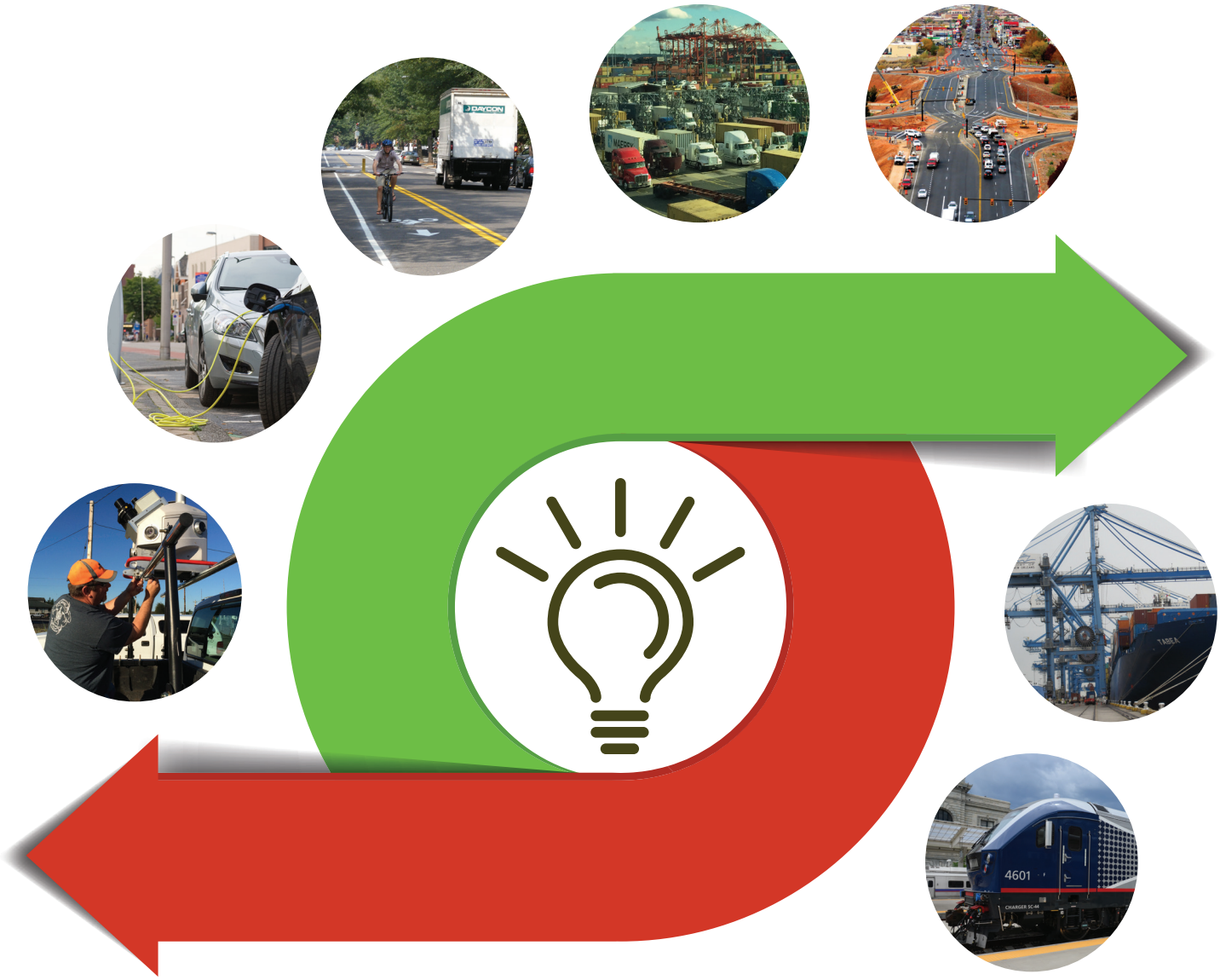

The Promises and Risks of Innovation

Findings from the Transportation Research Board's 2016 State Partnership Visits Program

Specialists in the Transportation Research Board's (TRB's) Technical Activities Division identify current issues, collect and generate information on the issues, and disseminate the information throughout the transportation community. The TRB Annual Meeting, TRB-sponsored conferences and workshops, webinars, standing committee meetings and communications, publications, and contact with hundreds of organizations and thousands of individuals provide TRB staff with information from the public and private sectors on all modes of transportation.

