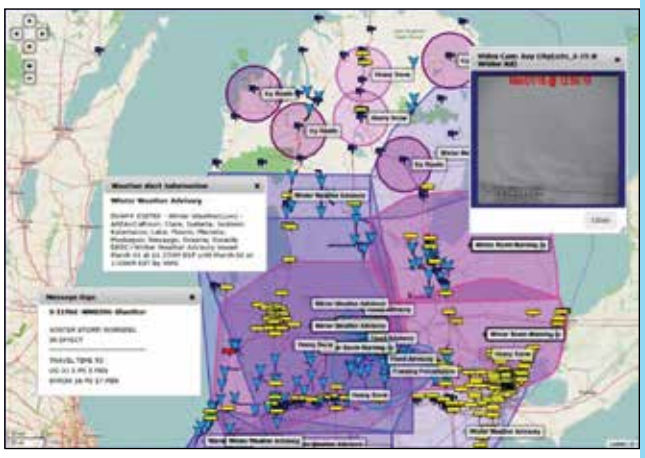
Since 2011, the Road Weather Management Program, with support from the ITS Joint Program Office, has collaborated with the State departments of transportation in Michigan, Minnesota, and Nevada on the Integrated Mobile Observations project. Hundreds of plows and maintenance vehicles in

these agencies' fleets are equipped with sensors and video cameras to acquire location, road weather information, and video images while they are out on the road.

The project demonstrates how weather, road condition, and other related connected vehicle data can be collected, transmitted, processed, and used to support decisionmaking applications and activities, including traffic management. These technologies are now being actively promoted by FHWA in the fourth round of Every Day Counts. For more information, visit www.fhwa.dot.gov/innovation/everydaycounts/edc_4.

In 2013, the Weather Responsive Traffic Management Program partnered with State DOTs in Michigan, South Dakota, and Wyoming to develop, implement, and evaluate strategies that utilize mobile road weather data (using field devices and vehicles) for traveler information, traffic control, and winter maintenance activities. The ITS Joint Program Office funded all three State projects.

The States shared the same goal: to improve the way they manage traffic conditions during weather events by using field observations from maintenance vehicles to inform and alert travelers through 511, dynamic message signs, Web sites, and mobile applications, as well as control traffic through variable speed limits. The States also share common adverse weather conditions and experience similar impacts on traffic flow from weather.



Winter storm warnings and advisory messages displayed on MDOT's Mi Drive Web site, which are generated by Wx-TINFO, warn travelers of adverse weather conditions on roads. *Photo: Steve Cook, MDOT.*

Through this partnership, each State developed and implemented a tool or strategy to help meet its goal. What follows are details of the projects and the demonstrated results.

Michigan's Use of Fixed And Mobile Observations

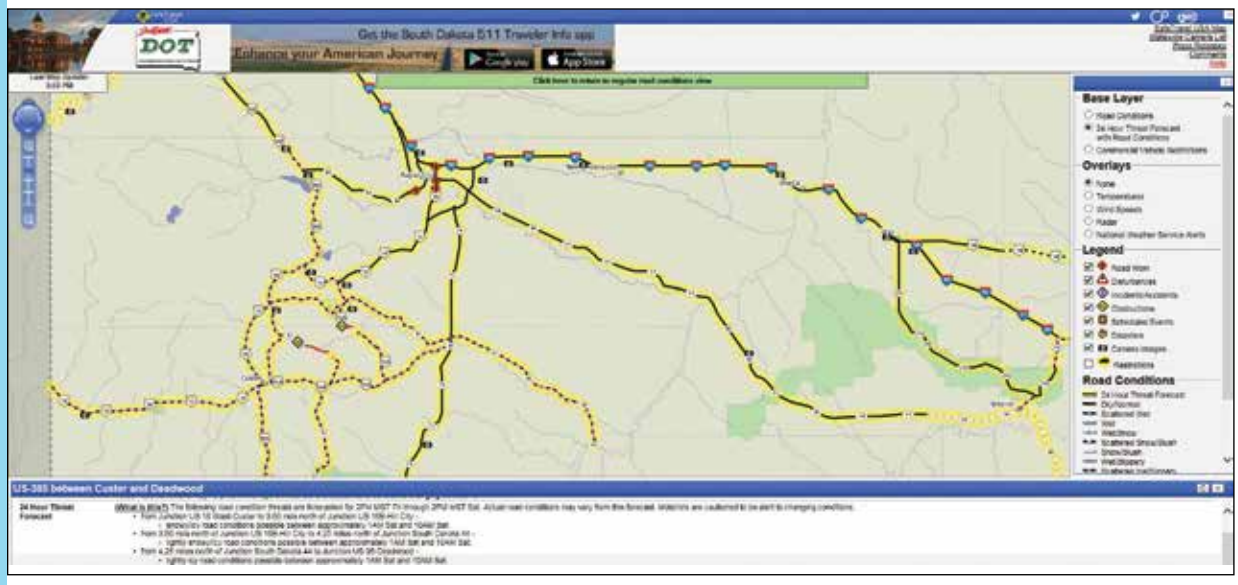
The Michigan Department of Transportation (MDOT) developed a weather responsive traveler information system called Wx-TINFO. The system integrates multiple sources of weather data into one program, enabling transportation operations center (TOC) staff to provide near real-time weather-related advisories and alerts for travelers.

MDOT designed the system to provide more accurate, timely, and effective messaging, enabling the traveling public to make informed travel decisions. In addition, Wx-TINFO provides information on road weather conditions that MDOT maintenance staff can use for weather maintenance operations.

