TR NEWS

January–February 2019 NUMBER 319

Harnessing Technology for a Safe, Equitable, Resilient System

FINDINGS FROM THE STATES

PLUS

Health Effects of the Built Environment

Historic Preservation and Protection of Bat Habitats

Innovative Highway Research

The National Academies of
SCIENCES · ENGINEERING · MEDICINE
TRB
TRANSPORTATION RESEARCH BOARD

The National Academies of
SCIENCES · ENGINEERING · MEDICINE

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The **Transportation Research Board** is one of seven major programs of the National Academies of Sciences, Engineering, and Medicine. The mission of the Transportation Research Board is to increase the benefits that transportation contributes to society by providing leadership in transportation innovation and progress through research and information exchange, conducted within a setting that is objective, interdisciplinary, and multimodal. The Board's varied activities annually engage about 7,000 engineers, scientists, and other transportation researchers and practitioners from the public and private sectors and academia, all of whom contribute their expertise in the public interest. The program is supported by state transportation departments, federal agencies including the component administrations of the U.S. Department of Transportation, and other organizations and individuals interested in the development of transportation.

Learn more about the Transportation Research Board at **www.TRB.org.**

TRB

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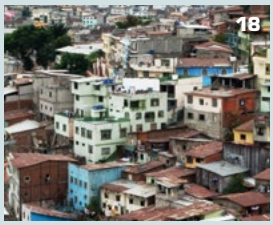

3 Harnessing Technology for a Safe, Equitable, Resilient System: Findings from the Transportation Research Board's 2018 State Partnership Visits Program

The 2018 state partnership visits to state transportation agencies by TRB senior program officers showcase emerging trends, applied research, research needs, and innovative solutions to challenges across all transportation modes and functions. State departments of transportation are deploying new technologies, streamlined and innovative processes, research-driven methods, and holistic systems approaches to further the goal of a transportation system that supports the health and economy of the nation and improved quality of life for its residents.

11 NASEM WORKSHOP

Advancing Obesity Solutions Through Investments in the Built Environment

Heather D. Cook

The National Academies of Sciences, Engineering, and Medicine hosted a workshop in 2018 to improve understanding of the built environment in preventing and treating obesity and to discuss promising strategies for healthier, more equitable environments. Transportation features prominently in several of the strategies; the author highlights these and other presentations to illustrate the array of initiatives addressing different aspects of built environments.

18 NASEM WORKSHOP

Urbanization and Slums: Infectious Diseases in the Built Environment

Cecilia Mundaca-Shah, V. Ayano Ogawa, and Anna Nicholson

The role of the built environment in the spread—or prevention—of infectious diseases was examined in a 2017 National Academies workshop. Authors present the intersection of transportation with characteristics of and microbial communities in the urban built environment, translating research into effective ways to prevent and mitigate infectious disease outbreaks, and strategies and policies for healthful urban environments that consider structural and socioeconomic determinants of diseases.

22 Abandoned Railroad Tunnels as Artificial Bat Hibernacula: Ohio DOT Preserves History and Protects Habitats

Timothy M. Hill, Matt Perlik, and Christopher Staron

In 2017, ecologists from the Ohio Department of Transportation's Office of Environmental Services (OES) conducted a routine ecological check under a rural state route in hilly southeast Ohio. The discovery of the first of several long-forgotten railroad tunnels led to the preservation of one of the largest previously unknown bat hibernacula in the state. In this article, the OES team that led a project to preserve the hibernacula—and the health of bat populations—relates their experiences and research.

25 All Set for the Future: Safety, Electrification, and Transportation

Allie Kelly and Anna Cullen

Authors share the innovative research initiatives of The Ray, a public–private–philanthropic partnership that acts as a platform for evolving technologies. An 18-mile corridor of I-85 in Georgia from LaGrange to the Alabama border, The Ray features an electricity-generating road demonstration project, solar arrays, tire safety stations, and more.

COVER A floatplane in Anchorage, Alaska. TRB's State Partnership Visits Program is an annual review of the priorities, goals, and initiatives of state departments of transportation. (Photo: Christine Gerencher)

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Welcome to the Redesigned *TR News*

In preparation for TRB's Centennial in 2020, the *TR News* Editorial Board has updated the layout of the *TR News* magazine—starting with this January–February 2019 issue. We hope you continue to enjoy its coverage of transportation research, highlights, and activities. *TR News* will celebrate TRB's Centennial with special features starting in the fall 2019 issue.

Graphic Design: Anne Rogers, National Academies Press

Coming Next Issue

A photo essay offers a look at the many sessions, workshops, events, awards, and networking opportunities at the 98th Annual Meeting of the Transportation Research Board. Feature articles examine the policy and efficacy of public–private partnerships; the first 5 years of Ohio's Research Initiative for Locals, an Ohio Department of Transportation program formed in 2013 to use research to solve local transportation issues; and a National Cooperative Highway Research Program project to develop national bridge design and construction specifications for accelerated bridge construction.

Photos: Risdon Photography

Despite challenging winter weather and a U.S. federal government shutdown, TRB's 98th Annual Meeting drew more than 13,000 students and transportation professionals to Washington, D.C., in January to share research and to hear from such distinguished speakers as U.S. Transportation Secretary Elaine L. Chao, who addressed transportation's future: innovation, safety, and improved infrastructure.

TR NEWS

features articles on innovative and timely research and development activities in all modes of transportation. Brief news items of interest to the transportation community are also included, along with profiles of transportation professionals, meeting announcements, summaries of new publications, and news of Transportation Research Board activities.

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Photo: Christine Gerencher

Harnessing Technology for a Safe, Equitable, Resilient System

FINDINGS FROM THE TRANSPORTATION RESEARCH BOARD'S 2018 STATE PARTNERSHIP VISITS PROGRAM

Above: Small airplanes are a common mode of transportation in Alaska, whose vast distances and inaccessible terrain make road travel difficult.

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. By identifying needed and in-progress research and by disseminating the results of completed research, these visits support TRB's mission of promoting innovation and progress in transportation through research and information exchange.

State visits last one or two days and typically consist of meetings with DOT management, discussions with DOT staff involved in various topic areas, exchanges of issues and ideas, and often a visit to DOT facilities or sites of ongoing projects. Technical Activities Division staff members contributed to the following summary of the issues facing state DOTs that were revealed through the State Partnership Visits Program in 2018.

Planning

For several years now, state DOTs, transit agencies, and metropolitan planning organizations (MPOs) have been transitioning their planning processes and plans to produce performance-based plans, performance measures, and targets in accordance with federal law and regulations. Several critical deadlines for establishing

Photo: Vertical Aerospace, Wikimedia

Vertical Aerospace's eVTOL (electric vertical takeoff and landing) aircraft takes flight for the first time. States are grappling with technological advances that could bring services like flying taxis into commercial use.

performance targets occurred in 2018; thus agencies spent most of that year focusing on these activities. Agencies recognize the benefits of performance-based planning and management in creating efficient transportation project planning and delivery, but many continue to grapple with the challenges that come with a shift in decision-making paradigms.

Several conferences and peer exchanges held in 2018 and planned for 2019 focus on these issues, with the goal of facilitating the transformation of state DOTs into multimodal transportation system agencies that focus on the outcomes of transportation decisions and systems operations. Rather than simply concentrating on the performance of an individual facility or mode or infrastructure, agencies wish to transition to a systems-wide focus that is driven by purpose—personal mobility, reliability, resilience, freight distribution, safety, and the efficient delivery of energy—in a way that minimizes environmental and cultural harm to current and future generations.

Planning addresses the role of transportation in serving the needs of the future. Planners use research, data, and models that predict future needs and challenges based on past trends. Travel forecasting models based on land use, economic, and transportation trends are the foundation of transportation planning, with an emphasis on finding the "sweet spot" between transportation demand and supply. From there, agencies can look to policy; pricing; and infrastructure development, operations, and management to develop projects and maintain operations performance and efficiency.

The ability to use past trends to predict current and future travel behavior is disrupted, however, by many factors that offer scant history to learn from and model; for example, the rapid proliferation of mobility as a service and service types, the ubiquity of instantaneous communications and apps that influence travel choices in real time, and the progress of technology in vehicle fleets that affect all modes—from new sources of energy fueling vehicles to increased automation and connectivity.

Data

The use of data by state DOTs to understand the use of their transportation networks is increasingly important. As a result many states are managing data as an asset, incorporating business plans and governance. Utah is a leading example. States now recognize that data will outlive current business systems. No longer can one data set provide a full understanding of the complex issues faced by state DOTs—for example, crash analysis is conducted with crash data cross-referenced to traffic and weather data. As more data are automated, a need is emerging for data flow between systems and for decisions to be made more quickly, in or near real time.

Big data and data analytics are emerging tools for many states. The opportunity and challenge for states is to develop teams with the expertise and understanding of transportation issues. Those teams need to care passionately about informing the decisions of the DOTs, their customers, and their states.