A major source of this information is the TRB annual state partnership visits program. Transportation professionals on the TRB staff meet on site with representatives of state departments of transportation and with representatives of universities, transit and other transportation agencies, and industry. In addition, TRB staff is involved with planning and delivering conferences, workshops, webinars, and meetings. This report summarizes what the TRB staff learned from visits and activities during the past year.

"Transformational" is a word frequently heard among state department of transportation (DOT) officials and technical experts. The word refers to an array of technologies and business models that promise to transform the way transportation is experienced, paid for, and managed. These transformational technologies include connected and automated vehicles, unmanned aerial systems or drones, ride-sourcing services such as Uber and Lyft, big data, and others.

The flip side of this reality is that the word "uncertainty" is also frequently on the lips of transportation professionals. The rapid pace of change is challenging the traditional processes for planning, decision making, construction, operations, and transportation service delivery.

How should transportation agencies estimate future travel demand for their systems? How will the services being offered by companies such as Uber and Lyft change travel behavior and land use? What protections are needed to secure the data and networks for safety and communications? What are the risks, and how should the risks be measured and accounted for in decision making?

The 2016 state visits by TRB senior program officers revealed the energy and insight with which state transportation agencies and their research partners are addressing the promises and challenges of transformational innovations.

Photo: New York City Department of Transportation, Flickr

A New York City DOT–hosted vendor demonstration for the U.S. DOT Connected Vehicle Pilot Program.

Institutional and Cross-Modal Issues

Planning

State DOT and metropolitan planning organization (MPO) officials are focused on practices, performance measures, benchmarks, and goals addressing federal requirements on asset management, safety, and other issues specified in the Fixing America's Surface Transportation (FAST) Act and the Moving Ahead for Progress in the 21st Century Act. At the same time, they are planning for and ensuring consideration of future needs in a rapidly changing environment.

State DOTs and MPOs developing long-range plans and programs seek new approaches and tools for evaluating alternative futures. California DOT (Caltrans), for example, applied scenario planning to prepare the California Transportation Plan 2040, responding to the strict federal performance management requirements, as well as to state laws for the reduction of greenhouse gas emissions.

Many cities demonstrated their commitment to innovation and their willingness to take risks by entering the U.S. DOT Smart Cities Challenge, submitting plans to leverage private-sector and public resources in developing automated vehicle corridors, integrating fleets with connected vehicle technology,

Photo: Larry Levine, WMATA

Workers repair a switch at the Washington, D.C., Metrorail's Twinbrook station, part of the agency's comprehensive, multiphase SafeTrack program to accelerate track work and upgrades.

Researchers at several universities are studying how agencies and the private sector can develop cost-effective transportation networks and systems.

electrifying vehicle fleets, and implementing other innovations. Technical and financial restrictions, however, hinder most organizations from addressing the future uncertainties, particularly with a growing backlog of maintenance needs.

Researchers at several universities are developing models and tools to help agencies and the private sector develop cost-effective transportation networks and systems. Texas A&M Transportation Institute is examining the impacts of a variety of economic scenarios on vehicle miles traveled; the Massachusetts Institute of Technology is exploring the effects of changing economic conditions on freight transportation; and the University of Maryland is testing the impacts of land use, economics, and transportation scenarios on transportation capacity and system needs.

Photo: Tysto, Wikimedia Commons

A red-light camera system in Springfield, Ohio. States continue to contend with the legality and constitutionality of automated enforcement, along with the use of unmanned aerial systems and the regulation of ride-sourcing services like Uber and Lyft.

Legal Issues

State DOT attorneys are kept busy with contracts, eminent domain, and other legal matters common to transportation construction and operations, such as the safety of roadside hardware. These attorneys, however, also are addressing critical issues related to transformational technologies.

States are grappling with the legality and constitutionality of automated enforcement, the use of unmanned aerial systems, and the regulation of ride-sourcing services such as Uber and Lyft. Legal opinions on these matters differ among states and among federal agencies, and local governments are playing a key role.

The main challenge is to harness the benefit of new technologies while preserving safety, privacy, and other rights and values. If regulation is too onerous, the benefits may be lost; if regulation is too lax, important rights and values may suffer.

Other critical questions relate to authority and governance: Should new technologies be regulated at the federal, state, or local level? Do these new approaches suggest a shift away from public authority to greater private-sector decision-making? Will new governance structures arise to guide the development of technologies?