The information for the travel alerts is generated by Wx-TINFO, linked to dynamic message signs in the coverage area, and delivered to the advanced traffic management system automatically. TOC operators retain the ability to approve or override messages from the system if deemed necessary.

The initial Wx-TINFO system has proven to be successful in

This Nevada DOT plow truck is instrumented with road weather connected vehicle technologies. *Photo: Rodney Schilling, Nevada DOT.*



In yellow highlighting, SDDOT's SafeTravelUSA Web site shows threat forecasts for adverse road conditions around Rapid City. *Photo: Dave Huft, SDDOT.*

fulfilling MDOT's project objectives: integrating disparate fixed and mobile datasets and devising operations plans from those data. The evaluation of the system showed that the Wx-TINFO system improved the traffic management capabilities of TOC staff during winter weather events and provided benefits to travelers.

"DOT operators are critical in providing motorists with valuable information during winter weather events," says Steve Cook, engineer of operations and maintenance with MDOT. "Mobile information can provide better roadway coverage and localized messaging for TOCs/[transportation management centers], thereby assisting motorists [with making] decisions on the safest trip alternative."

South Dakota's Traveler Information System

The South Dakota Department of Transportation (SDDOT) developed and implemented a weather responsive traffic management strategy that involves mobile data collection and traveler information dissemination during weather events. The project simplifies data collection by plow drivers and provides new traveler information to motorists, including 24-hour road condition forecasts.

The SDDOT mobile software application enables plow drivers to directly enter road conditions into the Integrated Roadway Information System using mobile data collectors already in the trucks. This improvement provides drivers with immediate and direct access to the system. Traditionally, drivers had to use radio communication to inform a supervisor, who would then enter the road conditions into the system, or maintenance staff, who would enter it into the system at the end of a run or shift.

The SafeTravelUSA Web site, 511 phone system, and a mobile phone app provide motorists with the enhanced information on road conditions. In addition, forecasts for 24-hour road conditions transfer directly from South Dakota's Maintenance Decision Support System to its traveler information systems when road conditions might deteriorate to an unsafe situation in the future.

The results show that the enhanced and expanded information provided to travelers is not only easy to find and understand, but also is useful to motorists for making prudent travel decisions.

"More than half of the travelers we surveyed said they changed the timing or routing of their travel based on the road condition threat forecast," says Dave Huft, research program manager with SDDOT, "while three quarters said they felt more prepared for their trips."

Wyoming's Mobile Reporting App

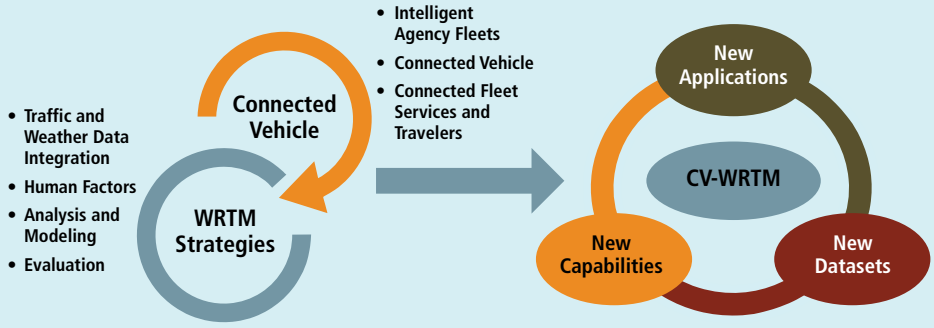
The Wyoming Department of Transportation (WYDOT) designed, developed, and implemented a new software application to improve the way maintenance personnel report road and weather conditions to their statewide transportation management center (TMC), recommend variable speed limit changes, and report a number of different types of traffic incidents.

The Road Condition Reporting Application runs on a tablet computer that uses Wyoming's extensive statewide communication system backbone called WyoLink. The agency installed the app on 20 tablets, mostly in WYDOT plow trucks on I–80 and portions of I–25, for the initial deployment during the 2014–2015 winter season.

App users report road conditions and other information to the TMC, and also share information with maintenance employees, including the road conditions as they are reported to the public, variable speed limit information, weather information, messages

This screen capture shows the user interface of WYDOT's Road Condition Reporting Application. *Photo: Vince Garcia, WYDOT.*

Connected vehicle-enabled weather responsive traffic management (WRTM) combines traditional traffic management with connected vehicle (CV) technologies.



Source: Guidelines for Deploying Connected Vehicle-Enabled Weather Responsive Traffic Management Strategies.

posted on dynamic message signs, and map-based asset location information. It is also used to send and receive messages similar to email.

Use of the app improved the effectiveness and efficiency of road condition reporting and TMC activities during weather events. The accuracy of field information substantially improved for road condition reports, variable speed limit and dynamic message sign change requests, and reports on the location of incidents.

"The road condition reporting application not only doubled the road weather condition reports from the field but also tripled the number of variable speed limit recommendations we normally get on the radio," says Vince Garcia, geographic information systems/ITS program manager with WYDOT. "Variable speed limits have reduced crashes and road closures in Wyoming."

A survey of TMC and field maintenance personnel indicated that everyone who responded agreed that the agency is better off with the app than without it.

Observations from Implementations

The implementation projects in Michigan, South Dakota, and Wyoming showed that DOTs can improve traffic management capabilities during weather events by using data from vehicles that provide onsite road weather conditions. It also showed the importance of field conditions observed and transmitted by maintenance vehicle drivers, including plow truck drivers.