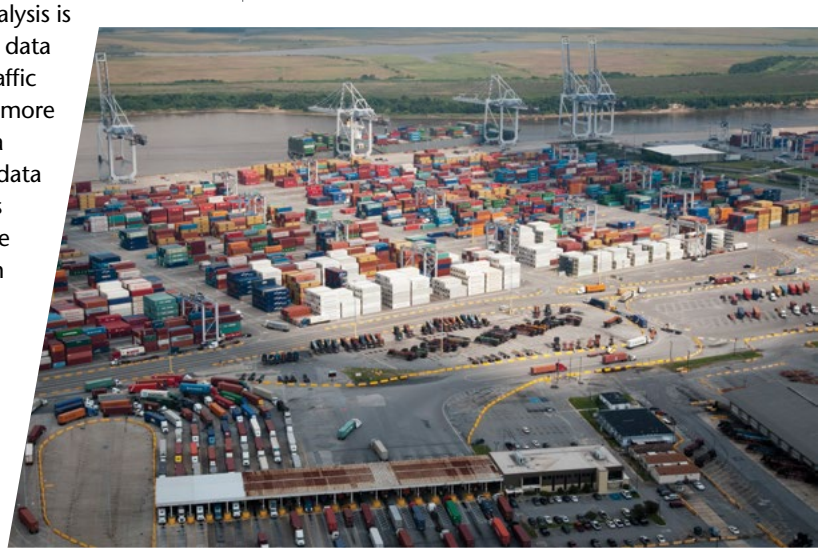
Aviation

The rise in use of unmanned aircraft systems (UASs) has spurred states not only to facilitate opportunities for the use of UASs in day-to-day transportation department operations but also to determine the role of UASs in managing and monitoring public operations via cooperation with state legislatures, local airports, and the Federal Aviation Administration (FAA). The rapid change in technological advances also has states looking at the aviation system impacts of urban air mobility in the nearer term, as full-scale flight testing is under way on several electric vertical takeoff and landing, or eVTOL, vehicles, with approval for commercial use likely within the next decade.

Several states also support efforts to facilitate commercial space operations and the opportunities the industries that use and support these operations can bring to their states.

Freight

The steady cadence of autonomous freight vehicle testing and adoption continued throughout 2018. Since 2015, when Nevada issued the first license for an autonomous



Infrastructure investments will allow the Port of Savannah to double its rail capacity by 2020, relieving congestion caused by a surge in megaships.

Photo: U.S. Army Corps of Engineers

Photo: California High-Speed Rail Authority, Wikimedia

The San Joaquin River Viaduct will carry the California High-Speed Rail over the San Joaquin River. It is the second major river crossing constructed as part of rail project.

commercial truck to operate on the state's open public highways, a total of 37 states have enacted laws or executive orders regarding autonomous vehicles and 16 states have authorized truck platooning. U.S. DOT released the report "Preparing for the Future of Transportation: Automated Vehicles 3.0," in which the administration revealed guiding principles that call for consistency in the national regulatory and operational environment for autonomous adoption.

The technology company Embark successfully completed a coast-to-coast test of a fully autonomous truck in early 2018, traveling from Los Angeles to Jacksonville, Florida, with sensor-enabled technology handling most of the driving. In the last-mile urban context, Udelv is poised to deploy electric autonomous delivery vans in Northern California and Oklahoma City after a year of successful testing. Market possibilities include deliveries of groceries, flowers, auto parts, and baked goods.

Ports and Waterways

With megavessels increasingly deployed in international waterborne commerce, U.S. coastal ports are feeling the pressure of maintaining port productivity in an environment that is more operationally complex than ever before. With more robust crane and yard equipment requirements and increased time at berth required to load and unload these massive ships, productivity can be hindered by many factors. Chief among these are ship schedule delays, which have become increasingly common given larger cargo volumes. When weather or delays at previous port calls cause vessels to miss their anticipated port call windows, schedule slippage cascades into many follow-on issues: labor availability and shift challenges, equipment availability, gate hours and trucking limitations, and chassis availability for container movements within and out of the port area. In some ports, schedule lapses can cause bunching of multiple vessel calls during certain times of the week, exacerbating port congestion and straining overall port capacity and resources.

States and ports continue to invest millions in near-port intermodal infrastructure to create capacity for these surges caused by megaship calls. The Port of Savannah is investing $128 million in a mega–rail terminal to stem the effects of increasing congestion and local impacts from truck traffic. Funded partially by leveraging a $44 million federal FASTLANE grant, the project promises to double the Port of Savannah's rail capacity when operations commence in 2020.

Rail

Three intrastate, intercity, high-speed rail projects in the United States made significant strides in 2018:

- Florida's Brightline began service in early 2018 between Miami and West Palm Beach. Late in the year, Brightline announced a strategic partnership with Virgin Group of the United Kingdom, bringing Virgin's brand recognition to the U.S. rail sector.
- Texas Central, which will provide service between Houston and Dallas, achieved several milestones in 2018: selection of a firm to provide construction project management, a civil construction consortium, and a contract operating partner.

Photo: Patrick Hamilton, Flickr

Florida's Brightline rail service opens commuting options between Fort Lauderdale and West Palm Beach.

- The California High-Speed Rail project continued construction in the Central Valley, with almost 2,500 workers engaged on what is considered the largest infrastructure project in the country. Several major viaducts now are under construction, including one that spans the San Joaquin River in Fresno.

State-supported initiatives that involve freight railroads include the Chicago Region Environmental and Transportation Efficiency (CREATE) Program, whose grade crossing and rail bottleneck elimination projects have been completed. Elimination of the rail bottlenecks has resulted in increased fluidity of both the freight and passenger rail systems in and around the nation's busiest rail hub. Illinois DOT played a large part in the CREATE program.

Photo: Bill VanderMolen, Flickr

Mcity, the outdoor laboratory at the University of Michigan, simulates real traffic conditions to test automated vehicles.

Public Transportation

Transit agencies nationwide are experiencing sluggish ridership. The Transit Cooperative Research Program is studying the trend, which has been attributed variously to attitudes of young people; the effect of transportation network companies (TNCs), or ride-hailing services; and increased teleworking. Meanwhile, the public transportation industry is experimenting with innovative service delivery options and technologies, including opportunities to use TNCs in the provision of Americans with Disabilities Act paratransit services and to complement transit service in low-density areas.

The state of Michigan is sponsoring an $8 million Mobility Challenge that offers demonstration grants for solutions to mobility gaps—such as service to seniors, travelers with disabilities, and veterans—using new technologies and public–private partnerships. Nine projects have been funded. Many of these issues will be explored at TRB's upcoming International Conference on Demand–Responsive and Innovative Transportation Services, which will be held in Baltimore, Maryland, in April.

Autonomous vehicles present possible opportunities for the transit industry. Many pilot projects employing automated buses or shuttles have sprung up on college campuses. Michigan is testing automated vehicles at Mcity, a 32-acre outdoor laboratory on the University of Michigan campus for testing the safety and performance of connected and automated vehicles. Mcity combines physical roadway features with traffic simulation. The state of Michigan also is building a large test facility, called the American Center for Mobility, on the site of the former Willow Run bomber plant. In Florida, SunTrax in Polk County is a similar test bed under construction.

Photo: Seattle DOT

Transit agencies work with various proposals to better serve those in need of paratransit services.

Many on-street test beds around the country feature automated transit vehicles in pilot test service. In states like Michigan and Florida, laws make it easier to conduct on-street testing of autonomous transit vehicles. The Federal Transit Administration is sponsoring Mobility on Demand Sandboxes around the country to further test shared-mobility business models and automated vehicles.

Environment, Energy, and Climate Change

As the 50-year legacy of the National Environmental Policy Act (NEPA) approaches, states continue to address environment and energy challenges. Through collaboration with state and industry peers, states examine how they can use new processes and technologies to address existing problems—but also explore how to best meet the challenges of the future. For example, states are finding ways to better map environmental effects of transportation projects on cultural and natural resources, air quality, noise, and public health. States also are investigating future infrastructure needs to meet increasing demand for alternatively fueled vehicles—particularly as some auto manufacturers have announced plans this year

to focus on greater electric- and hydrogen-based vehicle production lines within the next 10 years.

Legal

By identifying associated legal issues and potential statutory and regulatory solutions, attorneys representing state DOTs continue to focus on the legal intricacies related to transformational technologies and their incorporation into state transportation systems. Of particular concern are data privacy and security issues associated with connected and autonomous technologies and liability issues associated with potential tort actions involving connected and autonomous vehicles, UASs, and associated infrastructure.

Innovative project delivery and finance methodologies are recurring areas of interest and involvement for state DOT counsel. Evolving concepts of diversity in public procurement, equal access to public transportation, and the potential for DOT projects to have disparate impacts on underrepresented communities also pose challenges for state and local agency legal departments. The booming demand for and availability of on-demand transportation—including ride services, electric scooters, and bicycles—pose new aesthetic, tort liability, and risk management challenges.

On the environmental front, federal regulatory streamlining and reduction initiatives are being closely followed and analyzed by agency counsel.

Highway Design

Digital terrain models help highway designers visualize, plan, and model, but applying them during construction can be a challenge. The Kentucky Transportation Cabinet is exploring better ways to format and to provide the right amount of detail so that digital terrain models can be used seamlessly from design to construction inspection.

Wisconsin DOT has had success including performance-engineered mixtures

Did You Know?

