

DATA'S CRITICAL ROLE IN TRANSPORTATION DECISIONS

Findings from the Transportation Research Board's 2019 State Partnership Visits Program

Photo: Chris Hedges, TRB

The Technical Activities Division of the Transportation Research Board (TRB) conducts the State Partnership Visits Program, in which TRB staff with expertise in various modes and topics visit state departments of transportation (DOTs), university transportation centers, transit and other modal agencies, and private industry. These visits support TRB's mission of promoting innovation and progress in transportation through research and information exchange by identifying needed research and research in progress and by disseminating completed research results.

One of the most time-honored of the technical activities that TRB performs, state visits last one or two days and typically consist of meetings with various levels of DOT management; discussions with DOT staff involved in various topic areas; exchanges of issues and ideas; and, often,

Above: The TRB State Partnership Visits offer a snapshot both of current issues facing state DOTs and of emerging transportation trends.

a visit to DOT facilities or to project sites. Technical Activities Division staff members contributed to the following summary of the issues facing state DOTs, revealed through the state visits program in 2019.

Planning

The planning community continues to retool their agency methods and decision-making processes to be informed by data based on analytics and multimodal system performance. The theme of data-informed decision-making was reflected in two specialty conferences that were coordinated by different planning committees. The Standing Committee on Transportation Planning Applications held its biannual AppCon conference in Portland, Oregon, in June. The conference included interactive sessions and workshops on the application of specific technical tools and methods that could be used in DOT decision-making.

The Section on Transportation Policy, Planning, and Processes sponsored the Conference on Performance and Data in

Transportation Decision-Making in Atlanta, Georgia, in September to share policy and technical approaches to creating a more data-informed planning process. The conference drew more than 300 executives and professionals from state DOTs, metropolitan planning agencies, transit agencies, professional associations, and the private sector to share experiences and lessons learned from the application of data and analytics to planning. A Transportation Research E-Circular in development will report on the discussions that took place at the conference.

As "big data" become ubiquitous, it is anticipated that planning discussions will continue to use analytics to inform their processes and tackle the rapidly changing transportation industry, including how to integrate new modes, services, and technologies into transportation infrastructure and service portfolios.

Data

State DOTs report the increasing importance of data and information to support

their operations and decision-making, especially in an era of rapid change. For state agencies, this approach involves quicker response time and better analysis of data, often blended from multiple sources. The governor of Iowa has assigned lead agency responsibilities in data analytics to the state DOT, which is developing a strategic data business plan.

The recognition of the critical role of freight transportation in state economies is becoming widespread. Technology that offers the ability to track trucks by characteristics is growing quickly, but decision-makers also are increasing investment in projects that provide better ways of determining “what is in the box.” This information helps agencies demonstrate the value of freight transportation to the economy.

Research

In recent years, TRB has participated in several research-focused peer exchanges. As they identify and prioritize research needs, state DOT research offices also seek to share information on the design and management of research programs, contracts, and requests for proposals. Agencies face challenges in documenting the results of research, including identifying appropriate performance measures, tracking implementation, calculating return on investment, and finding outcomes. State DOTs have identified a need for improved communication mechanisms among research offices to minimize the duplication of research efforts. This includes exploring such research deliverables as short videos, quick summaries, and webinars to disseminate research findings in a more digestible way.

States also are considering the potential impacts of technology—especially automation—on the transportation workforce. One state agency cited recruiting and retaining new employees—in particular, midcareer engineers—as a major concern, along with competition for employees of protected classes.

Aviation

The rising use of automated technologies in aviation by state agencies continues to be managed and monitored. Some state

Washington State DOT employees assess rockslide damage using drones. Drone technology is helping agencies with traffic incident management, inspections, project management, and environmental surveys.



Photo: Washington State DOT

aviation departments are helping develop initiatives to use drone technologies in other DOT business practices, including traffic incident management, structural and right-of-way inspections, construction project management, and environmental surveys. Using these technologies appropriately and effectively requires coordination within the regulatory framework that is still being developed at the federal, state, and local levels. Therefore, states are working with their regulatory counterparts to more effectively monitor, track, and prevent inappropriate use of drones—particularly near airports, where drones may pose a safety threat to aircraft operations, and near people and high population centers.