The benefits include more accurate and timely condition assessment and forecasting that agencies can disseminate to travelers at home or on the road. Agencies may also use this information for traffic control purposes (such as setting variable speed limits). Other benefits include reduction in data entry and processing time by DOT staff in the TMC or office because data is automatically transferred from the field.

Guidelines for Deployment

FHWA recently developed guidelines to help accelerate deployment of weather responsive traffic management strategies and decision-support capabilities that use weather and traffic data from connected vehicles. *Guidelines for Deploying Connected Vehicle-Enabled Weather Responsive Traffic Management Strategies* (FHWA-JP0-17-478) includes a framework, explains the use of fixed and mobile data for new and existing applications, identifies the core capabilities needed to successfully implement those applications, and describes three pathways that agencies can take in deploying the strategies. The pathways are as follows:

Pathway 1: Intelligent Agency Fleets. This pathway connects the fleets that an agency owns, or has access to, to support weather responsive traffic management. The fleets may include plows, highway patrol vehicles, and other maintenance vehicles. Many of these fleets have existing remote communication capabilities through either cellular links or agency-owned radio systems, and can transmit both voice and data.

Pathway 2: Connected Vehicles. A connected vehicle can transmit and receive basic safety messages. This pathway relies on the possibility that regulation might require light vehicles to have dedicated short-range communications (DSRC) capabilities. DSRC is a networking technology that enables fast, secure, and reliable communication for various connected vehicle applications. The vehicles communicate not only with each other but also with DSRC-enabled roadside units, which then communicate with data collection and management systems.

Pathway 3: Connected Third-Party Fleet Services and Connected Travelers. In parallel with State DOT fleet efforts, several private fleets have high levels of connectivity and may send and receive information that is valuable to weather responsive traffic management. There are many private sector services and organizations that are looking to equip fleets with data integration and communications.

In addition to the pathways, the guidelines also describe and provide guiding principles for three applications of connected vehicle-enabled weather responsive traffic management (connected vehicle-enabled variable speed limits, infrastructure-to-vehicle situational awareness, and vehicle-to-vehicle situational awareness). Each application is dependent upon vehicle connectivity, regardless of the pathway.

"Advanced mobile data collection and connected vehicle technologies are significantly improving agencies' ability to respond quickly and appropriately to adverse weather," says Mark Kehrli, director of the Office of Transportation Operations at FHWA. "These technologies will continue to improve safety and operations during weather events as more and more agencies implement and expand their capabilities."

Roemer M. Alfelor manages the Weather Responsive Traffic Management Program at FHWA. He holds M.S. and Ph.D. degrees in civil engineering from MIT and Carnegie Mellon University.

For more information, contact Roemer Alfelor at 202-366-9242 or roemer.alfelor@dot.gov. The guidelines are available at http://ntl.bts.gov/lib/61000/61000/61004/FHWA-JPO-17-478.pdf.

Along the Road

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

Public Information and Information Exchange

USDOT Releases 5-Year RD&T Strategic Plan

Following a period of public comment and stakeholder input in 2016, USDOT released its *Research, Development, and Technology [RD&T] Strategic Plan*, which presents the Department's research priorities for the next 5 years (fiscal years 2017–2021). The document provides an action plan that responds to the trends affecting the current and future performance of the Nation's transportation system, as identified in USDOT's *Beyond Traffic 2045* report.

The RD&T Strategic Plan meets the statutory requirements of the Fixing America's Surface Transportation (FAST) Act, which requires the Secretary of Transportation to develop a 5-year strategic plan to guide future Federal transportation research and development (R&D) activities.

The plan defines four critical transportation topic areas: promoting safety, improving mobility, improving infrastructure, and preserving the environment. It describes the current and planned R&D strategies used by USDOT to address the research needs within each area and highlights cross-modal research areas and collaborative initiatives. It also describes four overarching research themes, identified during the stakeholder engagement process, which cut across all of the critical transportation topic areas. The themes are policy research, emerging technology, strengthening research coordination, and big data.

The plan includes a section on technology deployment that describes how the Department's Technology Transfer Program and each operating administration's technology deployment strategies address the FAST Act requirement to specify how research findings will be used to improve the efficiency, effectiveness, and safety of transportation systems.

For more information, visit www.transportation.gov/administrations/assistant-secretary-research-and-technology/dot-five-year-rdt-strategic-plan.

FHWA Is Among the Best Places to Work for a Fifth Consecutive Year

In January, the Federal Highway Administration was named one of the best places to work in the Federal Government by the Partnership for Public Service. FHWA ranked among the top 25 Federal agency subcomponents of 305 surveyed.

The new rankings make it the fifth straight year that FHWA has been listed in the top 10 percent. Federal employees were surveyed about their respective workplaces between April and June 2016. The rankings assess how public servants in the U.S. Government view their jobs and workplaces, providing important employee perspectives about leadership, pay, and other issues.

Published in the Partnership for Public Service's 2016 Best Places to Work index, the rankings are based on the Office of Personnel Management's Federal Employee Viewport Survey, which analyzes data collected from more than 421,000 Federal workers to produce a detailed view of employee satisfaction and commitment.

Agency subcomponents are not only measured on overall employee satisfaction but are scored on a wide range of workplace categories, such as effective leadership, employee skills/mission match, support for diversity, and pay. FHWA improved its scores in all 10 categories, with the biggest single-year improvements in training and innovation.

For a complete list of the 2016 rankings, visit http://bestplacestowork.org/BPTW/index.php.

Report Reveals Need for Infrastructure Investment

USDOT recently released a report on the state of U.S. transportation infrastructure, *2015 Status of the Nation's Highways, Bridges, and Transit: Conditions and Performance* (C&P Report). The publication is a biennial report to Congress that provides information on the physical and operating characteristics of the highway, bridge, and transit components of the surface transportation system.