Environment, Energy, and Climate Change

States are implementing plans and policies to reduce greenhouse gas emissions and are looking to develop meaningful analyses of the results. The solution includes encouraging the public and other infrastructure stakeholders to get involved in achieving statewide goals. Information contributes to success, but collecting, analyzing, and sharing the right information remains a challenge.

Photo: Bigstock

Electric car charging station, New Rochelle, New York. States are working to maximize benefits from renewable energy, as well as research into vehicle fuel economy; alternative fuel technologies, uses, and infrastructure; and air quality modeling and measurement.

States are looking at research into improvements in vehicle fuel economy; alternative fuel technologies, uses, and infrastructure; and air quality modeling and measurement to achieve statewide goals. Concerted efforts are under way to maximize benefits from renewable energy projects in road rights-of-way, as well as in other state-owned properties and lands.

Data

Improved freight data are a priority as freight flows gain in importance to the economy and to state DOTs. California initiated the Caltrans Truck Survey, modeled after the national Vehicle Inventory and Use Survey that was discontinued in 2002. Caltrans expects the survey results to yield insights on the inventory and flow of commodities and commercial vehicle fleets and to inform statewide freight travel demand modeling, the state's Freight Mobility Plan, and strategies to improve and facilitate freight movement within California.

In Iowa, data on the economy and freight flows are undergoing advanced analysis. Iowa DOT has partnered with the Iowa Economic Development Authority (IEDA) and Quetica, LLC, to develop a comprehensive, demand-based approach to supply-chain optimization for the state, using extremely large volumes of data on global freight movement. The analysis allows IEDA to offer a unique supply-chain design service to firms looking to locate or expand in Iowa. The project exemplifies an increase in state DOTs partnering with other state agencies to develop external data sets of broader interest to the state and its citizens.

Iowa DOT also is working with Iowa State University to apply advanced analytic tools to understand and respond to nonrecurring congestion on the highway network. Advanced tools such as Hadoop open-source software, real-time image processing, and high-performance computing are yielding new insights into the impacts of work zones and incidents.

With increasing interest in bicycle and pedestrian travel, state DOTs are collecting more data and collaborating with others to aggregate data sets, including roadway features, crashes, and usage. Oregon

Photo: Caltrans

Freight traffic in Los Angeles, California. Caltrans expects its latest survey results to yield multiple insights, including strategies to improve freight movement within the state.

A Portland, Oregon, planner's protected intersection concept is tested in Minneapolis, Minnesota. State DOTs are collecting more data and collaborating with other agencies to aggregate data sets on roadway features, crashes, and usage.

Photo: Nick Falbo, Alta Planning + Design

DOT maintains large databases related to geometric features, to identify locations of network deficiencies—such as a missing sidewalk or a missing bike lane—and potential safety improvements. The extensive data on crashes involving bicyclists and pedestrians help identify temporal and spatial crash patterns, prioritize locations for investment, and allocate funds for safety programs.

Photo: Christine Gerencher, TRB

A new dog recruit works with a handler at the Transportation Security Administration's canine training center's mock airport terminal. Only one-quarter of all recruits pass the course.

Aviation

Technology advances in aviation have enabled the evaluation of assistive air traffic management tools in remote or rural locations, the development of new ways to provide more information to the traveling public, and the securing of the entire aviation system from cyberthreats.

Unmanned aerial systems, their potential uses, and their quickly changing regulatory environment continue to attract close interest in the states. Some state DOTs are hiring staff to identify beneficial opportunities that take into account safety and other concerns associated with the rapidly evolving industry.

Freight

The FAST Act, signed into law in December 2015, highlighted the importance of the U.S. freight transportation system. The FAST Act authorized $1.2 billion per year in formula funding for a new National Highway Freight Program, required the establishment of a designated National Highway Freight Network, and authorized a $4.5-billion discretionary competitive grant program to support highway, rail, port, and intermodal freight projects.

To take advantage of the formula funding program, a state must develop a freight plan by December 2017 that "comprehensively [addresses] the state's immediate and long-range freight planning activities and investments." Many states have established freight advisory committees composed of public- and private-sector freight stakeholders to assist in identifying priority areas for freight mobility.

Transportation planners continue to focus on first- and last-mile delivery issues, especially in urban environments. Proposed projects involve off-hours deliveries, lockboxes, and consolidated pickup locations. The City of Seattle has promised $285,000 over the next three years to support the University of Washington's new Urban Freight Lab, which brings together freight carriers and public planning agencies to consider issues and innovative strategies related to urban delivery.