Pioneering Transportation Routes

In the 1800s the Commonwealth of Pennsylvania and private investors built more than 1,240 miles of canals, mostly along existing rivers to enable navigation. These were the original freight and passenger routes that carried the beginning of the great westward migration across the United States.

A portion of "The Old Brick Road" in St. Johns and Flagler counties in Florida is still intact. Only 9 feet wide and paved with millions of bricks, 10.6 miles of the road can still be driven today. This road was part of the Dixie Highway, a series of connected roads built to serve travelers from Ontario to Florida.

Photo: Ebyabe, Wikimedia

Portions of the Old Brick Road, part of the Dixie Highway in Florida, still exist and are in use today.

Established in the 1920s, the original transcontinental air mail route ran between New York and Chicago. Night flying was facilitated by rotating beacons placed every 3 to 5 miles. The route eventually had approximately 1,500 of these towers, built on concrete arrows 50 to 75 feet long and painted yellow, which pointed to the next beacon on the route. Some of these arrows are still visible today.

Photo: Andrew J. Russell, Yale University Libraries

The Golden Spike ceremony in Promontory, Utah, in 1869. Although the historic rail line still exists, it is no longer in use.

The Golden Spike that commemorated the completed the Transcontinental Railroad in 1869 was driven at Promontory Summit in Utah.[1] Many improvements have been made to the route through the years, including many relocations. In 1904, the Southern Pacific Railroad built a more direct route to the Pacific, across the Great Salt Lake, that bypassed Promontory Summit. The original line was scrapped in 1942 for the war effort. Today, Promontory Summit is the location of the Golden Spike National Historic Site. Tracks at the site are used for ceremonial and demonstration purposes but are not connected to the general railroad system. This year marks the 150th anniversary of the completion of the Transcontinental Railroad.

[1] www.nps.gov/gosp/index.htm

in rigid pavement designs, providing the opportunity to work toward specifying the performance characteristics of concrete mixtures and allowing design mixtures that address specific pavement performance requirements. New test methods to evaluate concrete can result in improved performance and economics.

Persistent leadership from state DOTs, cooperating with the Federal Highway Administration and academic and industry partners, has continued to advance accelerated bridge construction (ABC) techniques. ABC uses innovative planning, design, materials, and construction methods safely and cost-effectively to reduce onsite construction time when building new bridges or replacing and rehabilitating bridges.

In 2018, Georgia DOT fully replaced the 111-year-old Courtland Street Bridge in downtown Atlanta using ABC techniques. The $25 million project replaced all 28 spans of the Courtland Street Bridge over Decatur Street and the MARTA and CSX rail lines. These techniques also were used to rehabilitate the East Street Bridge, built circa 1911, that carries the Massachusetts Bay Transportation Authority Franklin Commuter Rail Line in Westwood. This project featured precast concrete abutment caps, precast concrete approach slabs, and two steel superstructures, installed over two separate weekends. Before the weekend closures, deep foundation–drilled shafts were installed behind existing abutments, utilities were relocated, and tracks were restored.

Highway Construction and Materials

In New England, transportation agencies have begun chemically fingerprinting highway materials with rapid techniques using X-ray fluorescence and infrared spectrometers. Fingerprinting applications range from tracking the aging of and additives in asphalt materials to deterioration signatures in bridge deck cores to the chemical content and acceptability of paints.

New Hampshire DOT has studied asphalt mixtures with higher-than-ordinary recycled content for more sustainable, cost-effective pavements. A large study correlated performance test results from laboratory and plant samples to help illuminate mix design methods and ensure adequate field performance. Massachusetts DOT has begun using American Association of State Highway and Transportation Officials (AASHTO) PP 84 standards for performance-engineered concrete pavement mixtures and has gathered data from new test methods on local materials to identify quality assurance and acceptance characteristics. Maine DOT is studying ways to improve concrete bridge deck durability, with a strategy to use lower-alkali cement; measure how mixes shrink during curing; and improve modeling of chloride diffusion.

The wide-ranging impacts of CAVs include transportation operations; safety; land use; geometric, pavement, and bridge design; transit and transit operations; freight and goods movements; and more.

Photo: Pmattes, Flickr

Hawaii DOT is installing 1,279 precast panel pieces on the H1 Freeway in Honolulu to complete a much-needed infrastructure rehabilitation.

Photo: Elmschrat, Wikimedia

Big Thompson Canyon, Colorado. Colorado DOT used soil mixing for stabilizing and rebuilding parts of US-34 through the canyon.

Agencies also are exploring new technologies for improved construction. Maine DOT has investigated the ability of push-type rolling pavement density meters to measure asphalt compaction and joint density more quickly. Vermont Agency of Transportation is researching the use of acoustic monitoring sensors, which detect cracks and damage in prestressed and prefabricated concrete bridge components that can occur during the forming, transportation, and installation phases of rapid bridge construction projects. North Dakota DOT used GPS-based intelligent compaction rollers on an Interstate Highway paving project. Four different pieces of equipment digitally mapped the coverage of rollers—and project data indicated that the density exceeded requirements. Hawaii DOT utilized innovative techniques for freeway construction, deploying precast concrete pavement panels in the rehabilitation of a high-volume section of roadway and reducing the duration of the construction closure.

Geotechnical Engineering

More and more, transportation agencies recognize the need to manage geotechnical assets. Maine DOT has started to manage slopes as part of its asset management program, and New Jersey DOT has developed a collaborative approach to implementing its rockfall mitigation program. In Montana, a comprehensive rock slope asset management program combines fiscal modeling with technical decision-support tools to aid policy makers, planners, and technical personnel, reducing risk both to users and to the agency.

Many states are recognizing that slope stability is critical to corridor resiliency and is especially important along emergency evacuation routes. Hawaii DOT has installed instrumentation on slopes to monitor many variables for a better understanding of the sequence of mechanisms that contribute to slope instability.

Advanced technology and innovative practices allow many DOTs to tackle complex geotechnical challenges. Oregon DOT completed fast-tracked projects in parallel with geotechnical analysis through landslide-prone areas with advance monitoring and by developing a green–amber–red response system to slope stability. Kentucky Transportation Cabinet saved both time and money using continuous horizontal drilling to explore subsurface conditions along tunnel alignments. Colorado DOT opted for soil mixing to stabilize and rebuild parts of US-34 through the Big Thompson Canyon, and Pennsylvania DOT used an innovative system of lightweight foamed concrete and geosynthetics to tackle a complicated reconstruction of an I-95 interchange over soft soils.

Highway Maintenance and Preservation

Maintenance departments also are preparing for a future in which an increased amount of roadway and other data will be available via connected and automated vehicles (CAVs). In order to grapple with issues of being data rich and information poor, agencies are exploring the application of artificial intelligence and machine-learning techniques to

- Analyze National Bridge Inventory ratings and bridge element data;
- Forecast optimal times of maintenance, repair, and rehabilitation; and
- Conduct autonomous visual classification of road assets.

Several agencies have developed internal maintenance innovations programs to develop pioneering employee-driven solutions. These types of programs are part of a broader strategy for employee engagement and retention. Colorado DOT and the Front Range Community College have developed a two-year applied science associate's degree in highway maintenance management. Other state agencies also are pursuing similar programs to better prepare the maintenance workforce of the future.

Highway Operations

At no time within memory has a new transportation technology emerged more quickly—and with more potential to spur transformation—than CAVs. The wide-ranging impacts of CAVs include transportation operations; safety; land use; geometric, pavement, and bridge design; transit and transit operations; freight and goods movements; and more.

The availability of CAVs is no longer a science-fiction vision of the future but is quickly becoming a reality as auto manufacturers, suppliers, and state DOTs aggressively develop, advance, test, and implement vehicles that can operate autonomously under varying conditions with minimum human interaction. CAV technologies also are turning roads into connected highways by using short-range communication technology among vehicles and infrastructure. This is known as "vehicle-to-everything" communication technology, or V2X.

AASHTO has implemented a nationwide challenge to deploy dedicated short-range communications (DSRC) infrastructure with signal phase and timing (SPaT) broadcast in at least one corridor (containing approximately 20 signalized intersections) in each of the 50 states by 2020. At present, more than 200 signals operate in 26 states, with approximately 2,100 more planned for the next few years. The primary purpose of the SPaT challenge is to offer state and local DOTs a clear first step for deploying vehicle to infrastructure, or V2I, technology and operations and for gaining experience with the technologies. This program will provide valuable experience and lessons learned in the procurement, licensing, installation, and operations of DSRC infrastructure.

Colorado DOT recently launched a $67 million project to turn I-70, I-76, I-25, and I-270 into connected highways. In the next 20 years, the V2X project is projected to reduce crashes by more than 85,000, injuries by more than 22,000, and fatalities by more than 300. Wyoming DOT's connected vehicle pilot on I-80 uses V2I as well as vehicle-to-vehicle and infrastructure-to-vehicle connectivity to improve monitoring and reporting of road conditions to vehicles traveling on the Interstate.