Freight

Several innovations and trends are driving freight mobility toward automation and autonomous strategies that leverage big data. Pervasive e-commerce demands, data-optimized supply chain logistics, warehousing and distribution advances, and shortages in human capital top the list of issues.

Recognizing the economic impacts and potential efficiencies for highway systems, the Federal Motor Carrier Safety Administration is working on rules to reduce barriers and set up regulatory frameworks to facilitate the safe introduction of automated driving systems—equipped commercial motor vehicles. For example, in December 2019, a truck drove 2,800 miles of the Interstate system from California to Pennsylvania—operating mostly in autonomous mode—to deliver a full truckload of refrigerated goods for Land O’Lakes.

Ports and Waterways

Trends in automation and digitalization within the freight system once again dominated research, business forums, and regulatory discussions in 2019. In the seaport industry, ever-increasing vessel sizes and the resulting landside cargo surges from megaship calls are driving operators at many congested U.S. seaports to adopt automation to achieve more efficient cargo handling.



The Port of Virginia is one of several terminals using automated container handling systems, allowing for better scheduling and longer operating hours.

At ports in California, Virginia, and New Jersey, automated container handling systems allow terminals to condense operations onto limited footprints. These systems optimize terminals to synchronize better with rail schedules and truck gate appointment systems and allow for longer terminal operating hours, spreading the peak at the gate and decreasing individual truck turn times.

On the inland waterways system, the U.S. Army Corps of Engineers is involved in an international working group, via the World Association for Waterborne Transport Infrastructure, that assesses standards, guidelines, and best practices for automation and remote operation of locks and bridges.

Rail

Rail-related fatalities occur among members of the public far more than among railroad passengers or employees. These fatalities include those involved in highway-rail grade crossing crashes; pedestrian strikes, often of trespassers; and suicides.



Photo: Virginia DOT



Photo: Florida DOT

An example of the dynamic envelope at a highway-rail grade crossing in Florida.

Recent state DOT efforts have concentrated on safety measures in these areas.

Florida recently noted increases in rail traffic because of increased commuter and intercity rail service and a continuing high level of freight traffic. Grade crossing and pedestrian-trespasser fatalities have increased to the point that they now are a major public safety concern. Florida DOT is implementing an engineering countermeasure, called "dynamic envelopes," at highway-rail grade crossings. These consist of pavement markings that delineate the areas around a rail crossing within which a vehicle or pedestrian would be in danger of being struck. Other initiatives include increased enforcement of traffic laws at crossings and targeted countermeasures in areas that experience frequent pedestrian trespassing.

One recent development that has caught the attention of state DOTs is the concept, adopted by many rail carriers, of precision-scheduled railroading (PSR). This concept involves strict schedule adherence, concentration of assets, and labor reduction, resulting in longer and heavier trains. In many cases, PSR has led to longer highway-rail crossing blockages and disruptions to manufacturing supply chains. The motoring public and manufacturing and logistics industries have turned to state DOTs for assistance in alleviating these problems, and state DOTs struggle with how to assist their constituents with these issues.

Transit agencies are considering how to navigate practical and policy issues associated with rising e-scooter use.

Public Transportation

In summer 2019, TRB participated in the Idaho Public Transportation Summit. The rural public transportation issues addressed included mobility options in rural communities, nonemergency medical transportation, intercity bus services, and route deviation. One transit agency entered an agreement with a transportation network company (TNC) to extend its service coverage. More than 80 buses serve employees of the Idaho National Laboratory. TRB staff reported on TRB's work of interest, such as the Rural Transportation Issues Research Roadmap, the National Intercity Bus Atlas, and conferences on rural public and intercity bus transportation and demand-responsive transportation.

The industry continues to experiment with innovative service delivery options and technologies; for example, exploring opportunities to use TNCs in the provision of paratransit services in accordance



Photo: Rabenspiegel, Pixabay

with the Americans with Disabilities Act of 1990. Transit agencies also are considering how to harness e-scooters, a new option for shared micromobility and first–last mile connection. Mobility as a Service, or MaaS, is becoming more popular, with transit agencies reflecting on their possible roles as leaders or bridges between public and private transportation providers.