The latest C&P Report identifies an $836 billion backlog of unmet capital investment needs for highways and bridges, or about 3.4 percent more than the estimate made in the previous report. Addressing the growing backlog—while still meeting other needs as they arise over the next two decades—will require $142.5 billion in combined annual capital spending from Federal, State, and local governments. In 2012, the most recent year from which data were available for the report, Federal, State, and local governments combined spent $105.2 billion on this infrastructure—35.5 percent less than what is needed to improve highways and bridges.

The report also indicates that $26.4 billion is needed per year to improve the condition of transit rail and bus systems. In 2012, total spending to preserve and expand transit systems was $17 billion. If transit investment is sustained at those levels, overall transit system conditions are expected to decline over the next 20 years, thus increasing the transit system preservation backlog from an estimated $89.8 billion to $122 billion.

© Peeter Viisimaa, Getty Images

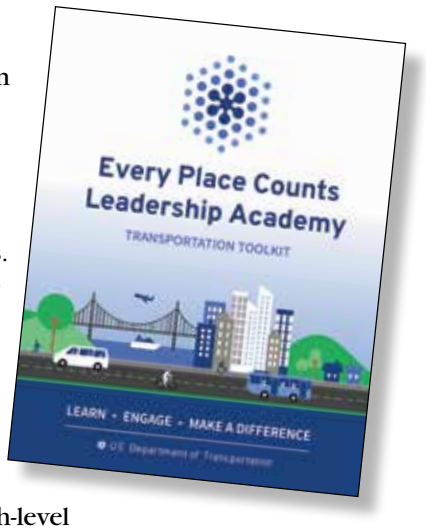
The latest Conditions and Performance Report to Congress indicates that the percentage of structurally deficient bridges decreased between 2002 and 2012, but commuter delays from traffic increased.

Between 2002 and 2012, the report found that the percentage of structurally deficient bridges decreased, road quality improved, delays in traffic cost the average commuter more time than ever, and transit route miles increased, with light rail growing faster than any other transit mode.

For more information, visit www.fhwa.dot.gov/policy/2015cpr.

USDOT Offers Leadership Academy Toolkit

While transportation agencies at the local, regional, and State levels offer opportunities for public involvement, the process may be confusing and intimidating for members of the public. It is difficult for someone who does not understand the process to become meaningfully involved in transportation decisions. In late 2016, USDOT launched the Leadership Academy to help demystify the transportation decisionmaking process for the traveling public. As part of the initiative, USDOT created a set of tools to help people learn about transportation and to provide the skills necessary for teaching others as well. The tools include an indepth toolkit, quick guide, resource library, facilitator guide, and stories.



The *Transportation Toolkit* explains the basics using clear design and plain language. The toolkit helps people determine how to participate effectively in the transportation decisionmaking process. For example, it explains how to find quality data to show the need for a transportation project and when may be the best time to contact an agency with an idea. For people who want a high-level overview, the *Transportation Toolkit Quick Guide* introduces the content of the toolkit in a short, colorful booklet.

For those interested in learning more, an online library provides resources with more details on topics such as the National Environmental Policy Act and civil rights laws. The *Facilitator Guide* can help emerging community leaders conduct their own Leadership Academy Workshop through a set of activities that help participants learn the content of the toolkit.

USDOT hosted regional workshops in fall 2016 in Kansas City, MO; Seattle, WA; and Washington, DC. The larger goal of the initiative is to enable transportation agencies, local communities, and advocates to host academies of their own. The Leadership Academy initiative aims to help emerging, under-represented community leaders—people who have great ideas but who may not consider themselves experts in transportation—to work with their local and State transportation agencies in a proactive, constructive manner.

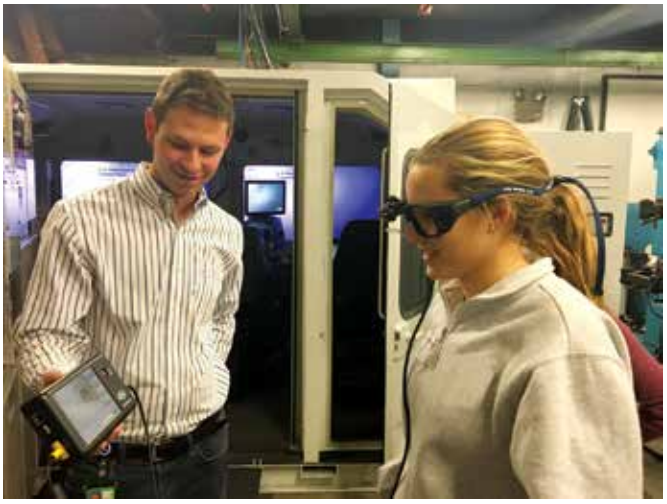
For more information, visit www.transportation.gov/leadershipacademy.

Volpe Hosts Students for STEM Mentoring

In December 2016, the John A. Volpe National Transportation Systems Center hosted 21 high school engineering students from Newton Country Day School, an all-girls college preparatory school in Massachusetts.

During their visit, two groups of students alternated between a "speed mentoring" session and a tour of the center's simulators. Each student had a hands-on opportunity to try at least one of Volpe's three simulators, including test driving a car, operating a train, or flying an airplane. Researchers use the simulators for human factors experiments to study how participants handle various new or dangerous scenarios—such as what drivers do when their brakes stop working.