Express toll lanes (ETLs) are another operations technology rapidly being adopted to improve travel time predictability. ETLs are a form of managed lanes that feature a variable toll rate based upon traffic demand. The purpose of ETLs is to offer drivers the option to buy into a free-flowing lane or roadway for a variable toll fee when their schedules require a more dependable travel time and adjacent general-purpose lanes are congested. These ETLs have been implemented in several states, including Virginia, California, Maryland, and Florida.

Safety

After two consecutive years of significant increases, motor vehicle–related fatalities decreased last year, according to National Highway Traffic Safety Administration data. In 2017, 37,133 people died in motor vehicle crashes—a decrease of almost 2 percent from 2016. Despite the improvement, however, this figure remains unacceptably high and has not reached the low fatality rates that occurred between 2010 and 2014. Speeding, distracted driving, and driving under the influence still represent significant contributing factors and states continue to implement a combination of behavioral and infrastructure countermeasures in an attempt to reduce fatal and serious injury crashes.

A collaborative effort between Minnesota DOT and the Minnesota Department of Health, Minnesota Walks creates safe, desirable, and convenient environments for pedestrians. Minnesota DOT also is examining how to build upon years of strategic safety planning at the state and county levels and ways to adopt a safe systems approach to future safety management and implementation.

Alabama DOT updated the state's multiyear, comprehensive strategic highway safety plan (SHSP) in 2017, working with local, state, federal, and other public and private stakeholders. Aligning with the Toward Zero Deaths initiative for all transportation system users and the goal to reduce fatalities and serious injuries by 50 percent by 2035, the SHSP 3rd Edition emphasizes high-risk behavior, at-risk road users, infrastructure and operations, and decision and performance improvement.

Conclusion

The 2018 State Partnership Visits Program offered TRB staff and state DOT personnel many opportunities to meet face to face and discuss the most pressing transportation issues facing the nation. These visits informed all participants on the many and varied policies and programs that state DOTs are using to improve the transportation system and support and promote the economy and quality of life.

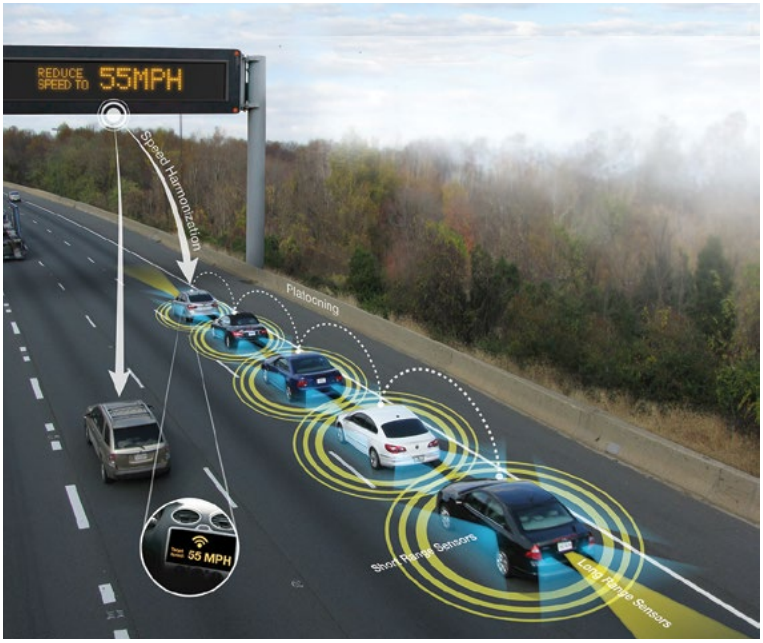


Photo: U.S. DOT

Photo: Tony Webster, Flickr

Left: Connected and automated vehicle technologies use short-range technology to facilitate communication among vehicles and infrastructure. Above: Express toll lanes allow drivers to buy into a lower-congestion lane or roadway, paying a toll that varies based on traffic.

Photo: KaBOOM!

Advancing Obesity Solutions Through Investments in the Built Environment

STEVE OLSON

The author is a freelance writer based in Seattle, Washington.

Above: A KaBOOM! playground in Miami, Florida. A recent National Academies workshop sought strategies for building and using infrastructure to prevent and treat obesity.

In the 20th and 21st centuries, changes in the built environment in the United States—that is, homes, buildings, streets, and infrastructure—contributed to a sharp decline in physical activity and other health-related outcomes. These developments in turn contributed to weight gain among Americans in recent decades (*1–3*). It follows, then, that the policies and practices that affect the built environment could affect obesity rates in the United States and improve the health of Americans (*1*).

In September 2017, the workshop "Advancing Obesity Solutions Through Investments in the Built Environment" was held to improve understanding of the built environment in preventing and treating obesity and to discuss promising strategies for more healthful and equitable environments. The workshop was convened by the Roundtable on Obesity Solutions, a forum established by the Health and Medicine Division of the National Academies of Sciences, Engineering, and Medicine in 2014 to engage leaders from multiple sectors to solve the obesity crisis.[1]

The workshop's objectives were

- To introduce attendees to the evidence-based principles of built environment design that support health and reduce the risk of obesity;
- To describe examples of successful multisector strategies creating health-promoting built environments;
- To discuss ways to ensure that built environment strategies improve health equity and environmental justice;
- To explore methods for scaling up and institutionalizing promising, effective, and equitable built environment strategies to improve health; and
- To discuss who could be involved and what next steps would be.

[1] For more information on the Roundtable, see http://nationalacademies.org/hmd/Activities/Nutrition/ObesitySolutions.aspx.

Photo: David Shankbone, Wikimedia

Photo: SC Digital Library

Left: Sprawling suburbs can create obstacles to walkability, reducing physical activities and increasing the incidence of obesity. Right: Los Angeles, 1910. At the turn of the 20th century, streets were shared equally by pedestrians, horse-drawn vehicles, and streetcars.

By conducting meetings, public workshops, publications, and innovation collaborations, the Roundtable has focused on the state of obesity solutions and how to drive progress. The Roundtable provides a venue for inspiring and developing multisector collaborations and policy initiatives to prevent and treat obesity and its adverse consequences throughout the entire lifespan and to eliminate obesity-related health disparities, as well as highlighting promising solutions to overcome challenges in implementation and scalability.

This article highlights some of the presentations to illustrate the array of initiatives around the country that are addressing different aspects of built environments—in all cases working to bring about change in accessibility and health outcomes.[2]

Overview of the Built Environment

James Sallis, University of California, San Diego, discussed how the structure of cities historically was based on the assumption that people would walk everywhere. Even in the first part of the 20th century, he noted, people walked in the streets despite having to dodge obstacles such as horses, streetcars, and other pedestrians.

Then motor vehicles took over the streets. "This may be one of the biggest experiments in human history and we are now starting to evaluate the outcomes on health," Sallis observed, noting that other changes in the built environment have had potential effects on physical activity and weight. As an example, he cited zoning laws that separated residential, commercial, and industrial uses and in turn affected walking.

Sallis commented that, despite growing evidence of environmental influences on health, healthcare providers and public health officials are not the ones making decisions about parks or transportation. He argued that changing the built environment requires new partnerships among such sectors as retail food, city planning, urban design, real estate, transportation, parks and recreation, law, advocacy, and public health.

Framework for Interventions

The 21st century poses many challenges to human health—including chronic disease, road traffic injuries, air pollution, fear of crime, and health inequities—all connected to urban planning, city design, and social policies, observed Rodrigo Reis of Washington University in St. Louis. He added that the connection between health and the built environment is part of the goals and targets related to urban planning or design in the United Nations Sustainable Development Goals (*4*).

Reis coauthored a paper in a 2016 special issue of *The Lancet* on urban design, transportation, and health. The paper outlines a framework of direct and indirect pathways through which urban planning and design decisions influence health and well-being (*5*). The framework describes planning and design interventions around constructs within regional planning (e.g., destination accessibility and distribution of employment) and local urban design (e.g., density and distance to transit). Reis pointed out that this framework calls for integrating policies around transportation, employment and economic development, social and health services, education, land use and urban design, housing, public open space and recreation, and public safety.

Furthermore, the framework identifies risk exposures (e.g., traffic, air pollution, personal safety levels, and physical inactivity) related to urban and transportation planning and design decisions. Reis explained that indicators in the framework can monitor cities' progress

[2] To view the complete proceedings and other presentations, see http://nationalacademies.org/hmd/Reports/2017/advancing-obesity-solutions-through-investments-in-the-built-environment-proceedings-in-brief.aspx.

in implementing policies, interventions, and outcomes that enhance health and reduce noncommunicable diseases. These indicators include legislation and policies, government investments in transportation, urban and transportation planning and design practices, transportation outcomes, and risk exposure outcomes (*5*).

Transportation and Land Use

Daniel A. Rodriguez of the University of California, Berkeley, presented research on the health impacts of transportation elements like street connectivity, traffic, and access to mass transit. He observed that higher connectivity in street grids often means shorter distances between places and greater safety from traffic, and this can encourage people to walk or bike rather than drive. Rodriguez cited findings from a study by Veerman et al. indicating that in low-density cities, simply installing sidewalks in neighborhoods as a single intervention is unlikely to improve health in a cost-effective way (*6*).