Environment, Energy, and Climate Change

Near-road air quality issues were the subject of a transportation pooled fund study, which helped states identify and address a broad range of issues, from meeting U.S. Environmental Protection Agency–mandated near-road monitoring to modeling for carbon monoxide and particulate matter hot spots.

States also are collaborating to identify best practices on historic bridge rehabilitation, creative mitigation strategies in the public involvement process and Section 106 of the National Environmental Policy Act, and ways to accomplish the requirements of the One Federal Decision Executive Order of 2017. Emerging issues for states include remediation requirements of per- and polyflouroalkyl substances and other organic contaminants and the en-

vironment and energy implications of the growing number of shared, automated, and electrified transportation options.

Equity

Accessible and affordable transportation options are crucial for people to access better jobs, secure educational opportunities, buy food and other daily provisions, and receive essential health services. In certain conditions, infrastructure, technologies, and policies unintentionally leave underserved populations without access to affordable transportation options. Transit Cooperative Research Program Project B-47, “Impacts of Transformational Technologies on Underserved Populations,” is developing a playbook with guidance on corrective action for transit agencies regarding data, methods, and metrics to achieve inclusive mobility in an era of transformational technologies.

Minnesota DOT is commencing a transportation equity initiative to better understand how the transportation system, services, and decision-making processes help or hinder the lives of people in the state’s underserved and underrepresented communities. The initiative also will identify possible solutions to address challenges and develop partnerships to advance transportation equity in Minnesota.



Photo: nyttend, Wikimedia

The Carrollton Bridge in Indiana, built in 1927, was rehabilitated nearly a century later. Historic bridge rehabilitation—conducted with the environment in mind—is an emerging issue for states.

Legal

Transportation attorneys are placing an increasing focus on how the actual and forecast impacts of the changing climate, along with the effects of recent disaster events on transportation facilities across the country, pose resiliency considerations in project development and asset management planning, as well as on the corresponding litigation risks.

The concept of Complete Streets, embraced by the 2018 edition of American Association of State Highway and Transportation Officials’ *Policy on Geometric Design of Highways and Streets*, encompasses many approaches to the design and operation of roadways and rights-of-way, with a focus on making the transportation network safer and more efficient for all users. Public agency lawyers are looking closely at attendant tort liability and risk management considerations and best practices for factoring them into their clients’ transportation design needs.

Risk allocation and mitigation is an ever-present factor in projects of all types and sizes—but more so in alternative delivery projects, such as those using design–build methods and public–private partnerships. Lawyers representing owner agencies are more and more involved with identifying the risk-assessment life cycle and management: the identification and allocation of risks at a project’s early stages; contractual considerations for the owner’s desired risk-sharing mechanisms; a risk profile’s effect on funding, price, and contingencies; and enforcement of the contract.

The growing popularity of such innovations as ridesharing, microtransit, dockless micromobility, and automated vehicles poses many challenges and opportunities for public transportation systems across the country. Among these challenges are legal and regulatory issues, including funding and litigation risks.

Highway Design

More and more, resilient and sustainable pavement designs are topics of research and of practical application as changes in weather patterns cause shifts in temperature and precipitation that affect pavement performance, life, and economics.



Photo: hydropeek, Flickr

The deck of the Pulaski Skyway Bridge in New Jersey used 5,000 cubic yards of ultrahigh-performance concrete.

Increased occurrences of flooding and temperature extremes affect pavements adversely. Also of concern is the heat reflected from pavements, especially in urban environments. Pavement life-cycle cost analysis is a topic of extensive study to help assess the breadth of the problem and better manage it in the future.

Many state DOTs use ultrahigh-performance concrete (UHPC) in bridges and structures. After a marked increase in UHPC use over the past several years, it is estimated that nearly 300 bridges nationwide use the material in superstructures, substructures, or both. Advantages of UHPC include lighter-weight bridge designs, decreased construction times when using precast system elements, increased durability and corrosion resistance of bridge members, extended service life, and reduced bridge maintenance and rehabilitation (which, incidentally, can increase worker safety in the long run).

States also have used UHPC in precast systems and for bridge decks, closure pours, and connections among precast members. For example, the Pulaski Skyway Bridge rehabilitation in northern New Jersey used a total of 5,000 cubic yards of UHPC in its bridge deck. Other states also have seen favorable results with UHPC.