Ports and Waterways

After nine years of construction, a variety of delays, and extensive debate about the changes that would follow, the expanded Panama Canal locks opened in June 2016. East and Gulf Coast seaports and state DOTs already are experiencing the effects, as larger vessels begin to call and increase capacity demands on port infrastructure and freight networks. Ports, states, and MPOs are collaborating to understand and plan for the oncoming effects dockside and beyond.

The New Jersey terminals of Port Elizabeth, Port Newark, and Bayonne comprise the largest load center for freight on the East Coast. Public agencies are collaborating with private terminal operators to optimize and prioritize near-port access projects, anticipating surges in capacity needs from the larger vessel calls. Projects are addressing near-dock rail access, highway ramp capacity improvements, terminal gate optimization practices, terminal productivity measures, and more.

Cargo surges are likely to have a cascading effect on freight network capacity, renewing interest in opportunities for coastal and inland container-on-barge transportation. In October 2016, U.S. DOT awarded $4.85 million in grants to six marine highway projects supporting the twin goals of relieving landside congestion and reducing air emissions. One project, Port of Baton Rouge and Port of New Orleans Container on Barge and Trailer on Barge, supports a new service to provide exporters with a marine alternative for repositioning empty equipment that otherwise would move via truck or rail; the service could eliminate up to 12,500 truck trips each year.

Photo: Scott Brotemarkle, TRB

Trucks and containers at Port Newark, New Jersey, part of the largest load center for freight on the East Coast, along with Port Elizabeth and Bayonne.

Photo: United Soybean Board, Flickr

Containership at the Port of New Orleans, Louisiana.

Photo: Bevis King, Flickr

A Siemens SC-44 Charger at Union Station, Denver, Colorado. The train meets common specifications for locomotives and passenger cars for states that support corridors of less than 500 miles.

Rail

The Passenger Rail Investment and Improvement Act of 2008 called for the states that support short- and medium-haul corridors of less than 500 miles to join together to develop common specifications for locomotives and passenger cars, enabling purchase in quantities at cost savings. The specifications resulted in the development of a new, higher-speed, 125-mph passenger locomotive for state-supported corridors. Deliveries began in 2016 and the new locomotives are undergoing testing. Five states and one private entity have placed orders for more than 75 locomotives.

Railroad traffic continued to decline in 2016, as coal shipments dropped and pipeline construction shifted shipments of crude oil away from rail. Growth in intermodal traffic has made up for some of these losses, and the trend toward containerization has continued—container shipments now outnumber intermodal trailer shipments by more than 10 to 1.

The FAST Act requires state DOTs to create freight plans that address the capacity needs of their networks for handling increases in freight traffic in the next quarter century. Many states are contributing to the construction of new intermodal terminals to increase freight capacity. These terminals not only help to slow the growth of freight traffic on state-maintained highways but become drivers of local and regional economies.

Public Transportation

Transit agencies and state DOTs are evaluating ways to take advantage of transportation network company (TNC) services and are discussing the evolution and potential impact of TNC regulations. A similar discussion involves the effects of connected and automated vehicles (CAVs) on transit and paratransit services. For example, TNCs may fill a useful role at the intersection of transportation and public health, by providing a cost-effective means for disadvantaged populations to travel to and from medical appointments.

State DOTs and transit agencies are adjusting to new technologies. Tennessee DOT, for instance, reorganized its planning department to focus on the management of big data, data visualization, and information graphics. Geographic information systems that communicate schedules and status reports to the public are gaining in use. Interest continues in new bus technology—the Transit Authority of River City in Louisville, Kentucky, is operating an experimental hybrid diesel–electric bus as part of a diesel-free downtown zone, identified with geofencing.

Transit plays a pivotal role at the intersection of health care and transportation. In partnership with the Health and Medicine Division of the National Academies of Sciences, Engineering, and Medicine and with the sponsorship of the Federal Transit Administration (FTA), TRB hosted a workshop on Exploring Data and Metrics of Value at the Intersection of Health Care and Transportation in June 2016. The program was part of FTA's Rides to Wellness initiative.

The TRB Demand-Responsive Transportation Conference in September 2016 continued the theme with a health care track, and the TRB Rural and Intercity Bus Transportation Conference in October also addressed health topics. Tennessee DOT is working with the state's Public Health Department to address the transportation needs of disadvantaged populations.