Instead, creating destinations to visit and encouraging higher population density are likely to be more cost-effective interventions than adding sidewalks here and there: "The peek-a-boo sidewalks that we see in the suburban United States—now you see them, now you don't, they have dead ends—that doesn't help us very much," Rodriguez noted.

Rodriguez cited an analysis of National Household Travel Survey data that found that people who walked to and from transit did so for a median of 21 minutes each day (*7*), and examined a study by Jerrett et al. that associated high traffic around people's homes with higher rates of obesity in children (*8*). Another element of the built environment Rodriguez explored was the mixing of land uses: intermingling residential, retail, and office space in the same neighborhood. He cited a study that found that the lack of mixed land uses and urban sprawl are associated more consistently with obesity relative to other physical environment factors (*9*).

Rodriguez also discussed the Multiethnic Study of Atherosclerosis. This research involved more than 5,000 participants with no diagnosed cardiovascular disease who had their body mass index (BMI) and waist circumference measured at baseline and at four subsequent follow-up appointments. One major finding was that a higher development intensity—that is, a combination measure of density, land use, destinations, street patterns, and mass transit—was associated with a less-pronounced increase in BMI and a decrease in waist circumference, after adjusting for such factors as age, gender, race and ethnicity, income, car ownership, health status, alcohol use, smoking, and time in transportation (*10*).

Rodriguez observed that more than half of the U.S. population currently lives in suburban environments, and that almost every city in the United States can improve its built environment. Planners, he suggested, are at the heart of the issue—as a contributing cause, but also as a remedy.

Photo: Paul Sableman, Flickr

Although the installation of sidewalks encourages walkability in low-density cities and suburbs, too many of these neighborhood sidewalks end abruptly—creating obstacles for pedestrians and cyclists.

Examples from Communities and Cities

Three panelists from North Carolina, Tennessee, and Montana discussed initiatives in their states that facilitate opportunities for active transportation and improve the built infrastructure to make it accessible for all citizens.

NORTH CAROLINA

Michelle Nance, Centralina Council of Governments, shared that the region around Charlotte—home to 2.4 million people—is expected to add 1.8 million more residents by 2050. To prepare, the "Connect Our Future" initiative establishes a shared vision for the region's growth. Part of the long-range planning process involved walkability audits, park access audits, and implementation of shared- and open-use policies.

To examine why the region's street connectivity, sidewalks, and access to transit and outdoor recreation were unused, Nance and her team sought to understand barriers and opportunities for physical activity within the community. To begin, they conducted a walkability audit by having community members walk around to a variety of predetermined locations. The subjects then responded to survey questions about, for example, whether the pedestrian walk signals were operational and the extent to

Photo: kitto1975, Flickr

Charlotte, North Carolina. In expectation of the city's population explosion, planners are examining barriers to walkability and will use this information to help develop policies to encourage healthy communities.

which the pedestrian infrastructure is accessible to people with disabilities.

According to Nance, the results showed that even in neighborhoods with higher street connectivity and good sidewalks, the many barriers to walking included long street-crossing distances and cars parked on the sidewalk. In addition, she and her team found that the streets were dark and considered unsafe by residents.

Nance and her team then conducted park-access audits to evaluate physical access to the regions' parks by car, bike, or foot, as well as safety and condition of the facilities. She pointed out that park access is about more than simply complying with the Americans with Disabilities Act—it includes proximity to the park entrance, safe routes to walk or bike to the entrance, good lighting and emergency call boxes, and a variety of in-park activities for all residents.

The results from the walkability and park access audits have led to additional audits by other community members and local leaders, who have used the results to inform policies that promote healthy communities.

TENNESSEE

Leslie Meehan, Tennessee Department of Health, examined ways to reduce the negative impacts of environments that can promote chronic diseases, including obesity. She explained that land use is the product of public policies—or the lack thereof. Referring to a crowded streetscape (see photo, below left), she observed, "Everything from where utility poles are, to how the signs are located, to the uses of the land—all of those things are influenced by policy, and that policy can certainly be amended."

As Americans started driving more during the 20th century, Meehan observed, the adult and childhood obesity rate increased. This spurred the Nashville Area Metropolitan Planning Organization (MPO) to think about the impact of transportation on health. The Nashville Area MPO encompasses about 1.3 million

Photo: Gary Layda

Photo: Rex Hammock, Flickr

Left: An example of a street that does not emphasize active transportation or healthy eating options. Right: A Complete Streets project in Nashville, Tennessee, included adding bike lanes and metal bollards to Division Street Bridge.

people—a population expected to double in the next few decades. As part of its policy planning process, the MPO conducted a telephone survey to ask respondents how they would spend transportation funds. The results showed that people wanted more mass transit, more walking and bicycling facilities, the preservation of existing roadways over new roadways, more choice in transportation options, and the ability to be physically active in their daily transportation routines.

> "This may be one of the biggest experiments in human history and we are now starting to evaluate the outcomes on health."

Using the results of the survey and other community input, Nashville Area MPO developed a new regional transportation plan for spending $8 billion in transportation revenue, which included a proposal for 1,000 miles of both walking and bicycling facilities. The MPO then identified areas with populations of low-income, minority, and senior residents, as well as areas with higher-than-average rates of chronic disease, to concentrate investments in sidewalks, bikeways, and public transportation. Within 10 years, Complete Streets projects—that is, projects creating streets with context-appropriate transportation facilities such as sidewalks, bikeways, and transit—increased from approximately 2 percent of the MPO's transportation projects to nearly 77 percent.

"One of the questions I am asked most frequently is how the worlds of transportation and health interact together," Meehan observed, adding that sectors can collaborate in many ways. For instance, Nashville MPO worked with the Centers for Disease Control and Prevention (CDC) to develop a model for estimating the health impacts to the population of increasing active transportation in the region. Different scenarios looked at how increases in bicycling or walking, and reductions in driving, correlated with decreases in diabetes and cardiovascular disease.

Meehan's final suggestion for bringing transportation and public health together was to reconsider the measures of success used by both sectors. She noted that the traditional measure of how well a roadway is working is how many cars can fit and how fast they can travel. Meehan argued that such measures as physical activity rates, sidewalks, sales and property taxes, obesity rates, and employment could yield a much more complete picture. Such measures extend beyond transportation and health, she asserted, and point to a "health in all policies" approach.

MONTANA

Montana is a large rural state with a statewide population density of about six people per square mile, noted Cathy Costakis of Montana State University in Bozeman, adding that that these rural differences may be related to educational attainment as well as to economic and built environment differences at the neighborhood level (*11*). In 2010, a state survey of cities with populations of 1,000 or more asking about local policies on active transportation revealed that 38 percent of surveyed communities had a "gold standard" sidewalk policy—that is, a 5-foot sidewalk separated from the street by a boulevard planting strip—for new developments (*12*).

Although 83 percent of the largest communities in Montana had such a policy, only 20 percent of the smallest communities did—and only 5 percent of all the communities had a bicycle policy.

Photo: Matt Otto, Flickr

Montana's largely rural communities often lack built infrastructure, like sidewalks or bike lanes, that facilitate safe passage along high-speed roads.

Photo: jasperdo

The city of Big Timber, Montana, used state community transportation enhancement funds to build ADA-compliant sidewalks in one of its neighborhoods.

This lack of policy can be seen in the built environment, Costakis added.

"There are people out there trying to walk and bicycle, but they were not included in the facility design of the community—and that is a policy issue. In many rural communities, the only place to walk is on the rural road, and in many cases there is no shoulder," she commented. "In Montana, a lot of those roads have 70-mph speed limits. Do you really want your kids walking there?"

According to Costakis, an additional complication is that in Montana many schools are being closed and consolidated, increasing the distance between home and school and making it difficult for children to walk or bike. Equity also is an issue: Costakis described a low-income part of a town that had fewer sidewalks and trails relative to wealthier areas in the same community. Another example included a crosswalk with no sidewalk or curb cut: "What if you have a disability?" she asked. "Is that a connected network for you?"

Costakis described the challenges some rural areas face, such as discrepancies in walkways near bus stops (Figure 1, below). "When you get out of the bus in a city you might have a really nice pathway to go on, but if you're in a county, well, best of luck to you," she noted. "And that's just not right."

Healthy Environments for All Children

The KaBOOM! Organization, which builds playgrounds in underresourced communities, focuses on transforming the built environment to make it as easy as possible for all children to play—particularly those growing up in poverty, commented CEO James Siegal. He emphasized how play not only produces active minds and bodies but also enables children to make friends, build strong bonds with caring adults, and develop creativity and cognitive skills.

Photo: KaBOOM!

The Hangout, a KaBOOM! "Play Everywhere" project in New Orleans, Louisiana, turned a dreary bus stop into a music and lights playground.

According to Siegal, in the organization's 22 years building playgrounds they found that very few communities worked to integrate play into the daily routines of children and families. To address this, KaBOOM! initiated a project called "Play Everywhere," collaborating with other organizations to solicit ideas for innovative, replicable ways of integrating play into the daily environment.