Highway Construction and Materials

Ohio and Illinois are pursuing construction methods to increase pavement durability and longevity by targeting higher den-

sity at pavement joints. Core sampling and other procedures have been added to quality assurance plans at or near the joints, instead of just on the mat, to draw attention to this critical location at which damage is more likely to occur. Also used in paving trials are joint-sealing materials that decrease permeable infiltration of water to one side of a joint before the neighboring lane is paved.

Ohio also has explored the use of nondestructive rolling density meters, as walk-behind ground-penetrating radar units, for faster assessment and wider coverage than cores at spot locations. Several

bridge construction projects in Oregon have placed new decks using concrete mixtures designed with special aggregate blends and mix designs that promote internal curing with better cement hydration, which can lead to fewer cracks.

South Carolina is bundling multiple bridge replacement projects together, using the design-build method of project delivery, to reduce risk and promote efficient construction, thus saving time and money.

Geotechnical Engineering

Monitoring the moisture-temperature profile in soils with depth provides soil temperature, moisture, and suction data. When paired with weather and soil properties, these data can feed into computational models as predictive tools. Such models are especially important for states in cold regions that manage lower-volume roads susceptible to subgrade weakening and seasonal traffic-induced damage. Properly predicting the timing and duration of the thaw and related soil weakening, and then posting seasonal road restrictions, can help minimize or eliminate damage to the road as well as the impact on local and regional populations and economies. Iowa, Minnesota, Alaska, and North Dakota are some of the states developing, refining, and using such tools.



Photo: Groveland Media, Flickr

Several states, including Minnesota, are developing, refining, and using tools that minimize the impact of freeze-thaw cycles on roadways.

Whether as routine maintenance or because of an emergency triggered by a catastrophic event, the stability of rock and soil slopes continues to be a focus for geotechnical researchers and practitioners at many state transportation agencies. Tennessee DOT has identified slopes as their second-most critical asset. Many states—including Vermont, Washington, and Montana—have a proactive slope rating and management system. Alaska DOT is developing a corridor health index, which includes consideration for “threatening slopes,” to aid in budget decisions. These advance concepts and technologies have allowed states to take a more preventative approach; for example, Oregon DOT uses lidar and remote-sensing instruments to examine slope deformation and changes.

The high-tech world of 3-D visualization and gaming technology has reached the geotechnical community. To review the options for a new road alignment, California transportation professionals donned goggles to view subsurface boring data, land surface topography, and aerial images combined with virtual and augmented reality tools. Seeing a 3-D layout and being able to move around virtually within the subsurface and surface features helped these transportation officials making better-informed decisions.

Highway Maintenance and Preservation

Across the nation, maintenance divisions at public agencies face workforce staffing challenges. Several agencies cannot compete with salary levels in the private sector. The workforce and retention issue is not limited to maintenance departments, but neither are the possible solutions. Georgia DOT has deployed a program, used initially within its Division of Planning, in which contract staff are initially hired as temporary workers to see they are a good fit. The DOT then could offer workers full-time positions, which provide benefits and higher pay. Other agencies have explored state maintenance innovation programs to incentivize creativity in maintenance field offices and to create a desirable place to work.

Highway maintenance departments also are experimenting with the practical application of artificial intelligence and machine learning to help forecast maintenance rehabilitation costs, supplement bridge and pavement management systems, and provide a prediction of winter weather roadway surface conditions. These tools are just starting to see application beyond the initial experimental stages. The amount of data is expected to increase further, and these tools will help agencies and maintenance departments transform data into useful information.

Highway Operations

A decade ago, an innovative concept for interchange design and operations—the diverging diamond interchange (DDI)—was first constructed in Missouri. A DDI facilitates free-flowing turns by temporarily crossing the traffic to the left side of the roadway, thus eliminating the left turn against oncoming traffic and limiting the number of traffic signal phases. Today, this innovative design is a widely accepted alternative to interchanges. When compared to conventional diamond interchange designs, the DDI design increases throughput and reduces delay and has been found to be significantly safer than conventional

diamond signalized interchanges. More than 100 DDIs are now in operation around the country, with more than 30 under construction and more than 150 under study.