Photo: Kansas City Regional Transit

The RideKC bus in Kansas City, Missouri, can be summoned and located via smartphone.

Highways

Design

Many state DOTs are using research results to inform roadway design policies, specifications, and practices. Wisconsin DOT, for example, has installed roundabouts successfully at several intersections; detailed technical analysis and sound engineering principles applied to the designs have achieved safe and efficient traffic operations and have reduced congestion. A safety study by the University of Wisconsin Traffic Operations and Safety Lab in 2015 showed that fatal and severe injury crashes had decreased by 40 percent at Wisconsin roundabouts, compared with signalized intersections; the report noted, however, that signalized intersections may be the more appropriate design in many instances.

DOTs have applied research results to design pavement infrastructure incorporating innovative materials and processes and have produced more durable, safe, economical, and environmentally sustainable pavements. Georgia DOT's research on inverted base pavement design sections indicates pavement performance similar to that of conventional pavement sections, but with a potential cost savings of 25 percent.

Missouri DOT and Colorado DOT are designing some pavement sections with warm-mix asphalt to gain environmental and economic benefits. In Louisiana, the Department of Transportation and Development (DOTD) conducted research on open-graded friction courses (OGFCs) for pavement design sections. The OGFC pavements had good macrotexture, with a significant reduction in accidents. Convinced by the performance, Louisiana DOTD has promoted OGFCs for the Interstate Highway System.

Photo: Dave Reid, Flickr

Drivers traverse a new roundabout in Wisconsin.

Construction and Materials

Materials performance has received increased emphasis, to balance in-service distresses and to determine the optimal recycled content. Performance-based specifications and tests for concrete and asphalt are maturing, with state DOTs at different stages of implementation.

New recycling streams from industrial byproducts and biobased additives are challenging agencies

Photo: Celeste Hoffman, Flickr

Workers pour warm-mix asphalt in Washington State. State DOTs are designing pavement sections with the material for environmental and economic benefits.

Photo: Washington State Department of Transportation, Flickr

An excavator removes broken pieces from nearly 50-year-old concrete panels on Interstate 405 in Washington State. Placement of sensors during construction is contributing data for long-life concrete pavements.

to update test methods and to develop advanced, chemistry-based requirements. The in-place recycling of roads is a focal point for states to share best practices on conventional and new materials, construction quality assurance, and comparative studies of performance and economic analyses.

Photo: Vermont Agency of Transportation, Flickr

A construction worker surveys work from below during an accelerated bridge construction in Vermont.

Interests in longevity have spurred the placement of innovative sensors during construction to track performance and contribute to materials selection and construction for long-life concrete pavements. Bridge decks are being developed and specified with high-performance, low-shrinkage concrete mixtures and additives.

Agencies are strengthening asphalt compaction requirements and are using concrete and asphalt additives to improve joints and mitigate the infiltration of water and deicing chemicals. The National Cooperative Highway Research Program (NCHRP) is addressing materials tests for design and quality assurance for long-term resistance to aging and weathering.[1]

Agencies are researching models for estimating construction time and bids for contracting and are comparing accelerated bridge construction under ordinary design–bid–build with design–build approaches. State DOTs are sharing their challenges and successes with alternative project delivery and contracting methods for addressing schedule and cost risks, accommodating disadvantaged business enterprises, and enhancing dispute resolution. Ongoing NCHRP projects are providing agencies with guidance and best practices for these alternative methods.[2]

[1] See http://materials.transportation.org/Documents/Research/NCHRP%20Materials%20Research-July%202016.pdf.

[2] See http://onlinepubs.trb.org/onlinepubs/nchrp/nchrpannual2016.pdf.

Geotechnical Engineering

Unknown subsurface conditions contribute to the financial and technical risks of transportation projects. More than half of state DOTs experience some design, construction, and performance problems from subsurface conditions. Continuing technical advances in instrumentation and modeling, as well as increased experience with new technologies, are enhancing state DOTs' ability to identify potential geotechnical risks and to reduce costs.

LiDAR scanners detect minor movements preceding catastrophic slope failure. South Carolina and Florida DOTs have used thermal integrity profiling to provide quality assurance for drilled shafts and cast-in-place piles. Kansas DOT uses electrical resistivity techniques to supplement and optimize drilling in subsurface investigations. Florida DOT is refining the use of seismic waves to explore subsurface conditions.