From the 1,000-plus contributions it received, the project identified 50 winning ideas for creating kid-friendly public spaces. The examples Siegal described included a parking lot converted into a giant sandbox in the San Francisco Bay Area; a transit center in Lexington, Kentucky, outfitted with a playable installation to help draw children away from traffic; and dead-end streets in Miami, Florida—formerly used for dumping and other illegal activities—converted into playgrounds. In New Orleans, Louisiana, he added, a

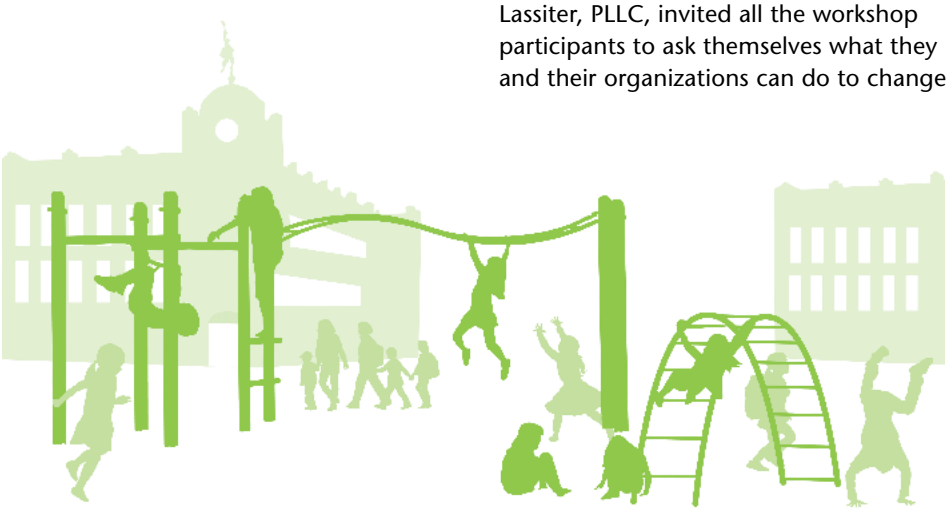
FIGURE 1 In Montana, a sidewalk near a bus stop in the city (left) and a bus stop in the county (right). (Source: Cathy Costakis, 2017)

a privileged few: "It means integrating play solutions into everyday spaces in underresourced communities—every public housing facility, every public elementary school, and everywhere else kids who need it most live and learn."

Considerations and Opportunities Moving Forward

Monica Hobbs Vinluan of the Robert Wood Johnson Foundation invited panelists to share their thoughts on particular actions that workshop participants could implement in their own communities and organizations. Janet Fulton, CDC, suggested collecting data that matter, forming partnerships from the federal to local levels, and thinking beyond the health benefits to the economic and social benefits of the built environment. Steve Lavrenz of the Institute for Transportation Engineers noted that health can be linked more explicitly to safety.

Bill Purcell of Farmer, Purcell & Lassiter, PLLC, invited all the workshop participants to ask themselves what they and their organizations can do to change the built environment and promote health: "What is your next step? How will you put into practice what you learned today? There are definitely things that all of us can do to create more healthy and equitable environments."



group transformed a bus stop into a musical play area called the Hang Out, where children could play drums and be active while waiting for the bus.

In the communities served by KaBOOM!, Siegal observed that safety concerns such as traffic, illicit activity, and violence create additional barriers to play; the healthy community finds solutions that create safe places for children. Siegal stressed that solutions cannot benefit only

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Urbanization and Slums

INFECTIOUS DISEASES IN THE BUILT ENVIRONMENT

Photo: Pixabay

CECILIA MUNDACA-SHAH, V. AYANO OGAWA, AND ANNA NICHOLSON

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Above: Increased urbanization is escalating the threat of disease worldwide. A National Academies workshop explored the behavioral factors and built environments that affect disease transmission as well as the strategies and policies that can promote healthier communities.

With increasing urbanization and interconnection of communities across the world, infectious diseases pose a serious and escalating threat to urban populations. According to United Nations estimates, the global urban population will top 6 billion by the year 2050, with most growth occurring in developing countries (*1*). Accompanying exponential urban growth has been a surge in the number of people living in urban and peri-urban slums. An estimated one in eight people around the world live in slums—although the proportion has decreased worldwide over the past 15 years, the absolute number of urban slum residents is fast approaching 1 billion (*2*).

Examining the phenomenon of slums involves a close look at the urban built environment; that is, all the physical parts of a city in which humans live and work, such as homes, buildings, streets, and infrastructure. The risk of infectious diseases in slums is compounded by poverty and by a surrounding physical and social environment that often is overcrowded; prone to physical hazards; and deficient in adequate or secure housing and basic infrastructure, including water, sanitation, and hygiene services (*3*). The populations most at risk will face worsening health consequences if the growth in urban and

Photo: Meena Kadri, Flickr

A woman walks to market in the Dharavi slums in Mumbai, India. The risk of infectious diseases is exacerbated by poverty and a physical environment lacking in basic sanitation, clean water, and hygiene services.

The Forum on Microbial Threats provides opportunities for discussion and scrutiny of critical scientific and issues about the prevention, detection, surveillance, and responses to emerging and reemerging infectious diseases in humans, as well as the microbiome in health and disease. For more information, visit http://nationalacademies.org/hmd/activities/publichealth/microbialthreats.aspx.

slum populations is not matched with an emphasis on research that brings together such disciplines as urban planning, public health, environmental health, and social and behavioral sciences.

To examine the role the urban built environment plays in infectious diseases, the Forum on Microbial Threats at the National Academies of Sciences, Engineering, and Medicine, in collaboration with the Board on Life Sciences, hosted the public workshop Urbanization and Slums: New Transmission Pathways of Infectious Diseases in the Built Environment in December 2017 (see box, above).

The topics explored during the forum included the following:

- Microbial communities in the urban built environment that affect human health;
- Urban built environment characteristics, as well as social and behavioral factors that may increase transmission of infectious diseases;
- Opportunities, challenges, and knowledge gaps for translating research into ways to shape urban environments that prevent and mitigate infectious disease outbreaks; and
- Strategies, interventions, and policies for creating sustainable, health-promoting urban built environments that consider structural and socioeconomic determinants of diseases.

Although the workshop was not charged with a specific transportation-related objective, the role of transportation emerged during presentations and discussions. This article highlights parts of the conference proceedings that discuss transportation as related to infectious disease transmission in slums.[1]

[1] To view the entire publication, visit www.nap.edu/catalog/25070/urbanization-and-slums-infectious-diseases-in-the-built-environment-proceedings.

Photo: Colombia Water System, Flickr

Without accessible water, many New Delhi, India, residents get water from tankers, which can be breeding grounds for bacteria like E. coli.

Defining Slums

Alex Ezeh, former executive director of the African Population and Health Research Center in Kenya, said that when people think of slums, they typically picture a specific space or geographic location. He noted that current estimates and statistics derived from United Nations data on slums in low- and middle-income countries do not characterize slums as specific places, however. Slums instead are characterized by groups of people or households that lack access to safe water, sanitation, and other infrastructure; people who have insecure tenure within the urban space; and people living in high-density settings (*4*).

Ezeh observed that because estimates based on these data do not refer to the specific geographic locations commonly considered to be slums in low- and middle-income countries, the practical value of these estimates is not entirely clear.

Possible Routes of Human Exposure to Microbes

Yuguo Li, professor of mechanical engineering at the University of Hong Kong, explained the three major routes of respiratory infection transmission in the built environment: air people breathe, or the airborne route; surfaces they touch, or the fomite route; and people they meet. He explained that an urban setting contains many opportunities for transmission, as people go about the day in their homes and on public transport, visiting offices, classrooms, restaurants, and shops.

The fomite route of transmission involves exposure from touching contaminated inanimate surfaces. Li discussed an outbreak of norovirus on an airplane in 2009 to illustrate how quickly a virus can be transmitted through the airborne route: of the 118 passengers on the airplane, 22 became infected, the majority of whom were seated along the aisles (*5*).

Photo: Adian Pingstone

A 2009 outbreak of norovirus was linked to contaminated surfaces on an airplane. Viruses on aircraft are spread predominantly via oft-touched surfaces like aisle seats.

Li hypothesized that the aisle seat passengers had a greater infection risk through the fomite route: people touch the aisle seats more often, crew members have more access to those seats, and aisle seat passengers may tend to use the toilets more often, where contaminated microbes are prevalent. He explained how all of the touch surfaces on an airplane are connected and can be contaminated quickly (*6*).[2]

Successful Efforts that Have Motivated Change

David Smith, professor of global health at the University of Washington, observed that in the early 1980s, the Guasmo Sur barrio in Guayaquil, Ecuador, was considered the biggest slum in the world. The barrio had been formed by poor residents squatting in, or occupying, the area and siphoning power from existing lines. The city government initially tried to raze the area but then relented; within 4 years, the government had provided infrastructure including roads, sewage, drainage, and metered electricity. According to Smith, this type of transition and development can help to mitigate infectious disease transmission and can happen quickly if governments are incentivized.

In discussing methods to mitigate infectious diseases in Indian slums, Siddharth Agarwal, director of the Urban Health Resource Centre in India, reported that India now has an urban health policy in place that encourages coordination among sectors at both the municipal and community levels to promote overall well-being and health and to reduce the risk of infectious disease.