The Boston chapter of WTS, an international organization that promotes the advancement of women in transportation, organized the event and partnered with Volpe to host the Newton Country Day School students. Fifteen volunteers from WTS and Volpe staff spoke to the



SLM

A Volpe staff member demonstrates to a student how eye-tracking technology works.

students about the variety of careers available in transportation and the science, technology, engineering, and mathematics (STEM) fields.

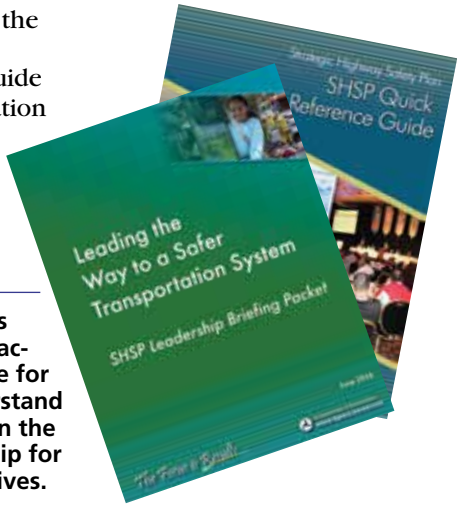
Luisa Paiewonsky, director of Volpe's Center for Infrastructure Systems and Technology, offered the students advice on the many technical and nontechnical skills they will use throughout their collegiate and professional careers. She also described the breadth and depth of projects managed at Volpe, which include all modes and various topic areas, such as the environmental impacts of transportation, human factors and safety concerns, and infrastructure resilience.

Volpe

FHWA Products Support the SHSP Process

FHWA's Office of Safety has created two resources that can help bring new stakeholders up to speed on a Strategic Highway Safety Plan (SHSP). The *SHSP Quick Reference Guide* (FHWA-SA-16-097) and *Leading the Way to a Safer Transportation System: SHSP Leadership Briefing Packet* (FHWA-SA-16-096) may be particularly useful for transportation leaders and newcomers to the SHSP process.

The reference guide provides transportation professionals with quick and easy access to the information they need to successfully understand and manage an SHSP. It provides an overview of the basic elements and requirements of an SHSP and offers helpful resources and links where practitioners can go to learn more. The guide also contains practical tips and noteworthy practices from professionals involved in the daily operations of the SHSP process.



Two recent products from FHWA help practitioners responsible for their SHSP to understand the process and gain the support of leadership for traffic safety initiatives.

Leaders are critical to the success of all traffic safety efforts and can have an immediate and lasting impact through a State's SHSP. The leadership briefing packet helps State and local leaders understand the importance of the SHSP, its role as part of the Highway Safety Improvement Program, and why their involvement in this effort is crucial. The packet is particularly useful as part of a larger briefing on safety or as a way to gain more support for the SHSP, such as after passage of major transportation legislation or when there are changes in a State's administration.

The reference guide is available as a Web-based document and as a printable publication at http://safety.fhwa.dot.gov/hsip/shsp/quick_ref_guide. The leadership briefing packet is available at http://safety.fhwa.dot.gov/hsip/shsp/fhwasa16096.

For more information, contact Chimai Ngo at chimai.ngo@dot.gov.

Indiana and Kentucky Complete East End Crossing

In December, then Deputy Federal Highway Administrator David Kim joined Kentucky Governor Matt Bevin, Indiana's then Governor-elect Eric Holcomb, and other State and local officials to mark the completion of the federally funded East End Crossing. The project is the second half of the $2.3 billion Ohio River Bridges project. Combined with the Downtown Crossing, which connects Louisville, KY, with nearby Jeffersonville, IN, the Ohio River Bridges project is among the Nation's largest infrastructure improvement projects, relying on more than $1 billion in Federal loans, bonds, and other funds. Planning for the project began in 1969, and construction began in 2013.

The new East End Crossing, shown here, increases the number of driving lanes in each direction and adds a protected path for bicyclists and pedestrians, improving the travel experience for all road users. *Photo: Louisville-Southern Indiana Ohio River Bridges Project.*

A joint effort between Kentucky and Indiana, the East End Crossing is the area's first new bridge in more than 50 years. It will improve travel for an estimated 35,000 drivers each day. Connecting Utica, IN, and Prospect, KY, the bridge's Kentucky approach will extend I–265 (Gene Snyder Freeway) from U.S. 42 to the bridge, adding two new lanes in both directions for 1.4 miles (2.3 kilometers). The Indiana approach will also be a four-lane section, extending State Route (SR) 265/Lee Hamilton Highway 4 miles (6.4 kilometers) from SR–62 to the bridge. In addition, the project included a scenic multiuse path along the northern side of the Ohio River for bicyclists and pedestrians.

The East End Crossing improves access for area residents commuting between eastern Jefferson County and southern Indiana. For commercial freight and other travelers passing through the Louisville area from the north or south, the East End Crossing is an alternate route that bypasses Louisville's downtown traffic.

Pilot Program Offers Adaptive Bicycles in Portland

Oregon's Portland Bureau of Transportation (PBOT) is developing a pilot project to increase access to adaptive bicycling. The organization solicited input from community stakeholders and future customers, and plans to launch the program in June 2017.

Jonathan Maus, bikeportland.org

A pilot program is exploring how to increase access to adaptive bicycles, such as this hand-cranked cycle, for Portlanders with disabilities.

PBOT previously has received requests for physical accommodation in its BIKETOWN bike share system. As part of the pilot development, PBOT staff interviewed staff from bike share systems in other cities, city program staff, companies and organizations serving people with disabilities, and Portlanders with disabilities. In summer 2016, PBOT attended a series of events related to adaptive cycling and interviewed attendees with disabilities about an adaptive bicycling rental service.