In the United States, wrong-way driving (WWD) crashes result in 300 to 400 fatalities each year. Although WWD crashes are random and infrequent, they typically involve high-speed head-on or sideswipe crashes that result in multiple injuries or fatalities. Many states now are exploring programs to try to reduce these crashes, such as improved traffic control devices, warning systems for wrong-way-entering drivers, and alerts for transportation management centers and first responders.

The development of connected and automated vehicles (CAVs) continues to dominate operations research and capture the attention of DOTs across the country. Since 2012, more than 40 states and the District of Columbia have enacted or are considering legislation related to automated vehicles. Auto manufacturers, suppliers, technology companies, and state DOTs constantly announce new testing and deployment. The future impacts of CAV on transportation are wide-ranging and will be felt in the areas of transportation operations, safety, pavements, transit, and freight movements.



Photo: Coolcaesar, Wikimedia

Wrong-way driving crashes result in nearly 400 fatalities each year. Solutions deployed by states include traffic control devices like signage and warning systems.

Did You Know?

- › Pipeline transportation accounts for 19% of total U.S. freight ton-miles.
- › In 2017, U.S. consumption of gasoline, diesel, and other fuels for highway use was almost 178 billion gallons.
- › Average hydrocarbon emissions (grams/mile) for gasoline-powered automobiles in the United States has dropped from 1.32 in 2000 to 0.28 in 2018.
- › Anchorage, Alaska, has the second-busiest U.S. cargo airport (by landed weight of all-cargo shipments). First- and third-busiest, respectively, are Memphis, Tennessee, and Louisville, Kentucky.
- › Passenger cars and light trucks accounted for 91.5% of U.S. vehicle miles traveled in 2017.
- › The transportation and utilities industry employs 5.5% of all U.S. employees.
- › California has the most highway tunnels (90) of any state. Ten states have none.
- › In California, the ports of Los Angeles and Long Beach have more than 150 container cranes combined.



Photo: Lan Bui, Flickr

The Port of Long Beach, when combined with the Port of Los Angeles, has more than 150 container cranes.

- › New York has the most transit trips of any state. Second is California, with more than twice the number of transit trips as the third-highest state, Illinois.
- › The average freight shipment by truck travels 188 miles. The average freight shipment by rail travels 554 miles. The average freight shipment by combined rail and truck travels 1,140 miles.

Safety

According to the National Highway Traffic Safety Administration, 36,560 people were killed in motor vehicle crashes on the nation's roadways in 2018. This marks a decrease of 2.4% from 2017, which followed a 0.9% decrease from 2016 and back-to-back yearly increases in 2015 and 2016. Nationwide vehicle miles traveled seem to have increased by 0.3% from 2017 to 2018.

The number of crash fatalities remains unacceptably high, however, and has not yet returned to the lower levels experienced between 2010 and 2014. In 2018, decreases in fatalities occurred in almost all segments of the population—with the exception of fatal crashes involving large trucks, pedestrians, and pedalcyclists.

To strengthen motor vehicle crash reduction efforts, Connecticut DOT collaborated with the University of Connecticut Transportation Safety Research Center

(CTSRC) to develop the Connecticut Crash Data Repository. As a result, crash report processing times have been reduced from 16 months to two weeks. Crash data also is linked with roadway, judicial, and public health data from other state sources, which further strengthens safety decision-making. The repository earned Connecticut DOT and CTSRC a special achievement award from the Governors Highway Safety Association.

The Kentucky Transportation Cabinet (KYTC) also uses data to better inform investment decisions. KYTC's Strategic Highway Investment Formula for Tomorrow is a data-driven, objective approach to comparing capital improvement projects. Safety is one of five attributes scored to help prioritize limited transportation funds, along with asset management, congestion, economic growth, and cost-benefit. KYTC currently is updating its Strategic Highway Safety Plan as a data-driven

approach to reducing crash-related fatalities and serious injuries across the state. In partnership with the University of Kentucky, the Safety Circuit Rider program uses crash data to locate high-incident sites along roadways and to assist communities in finding low-cost roadway safety improvements.

Conclusion

The 2019 State Partnership Visits Program offered TRB staff and state DOT personnel many opportunities to meet and discuss the most pressing transportation issues facing the nation and the many policies and programs that state DOTs are using to improve the transportation system in order to make it more safe, efficient, and resilient. Information exchanges on current and needed research topics informed all parties of the latest advances in technology and methodologies.