Agarwal noted that some slums and informal settlements already have seen improvements in access to services such as water supplies, garbage removal, and paved streets. For example, a successful 5-year campaign by community women's groups and youth groups convinced civic authorities to build a permanent bridge over a large drain at the entrance to a slum—directly improving the lives of 120,000 residents.

Jason Corburn, director of the Institute of Urban and Regional Development, described Medellín, Colombia, as an example of positive urban transformation. In the early 1990s, Medellín was the most violent city in the world; today, it no longer places in the top 100 of cities plagued by gun homicides. He explained that this was not achieved through aggressive policing but instead through deep investment in infrastructure and public spaces, as well as through the use of ski lifts and escalators for public transportation.

Cross-Disciplinary Challenges and Opportunities for Solutions

During group discussions, participants considered possible solutions for collaboration across multiple disciplines.

Photo: Michael Shick, Flickr

The Guasmo Sur barrio in Guayaquil, Ecuador, is the world's largest slum. Government intervention to provide better infrastructure in Guayaquil—roads, sewers, and electricity—reduced disease transmission.

[2] A TRB symposium in 2009 also addressed this topic. For more information, see *Conference Proceedings 47: Research on the Transmission of Disease in Airports and on Aircraft,* www.trb.org/main/blurbs/163870.aspx.

Photo: Katherine Kortum

Photo: Vmenkov, Flickr

Above: Metrocable, a gondola lift in Medellín, Colombia, offers better access to jobs and transportation to residents of poorer communities. Right: Mitigating microbial threats in urban areas will depend greatly on transportation options and better transportation infrastructure.

One discussion focused on bridging the gap between research and institutional decision-making and policy by training researchers to engage with policy makers on nonhealth issues: transportation, housing, and economic development. Another group discussion focused on potential interdisciplinary opportunities within institutions—medicine, epidemiology, public health, economics, civil and environmental engineering, urban planning, geography, microbiology, demography, modeling, policymaking, law, and community mobilization—to work on urban and slum health.

Christopher Dye, director of strategy, policy, and information, Office of the Director-General, World Health Organization, explored how the United Nation's sustainable development goals could help mitigate microbial threats in urban environments. The proposition for development guided by these goals includes public health systems integrated with a variety of other sectors like agriculture, education, transportation, energy, industry, and other sectors.

Conclusion

An examination of transportation modes and infrastructure offers insight into how infectious diseases can spread in urban slums and also how slums can be safer and healthier through building transportation-related infrastructure. The sheer number of people living in slums worldwide necessitates solutions best approached through collaboration across disciplines—not only in transportation fields (e.g., civil and environmental engineering, urban planning, and geography), but also in fields including hard sciences, medicine and public health, and social sciences.

Snap Searches provide a succinct summary of TRB activities on a given topic. To see the Transportation and Health Snap Search, visit http://onlinepubs.trb.org/onlinepubs/snap/transportation-andhealth.pdf.

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Conference Proceedings 55 **offers a summary of the Airport Cooperative Research Program (ACRP) conference "Airport Roles in Reducing Transmission of Communicable Diseases," held in March 2018 in Washington, D.C. The ACRP Insight Event convened airport and public health professionals to address key challenges and issues facing the aviation sector in reducing the transmission of communicable diseases. For more information, see http://bit.ly/trbcp55.**

Photo: Ann Froschauer, U.S. Fish and Wildlife Service

ABANDONED RAILROAD TUNNELS AS ARTIFICIAL BAT HIBERNACULA

Ohio DOT Preserves History and Protects Habitats

TIMOTHY M. HILL, MATT PERLIK, AND CHRISTOPHER STARON

Hill is Administrator, Perlik is Assistant Environmental Administrator, and Staron is Environmental Specialist, Office of Environmental Services, Ohio Department of Transportation, Columbus.

Above: Little brown bat (*Myotis lucifungus*). Inset: The interior of Tunnel 9, facing the entrance. (Photo: Chris Staron, Ohio DOT)

In 2016, ecologists from the Ohio Department of Transportation's (DOT's) Office of Environmental Services (OES) conducted a routine ecological check for a small transportation maintenance project, addressing a potentially hazardous underground void beneath a rural state route. Little did the ecologists realize that this route in hilly southeast Ohio sat atop one of several long-forgotten abandoned railroad tunnels—and that its discovery would lead to the preservation of one of the largest previously unknown bat hibernacula in Ohio.

During the Appalachian coal boom of the late 1800s, railroads tunneled through the hills of southeast Ohio to facilitate coal shipments to outside markets. Built with countless hand-cut, hand-laid stones, these tunnels—10 in all, some as long as 2,300 feet—were bypassed in the mid-1900s, sealed with brick or dirt, and left in place. In the decades that followed, the tunnels either were broken into by nearby residents or the dirt around their openings eroded, allowing access. At some point, bats began to use the tunnels, which offered warmth in the winter, a continuous water supply, and many bat roosting sites in the nooks and crevices among the hand-laid bricks.

Public Safety Concerns in the Abandoned Rail Tunnels

It became evident that other, non-bat residents used the tunnels as local hangouts. The tunnels showed evidence of graffiti, camp fires, and other human activity. During a late winter visit to the tunnels, many dead bats were found. Investigators collected the bats, expecting to confirm that the bats died of white-nose syn-

Photos: Chris Staron, Ohio DOT

The external entrance to abandoned railway Tunnel 9 in Harrison County, Ohio.

Tricolor bats (*Perimyotis subflavus*) were observed roosting along the ceiling of Tunnel 9.

drome (WNS). To the Ohio DOT wildlife biologist's surprise, however, necropsies indicated tiny white pellets in the bodies of the bats. The bats had been shot off the ceiling by Airsoft pellet guns—meaning that kids posed a greater risk to the bats than disease.

White-Nose Syndrome

Most bat hibernacula in Ohio have experienced a death rate of nearly 100% from WNS, an emerging fungal disease in North American bats. The WNS fungus was introduced from Europe in the 2000s and has spread across eastern North America. It attacks the bare skin of bats, growing on their bodies in the cool, moist environment of winter hibernacula and irritating the skin. This makes bats awaken over and over during their winter hibernation, increasing their metabolism and burning the fat reserves needed to survive the long winter. Eventually, bats with WNS burn through their fat reserves and die from starvation before emerging from the hibernaculum in the spring.

Surprising Discovery

A visual survey in abandoned railroad Tunnel 9 found two species of bats: the tricolored bat (*Perimyotis subflavus*) and the little brown bat (*Myotis lucifugus*). The finding of little brown bats was significant: once one of the most common bats in Ohio, with population estimates in the hundreds of thousands, the little brown bat species had all but died out in Ohio from WNS.

Tunnel 9 contained 217 little brown bats, making the site the second largest hibernacula of little brown bats in Ohio. Ohio DOT senior ecologist Chris Staron questioned how the bats were surviving at this site and not dying from WNS. Ohio DOT then partnered with Joe Johnson of Ohio University, who was very interested in the newly discovered little brown bat hibernacula.

After temperature and humidity monitors were placed throughout Tunnel 9 and left there during the winter of 2017, another surprising discovery was found: the tunnel's average winter temperature is below 40 degrees Fahrenheit. These are considered very cold temperatures for hibernating bats. Why, then, were bats in this cold hibernacula not dying from WNS? As it turned out, the low temperature in the railroad tunnel kept the fungus dormant. Bats were not irritated and awakened by the fungus and were able to hibernate normally the entire winter.

A few years earlier, Greg Turner of the Pennsylvania Department of Natural Resources had been working to create a cold hibernacula at a nature cave in central Pennsylvania to slow the growth of WNS. Ohio DOT biologists compared Tunnel 9's data with the Pennsylvania cave data and found a striking similarity in temperatures (see Figure 1, below)—the temperatures in Tunnel 9 almost matched those of the Pennsylvania cave. Although Tunnel 9's temperatures were slightly warmer, they reduced fungal growth enough to allow bats to survive the winter. The cold hibernaculum of the Pennsylvania cave appears to be working—hibernating bat populations have increased there from year to year.