The individuals with disabilities who PBOT interviewed almost universally expressed a desire or need for a staffed service. Individuals explained their needs for personal wheelchair storage, assistance with fitting, and possible assistance to move between their mobility device and the adaptive bicycle.

In part because of safety concerns regarding riding in motor vehicle traffic and a primary interest in exercise and recreation, people wanted to use adaptive bicycles to ride on trails or paths without motor vehicles. The pilot focuses on adaptive cycle rentals through existing bike rental businesses located on or in close proximity to nonmotorized trails. PBOT is considering providing both hand-cranked bicycles and three-wheel bicycles.

This pilot expands PBOT's work to increase access to adaptive bicycling. Other projects include providing adaptive bikes for the Safe Routes to School in-school bike safety education program, offering scholarships to Bike First (a camp that teaches riding skills to students with disabilities, including those with cerebral palsy and vision impairments), and donating senior trikes to Portland Parks & Recreation's Senior Recreation program.

City of Portland

Personnel

USDOT Welcomes Secretary Elaine Chao

Secretary Elaine L. Chao is the 18th U.S. Secretary of Transportation and comes to the Department with extensive experience in the transportation sector. She was a transportation financial officer with two major banks, worked on transportation and trade issues at the White House Office of Policy Development, and served as Deputy Maritime Administrator, Chairman of the Federal Maritime Commission, and Deputy Secretary of USDOT.

In addition, as the 24th U.S. Secretary of Labor (2001–2009), Secretary Chao was the first Asian-American woman to be appointed to the President's Cabinet in U.S. history. She also has served as the president and chief executive officer of United Way of America (now United Way Worldwide) and director of the Peace Corps.

Secretary Chao understands the critical role of the Department in ensuring the safety of the Nation's roads, rails, and skies. She is also aware of the key role that infrastructure plays in the country's economic competitiveness, and in strengthening economic growth in both urban and rural areas.

Internet Watch

by Katie Lanham

New NHTSA.gov Aims to Make Roads Safer

Each year, hundreds of thousands of people visit the Web site of the U.S. Department of Transportation's National Highway Traffic Safety Administration, www.nhtsa.gov. These parents, driver educators, motor vehicle researchers, advocates, and the driving public are all in search of the same thing—information that will help create a safer driving environment for themselves, their loved ones, and the public.

In December 2016, NHTSA launched a new NHTSA.gov to make it easier to find important information related to traffic safety. From recalls to safety tips, the new site is a helpful tool that supports NHTSA's goal of eliminating traffic fatalities and major injuries on the Nation's roadways.

What's Different

The new site is designed for the public. Topics are presented in easy-to-understand terms and organized to reflect the way consumers think about safety on the Nation's roads. Using the latest Web technology, best practices in user experience, and responsive design, the site puts popular topics at the fingertips of any user, whether via smartphone, tablet, or computer.

For those looking to discover behavioral issues associated with safety, NHTSA's aim is to educate. The agency presents its primary topics in a simple manner: (1) What is the problem? (2) What is NHTSA doing about it? and (3) What is the end result? For those who want to dig deeper, keyword tagging and improved search capabilities enable users to find the latest information on a given topic.

The site includes new features and functionality to improve the user experience and make it easier to find more information in one place. For example, the technical team developed an application program interface that, for the first time, pulls information from NHTSA's safety defects database, its 5-Star Safety Ratings, and from manufacturers to present a complete picture of a vehicle's safety profile.

One of the key features of the new site is the Safe Cars Save Lives section on the home page. A simple tool enables consumers to enter a vehicle identification number (VIN)—or the year, make, and model of a vehicle—and immediately get all of the latest recall information, crash test ratings, and safety updates related to that specific vehicle.

What's the Same

All the data, research, stats, legal documentation, and resources that NHTSA has provided to various stakeholders for years remain on the site. At the top right corner of the navigation are direct links to the agency's rich library of information: "Research & Data," "Laws & Regulations," and "Information For." The latter offers a dropdown menu to select topics by user type: parents and caregivers, those looking to import a vehicle, and vehicle manufacturers. Stakeholders can either self-select from the navigation or use the primary search tool to find the latest reports, research, and data on a topic.