Micropiles provide options and cost savings in certain foundation designs and site conditions, as the process becomes more familiar and standardized. Alabama DOT replaced some predrilled H-piles with micropiles on a large Interstate project. Tennessee is using micropiles bonded to bedrock in the construction of the Foothills Parkway.

The geotechnical world is making use of mobile applications, or apps, on smart devices to save time and costs. A Minnesota DOT custom app has improved access to subsurface information in the field in real time.

Geotechnical asset management is gaining recognition as an important part of maintaining and preserving infrastructure. North Carolina DOT and Alaska DOT have established programs to evaluate potential geohazards, reduce risk, and focus maintenance resources in key locations.

Maintenance and Preservation

Maintenance leaders are responding to the rapid developments in automated and connected vehicle technologies and are investigating the potential changes in maintenance practices that may be needed with the deployment of automated vehicle technology. For example, enhanced pavement markings are an area of interest.

Highway maintenance and equipment fleet managers have used automated vehicle location technology for their fleets for more than 20 years. The data help monitor truck location and materials use during winter operations and increasingly are being used to optimize winter maintenance routes, potentially saving public agencies time and resources.

Maintenance divisions at public agencies across the nation are making use of innovative technologies. Handheld data collection devices for recording asset conditions and work quantities have been a particular success. Many agencies also are investigating unmanned aerial systems for bridge inspections, for measuring differentials in surface temperature, and for assessing the general damage after extreme events.

Photo: Oregon Department of Transportation, Flickr

An Oregon DOT technician activates a LiDAR 3-D scanner to detect slope instability.

Operations

The push to improve operations and safety at intersections and interchanges has led state DOTs to explore a range of innovative geometric designs. Successful configurations include diverging diamond interchanges and continuous flow intersections. Utah DOT has implemented these designs in the Salt Lake City area, and many other states are constructing or studying the designs.

Connected and automated vehicles present quickly emerging issues and the potential to spur

Photo: Utah Department of Transportation, Flickr

Drivers navigate a diverging diamond interchange in Utah. State DOTs have explored a range of innovative geometric road designs.

revolutionary change not only for highways but for all transportation modes. The developments have impacts on transportation operations; land use; safety; geometric, pavement, and bridge design; transit and transit operations; freight and goods movements; and more. The the technological advances may take many different paths, but public agencies are exploring the possible impacts on their infrastructure and services, because the technology development will not wait.

The American Association of State Highway and Transportation Officials (AASHTO) recently approved a challenge of deploying dedicated short-range communications (DSRC) infrastructure with signal phase and timing (SPaT) broadcast in at least one corridor in every state by January 2020; a corridor consists of approximately 20 signalized intersections. This challenge includes a commitment to operate the SPaT broadcasts for a minimum of 10 years.

The primary purpose of the SPaT challenge is to provide state and local DOTs with a clear first step toward deploying vehicle-to-infrastructure (V2I) technology and operations and to gain experience with V2I technologies. The challenge provides valuable experience and lessons in the procurement, licensing, installation, and operations of DSRC infrastructure.

Safety

In 2015, the United States experienced the largest percentage increase in crash-related fatalities in nearly 50 years. Preliminary data for 2016 suggest the trend is continuing. Fully automated vehicles offer the promise of significant safety benefits in the future, and some vehicle technologies already are showing value for safety. In the meantime, states are focusing on improving safety through collaborative and data-driven approaches and a mix of infrastructure- and behavior-related countermeasures, with the goal of reaching zero crash-related fatalities.

Utah DOT has established strong relationships with partner agencies to implement the state's Strategic Highway Safety Plan and statewide Zero Fatalities campaign. To enhance data-driven safety decisions, Utah DOT has developed an advanced online analysis tool, which also offers countermeasures for consideration. A user-friendly interface provides various departments in the agency with information on incorporating safety considerations into investment decisions.

District DOT, Washington, D.C., is playing a lead role in the mayor's Vision Zero initiative to reach

Photo: District Department of Transportation, Flickr

A bicyclist rides against the flow of vehicular traffic in Washington, D.C. District DOT is leading the mayor's initiative to reach zero fatalities or serious injuries to travelers in the city's transportation system by 2024. The effort focuses on near-term strategies, including safety improvements for pedestrians and bicyclists.

zero fatalities and serious injuries to travelers in the district's transportation system by 2024. The initiative involves more effective use of data, education, enforcement, and engineering, with a focus on some of the most urgent near-term strategies, such as safety improvements for pedestrians and bicyclists. These initiatives also contribute to another goal—to have 75 percent of all commuter trips via bicycle, walking, or transit by 2032.