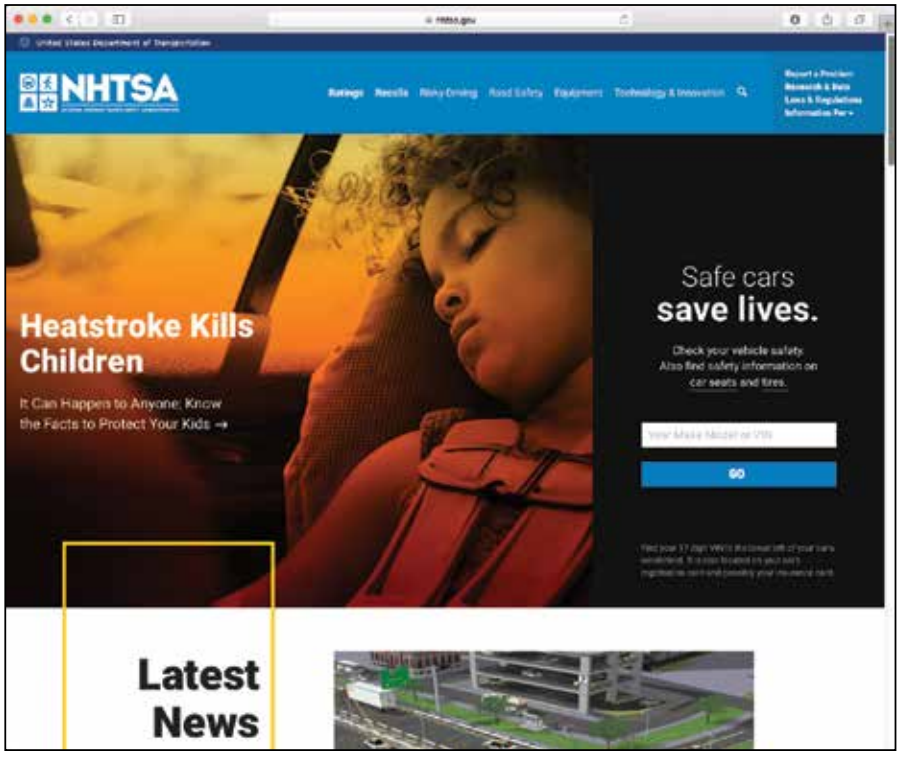
A Site That Saves Lives

The new NHTSA.gov consolidates all of the agency's content into one cohesive site. Previously, this information was spread across multiple Web sites, including SaferCar.gov. Now consumers can access the site anywhere, from any device. NHTSA encourages the public to visit the site and explore the new features offered.

"People turn to the National Highway Traffic Safety Administration every day for critical, life-saving news and information that directly impacts their lives," says Jack Danielson, NHTSA's executive director. "Whether you are on your phone or sitting at your desk, the new Web site makes finding safety information faster and easier. We believe that better access to life-saving information can help all Americans travel safely on our roadways."

For more information, visit www.nhtsa.gov or contact Lucia Sanchez at 202-366-2564 or lucia.sanchez@dot.gov.

Katie Lanham is a Web writer with UIC Government Services/Bowhead and supports NHTSA.



by Judy Francis

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NHI's courses on transportation planning can help practitioners understand the full scope of the process and support more effective decisionmaking.

Understanding Transportation Planning

Transportation planning is a complex process involving many aspects, from data collection to coordination and public engagement. Transportation professionals may be knowledgeable about their part in the process, but may not understand how the other parts fit together within the Federal transportation planning process. New practitioners also may be looking for information about what needs to happen to get a transportation project implemented. Two new courses from the National Highway Institute can help: Basics of Transportation Planning (course number FHWA-NHI-151052) and Transportation Planning Process (course number FHWA-NHI-151053).

Understanding the Basics

Each step in the planning process helps to support effective decisionmaking. The Basics of Transportation Planning course introduces participants to requirements for urban, statewide, and nonmetropolitan transportation planning. "It provides a forum and foundation for planners and practitioners to access, learn, and review information on the transportation planning process in an easily accessible, Web-based format," says Kenneth Petty, director of the Federal Highway Administration's Office of Planning.

The course contains three areas of focus. The first discusses the purpose and importance of the transportation planning process in supporting decisionmaking for transportation investments, and describes transportation planning products such as metropolitan transportation plans and statewide transportation improvement programs. The second addresses the roles, responsibilities, and relationships that exist among the various participants. The third focus area introduces the key phases of the transportation planning process, with each lesson addressing one phase in the process.

The 4-hour, Web-based training is available at no cost and can be completed independently, but it also functions as an introduction to and prerequisite for the Transportation Planning Process course.

The Planning Process in Context

Transportation Planning Process is a 2-day, instructor-led training that explores the basic course's lessons in greater depth, and underscores the relationship between the transportation planning process and informed decisionmaking. The course expands participants' knowledge and understanding of planning practice fundamentals through the use of small group discussions and activities, games, and interactive peer exercises. Participants learn how a well-structured process improves coordination among the different agencies involved in funding and project development, provides transparency, and helps ensure that transportation investments support community needs.

Participants learn effective approaches to planning and how plans can be coordinated. The course covers how to use a performance-based approach, including establishing and reporting performance targets. Interactive exercises enable participants to develop goals, objectives, performance measures, and targets as they consider how public engagement and intergovernmental cooperation may be integrated into the process.

The course emphasizes understanding local demographics, associated travel behavior, and any emerging concerns, while balancing consideration of system performance and financial planning. Participants learn to consider the use of scenario planning during the development of a transportation plan to examine the community's needs and circumstances.

Targeting a Wide Audience

Both courses serve as resources for a broad range of transportation professionals to understand the basics of transportation planning. The courses may be of particular interest to staff at State departments of transportation, metropolitan planning organizations, transit agencies, rural planning organizations, FHWA, the Federal Transit Administration, and other transportation groups. Those whose work or whose interests intersect with the transportation planning process, such as staff at environmental and resources agencies or representatives from stakeholder groups, also may benefit from them.

For more information, visit www.nhi.fhwa.dot.gov. To register for a training session or to sign up to receive email alerts when sessions are scheduled, visit the course description page.

Judy Francis is a contracted marketing analyst for NHI.

Communication Product Updates

Compiled by Lisa A. Shuler of FHWA's Office of Corporate Research, Technology, and Innovation Management

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

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

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For more information on R&T communications products available from FHWA, visit FHWA's Web site 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).

Automated High-Performance Liquid Chromatography Saturate, Aromatic, Resin, and Asphaltene Separation (TechBrief)
Publication Number: FHWA-HRT-15-055

Dividing a material into its constituent parts is necessary to define its composition. Researchers can use these compositional analyses for binder formulation through blending, rejuvenation, and modification, as well as for predicting physical performance. The most common type of analysis divides a crude oil or asphalt into saturate, aromatic, resin, and asphaltene fractions. This technical brief focuses on the use of an automated high-performance liquid chromatography process that also further separates the asphaltene fraction.