SHRP 2

Implementation

When TRB completed the research and development phase of the second Strategic Highway Research Program (SHRP 2) in 2015, FHWA and AASHTO assumed the responsibility for the implementation of the products by state DOTs and other agencies. States are actively testing and adopting more than 60 SHRP 2 products, and FHWA reports that more than 430 implementation projects are in progress across the country.

All but a few projects in the $200 million research program produced usable results—a testimony to the effectiveness of TRB's approach to research management, which involves close cooperation with the ultimate users in state DOTs and other agencies and organizations.

SHRP 2 Safety Data

The safety focus area of SHRP 2 produced an unprecedented amount and variety of data on driving behavior, vehicle and roadway characteristics, and environmental factors through the SHRP 2 Naturalistic Driving Study (NDS). The NDS monitored more than 3,500 volunteer drivers in instrumented cars that traveled 5.4 million vehicle miles.

The companion Roadway Information Database (RID) contains detailed roadway data collected on 25,500 miles of highways in and around the study sites, approximately 200,000 highway miles of data from highway inventories, and data on crash histories, traffic and weather conditions, and work zones in the study sites. The NDS and RID data can be linked to associate driving behavior and outcomes with the roadway environment.

Use of the SHRP 2 safety data is growing. Through the InSight website,[3] researchers can review the data elements, conduct preliminary analyses, and download a training data set. Researchers can request an InDepth dataset for more complex analyses; more than 150 InDepth data use licenses have been issued since April 2015.

FHWA, in conjunction with AASHTO, is sponsoring nine states and 10 university research projects that are using the data, and approximately 20 state DOTs also are working with the data, often with a university partner. Other users include automobile manufacturers, insurance companies, and research firms.

Research topics are varied and include developing analysis tools, run-off-the-road accidents, younger and older drivers, car following behavior, and the safety systems and designs of automated vehicles. Researchers have published 46 papers and submitted 28 for presentation at the 2017 TRB Annual Meeting.

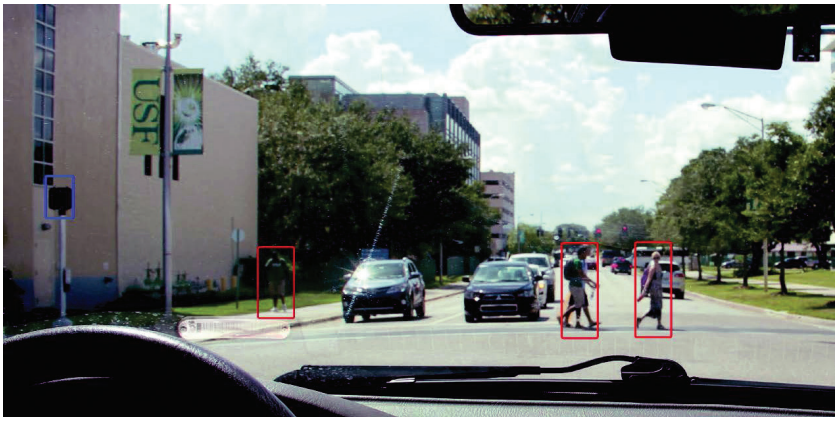

Photo: Courtesy of CUTR at the University of South Florida

Pedestrians are detected at a signalized intersection using a video processing method developed by researchers at the Center for Urban Transportation Research (CUTR), University of South Florida. The tool assists in analyzing interactions between drivers and pedestrians at signalized intersections, using videos in the SHRP 2 Naturalistic Driving Study database.

Hope and Enthusiasm

Although the uncertainties identified in this summary are unlikely to be resolved soon, clearly state transportation agencies and their partners are addressing the challenges directly, with hope and enthusiasm for the expected improvements in the movement of people and goods.

Did You Know?

◆ Minnesota DOT established one of the nation's first freight advisory committees in 1998.

◆ Forty-one states, including 16 state capitals and all states east of the Mississippi River, are served by commercially navigable waterways.

Photo: Viv Lynch, Flickr

A barge on the Cumberland River near Nashville, Tennessee, one of many state capitals served by a commercially navigable waterway.

[3] www.insight.shrp2nds.us.