Developed by scientists at the Western Research Institute, the novel separation process is called asphaltene determinator. The process reduces the time involved to complete a separation from days to hours. Researchers are exploring separation profiles from the process to develop indicators that correlate with binder performance.

The technical brief includes an overview of how to conduct the separation, as well as initial results from FHWA's tests of binders at varying degrees of aging. More work is needed to further develop and validate these correlations.

The document is available to download at www.fhwa.dot.gov/publications/research/infrastructure/pavements/15055/index.cfm.

Traffic Bottlenecks: Identification and Solutions (Report)
Publication Number: FHWA-HRT-16-064

This report discusses a research project aimed at developing practical methods for prioritizing and mitigating traffic bottlenecks, one of the top causes of surface transportation congestion in the United States. Researchers developed a new approach for ranking traffic bottlenecks and a playbook of 70 bottleneck mitigation strategies. The report includes a benefit-cost analysis of five low-cost mitigation strategies and research on three innovative mitigation strategies that are not currently used in the United States.

In advancing a new approach for ranking traffic bottlenecks, researchers created a data-driven software tool with numerous performance measures to identify congestion and bottlenecks. In parallel, the team conducted extensive traffic simulations to assess the operational benefits of less frequently used strategies as opposed to popular strategies, such as ramp metering, which have been extensively researched and implemented in recent decades.

The project also focused on low-cost solutions rather than solutions that require significant infrastructure investments or advanced vehicle technologies. These low-cost solutions included the use of dynamic lanes, contraflow or reversible lanes, and hard-shoulder lanes; lane-width reduction; and modest extension of auxiliary lanes.

Research results demonstrated that these solutions produced favorable benefit-cost ratios with only minor modifications to existing infrastructure. Researchers further developed preliminary design guidance on signing, signalization, and striping for these strategies, and began a followup human factors study for two of the strategies.

The congestion bottleneck identification tool is available from Chris Melson, christopher.melson@dot.gov, or Joe Bared, joe.bared@dot.gov. This report may be of interest to practitioners involved in transportation operations. It is available to download at www.fhwa.dot.gov/publications/research/operations/16064/index.cfm.

Integrated Corridor Management and the Smart Cities Revolution: Leveraging Synergies (Report)
Publication Number: FHWA-HOP-16-075

In 2014, the U.S. Department of Transportation defined a smart (or connected) city as a system of interconnected systems. These include employment, health care, retail, transportation, entertainment, public services, residences, and energy distribution. This system of systems is tied together by information and communications technologies that transmit and process data about a wide variety of activities within the city.

Conceptually, integrated corridor management (ICM) can be viewed as a practical application of a smart cities objective within the defined parameters of a corridor, not necessarily citywide. The ICM approach is based on three fundamental concepts: a corridor-level operations nexus; agency integration through institutional, operational, and technical means; and active management of all participating corridor assets and facilities. The goal of ICM is for transportation networks to realize significant improvements in the efficient movement of people and goods through aggressive, proactive integration of existing infrastructure along major corridors.

Because smart cities and ICM are fundamentally similar in terms of their requirements and objectives, this primer focuses on opportunities for codeployment synergies and how approaches and lessons learned from one initiative can be translated to the other. The report explores opportunities to effectively integrate strategies institutionally, operationally, and technically, both by leveraging existing platforms and considering new options for coordination between ICM and smart cities stakeholders. It also identifies potential challenges to integrating ICM and smart cities, along with potential solutions.

The intended audience for this report includes stakeholders from State and local transportation departments, metropolitan planning organizations, city agencies, and other organizations in the public and private sectors that provide services within a city or metropolitan area and are seeking to provide those services in a smarter, more efficient, and sustainable manner. This report aims to encourage these groups to think broadly about how to go about creating smart cities and how ICM can help achieve those goals.

The document is available to download at www.ops.fhwa.dot.gov/publications/fhwahop16075/fhwahop16075.pdf.

Dimensional Stability of Grout-Like Materials Used in Field-Cast Connections (TechNote)
Publication Number: FHWA-HRT-16-080

This technical note provides information about current approaches to quantifying the dimensional stability of grouts and grout-like materials, including those categorized as nonshrink cementitious grouts, and highlights some of the limitations of the test methods currently in use. The document proposes additional methods of materials testing to better quantify dimensional stability, as well as strategies to help mitigate some of the shrinkage observed in these types of materials.

Some grouts, especially those classified as nonshrink grouts, have displayed cracking mainly linked to their poor dimensional stability when used in connection details during bridge construction projects. The typical standards and test methods may provide an incomplete picture of the overall performance regarding the dimensional stability of these materials. Two common test methods have a series of shortcomings that researchers should consider when evaluating the dimensional stability of grout-like materials. For example, both methods provide a qualitative performance comparison rather than a quantitative assessment of the likelihood of shrinkage and expansion.

To provide a more direct correlation to shrinkage and potential cracking issues in these types of materials, FHWA recommends the use of additional test methods that might be more directly related to the real-world performance of these materials.

The researchers recommend internal curing as a convenient strategy to reduce shrinkage deformations and, consequently, shrinkage cracking. The inclusion of internal curing in prebagged grout materials could be implemented in the field as a grout extension or even as part of the premix material. This would also facilitate curing operations, especially in difficult-to-access locations.

This document is available to download at www.fhwa.dot.gov/publications/research/infrastructure/structures/bridge/16080/index.cfm.

Reporting Changes of Address

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FHWA-HRT-17-004
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