Preservation of a Valuable Ohio Resource

Seeing an opportunity to preserve this now-valuable resource, Staron partnered with the Ohio Department of Natural

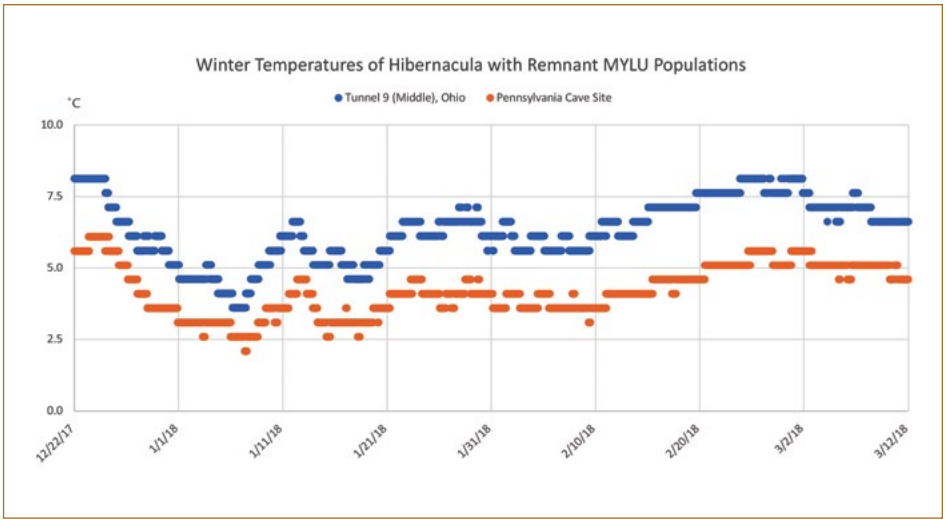


FIGURE 1 Winter temperature trends in Tunnel 9 in Ohio (blue) compared with natural cave hibernacula in Pennsylvania (orange). (Source: Joe Johnson, Ohio University)

The east end bat gate at Tunnel 9, under construction in July 2018 *(left)* and completed *(right)*. The west end gate also was completed in July and includes a locking human access door for future research. The gates were finished in time for bats' fall swarming activities. (Photo: Chris Staron, Ohio DOT)

Resources (ODNR) and Ohio University to develop a conceptual plan to build bat gates at the tunnel. Staron worked with Ohio DOT survey and design teams to develop tunnel-specific bat gate plans, based on designs from the ODNR Division of Mineral Resource Management and Forestry (see Figure 2, below). The Ohio DOT OES purchased the steel and other materials needed for the gates. ODNR employs a team that designs and installs bat gates on abandoned coal-mine openings throughout southeastern Ohio; this team built the gates.

For Ohio DOT, the goal was simple: install bat gates to eliminate the risk to human safety and preserve bat hibernacula. Preserving hibernacula protects the most sensitive, and perhaps most critical, component of a bat's life cycle.

As of fall 2018, Ohio DOT is working on gating and protecting four of the other known historic railroad tunnels as bat hibernacula. Historic mapping indicates that although there may be as many as 10 tunnels in the area, Ohio DOT has only located five of them. More tunnels may be harboring bats. Tunnel 9 is now gated and the bats are protected. Ohio DOT will continue to work with ODNR and the U.S. Fish and Wildlife Service (FWS) to gate and adjust the other four tunnels to make them successful hibernaculum for bats.

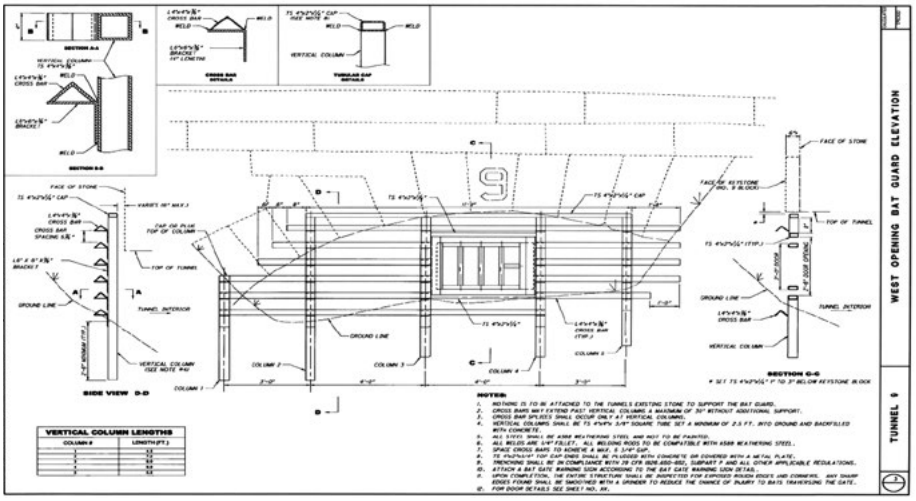


FIGURE 2 Early conceptual drawing of the east end bat gate design for Tunnel 9 in Harrison County, Ohio.

U.S. FWS Conservation Credit

Ohio DOT partnered with U.S. FWS so that the DOT could achieve bat conservation credits as a return on their investment in the gate installation and conservation easements. FWS agreed that conservation easements should be placed on the forested property immediately above and adjacent to the tunnels and their ownership transferred to a long-term conservation steward. These steps are essential not only to protect the immediate hibernacula within the tunnels but also the foraging areas immediately surrounding each tunnel. Ohio DOT also is considering acquiring additional forested property near the tunnel openings for potential long-term preservation and bat conservation.

BAT FACTS

More than 1,100 species of bats can be found across the globe, comprising one-quarter of all mammalian species. Forty species of bats live in the United States alone.

Bats can eat up to 1,200 mosquitoes per hour, can live for more than 30 years, and can fly at speeds of up to 60 mph.

Resource: The Nature Conservancy. Top 10 Bat Facts. www.nature.org/en-us/about-us/where-we-work/united-states/arizona/stories-in-arizona/top-10-bat-facts. Accessed February 5, 2019.

All Set for the Future

Photo courtesy of TheRay.org

SAFETY, ELECTRIFICATION, AND TRANSPORTATION

ALLIE KELLY AND ANNA CULLEN

Kelly is Executive Director and Cullen is Director, External Relations, The Ray, Atlanta, Georgia.

Above: An 18-mile corridor of Georgia I-85, known as The Ray, is a living laboratory of future infrastructure technology.

In 2018, the future of transportation met the mainstream: more than a half-dozen global automakers pledged to go all-electric, including Volvo, Volkswagen, Aston Martin, Mercedes-Benz, GM, Jaguar Land Rover, and Ford's Team Edison. Advancements in artificial intelligence hasten the implementation of autonomous and connected vehicles—at least until the concept of mobility as a service steals the market.

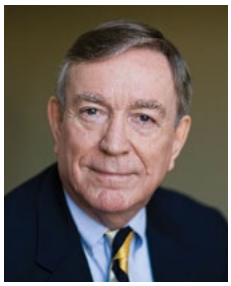
Autonomy and electrification are two pieces of a larger transportation and infrastructure conversation. The transportation sector faces a growing number of challenges—particularly that for the past decade the number of highway deaths in the United States has increased from year to year. Additionally, transportation's contributions to global carbon emissions continue to face significant scrutiny, and the system as a whole is reliant on infrastructure in critical need of updating.

The Ray, a broad public–private–philanthropic partnership (P4), accepts those challenges and considers the public support and enthusiasm for practical innovation to be a unique opportunity to meet the future of transportation head-on. The Ray is building the highway of the future via a proving ground and a living lab, acting as a platform for evolving technologies.

An 18-mile corridor of I-85 in Georgia from LaGrange to the Alabama border, The Ray is named for Ray C. Anderson, the founder of the modular carpet tile design and manufacturing company Interface. A pioneer of corporate sustainability, Anderson used his own money and company to prove that it is possible to "do well by doing good." His innate competitiveness, business acumen, and passion for environmental stewardship ignited a global movement toward sustainable business practice.

Following Anderson's death in 2011, the Georgia state legislature named the section of I-85 between his hometown and the original Interface headquarters in his honor. Soon, however, Anderson's youngest daughter, Harriet Anderson Langford, realized the irony of her father's name on a highway and began wondering "What if?"

"What if there was a better way?" Langford asked. "What if a highway could be a zero-death, zero-waste, and zero-emissions corridor?" Langford, The Ray, and the Georgia Department of Transportation (DOT) have worked toward this goal for the past 5 years.



Ray Anderson

Energy–Transportation Nexus

The nation's Interstate Highway System is more than 60 years old. Its construction put Americans to work, connected and united the states, and changed the country. Americans celebrated the system as an efficient means of getting from point A to point B.

On closer examination, however, the road as a point of connectivity for drivers is only the starting point of its potential. The nation is in a new era, with rapid changes in how and where Americans work and in their related mobility needs. The energy–transportation nexus leverages existing assets and infrastructure to produce more value and better outcomes in the transportation sector. It could become a significant tool in diversifying state DOT revenue beyond unreliable congressional appropriations, tolling, and motor-fuel taxes.

WATTWAY

Renewable energy generation presents vast opportunities for the transportation industry. In December 2016, The Ray and Georgia DOT installed a 50-square-meter pilot of Wattway, a solar (photovoltaic panel) pavement surface in an Interstate access lane at one of Georgia's gateway visitor centers. This demonstration project is the only publicly accessible, drivable solar road in the United States—and it generated nearly six megawatt-hours of clean, renewable energy for Georgia DOT's operations in just one year. That is approximately the average energy consumption of a typical American household over the same time frame.

Obviously, a flat, horizontal orientation is not optimal for solar panels. The purpose of the Wattway pilot is to demonstrate that the road itself—until now, a single-use asset—can have a second purpose. The durable road generates energy while serving its core mission as a safe surface for vehicle traffic. The promise of Wattway may or may not be miles and miles of solar roads; strategically deployed, however, solar pavement and paths are a part of a clean-energy solution that helps to satisfy the growing

Photo courtesy of TheRay.org

Nearly 20% of drivers who used WheelRight in the past year were warned that their tires were underinflated.

Photo courtesy of TheRay.org

A Georgia visitor center along The Ray features a solar pavement surface, a rapid-charging station, and a tire safety station.

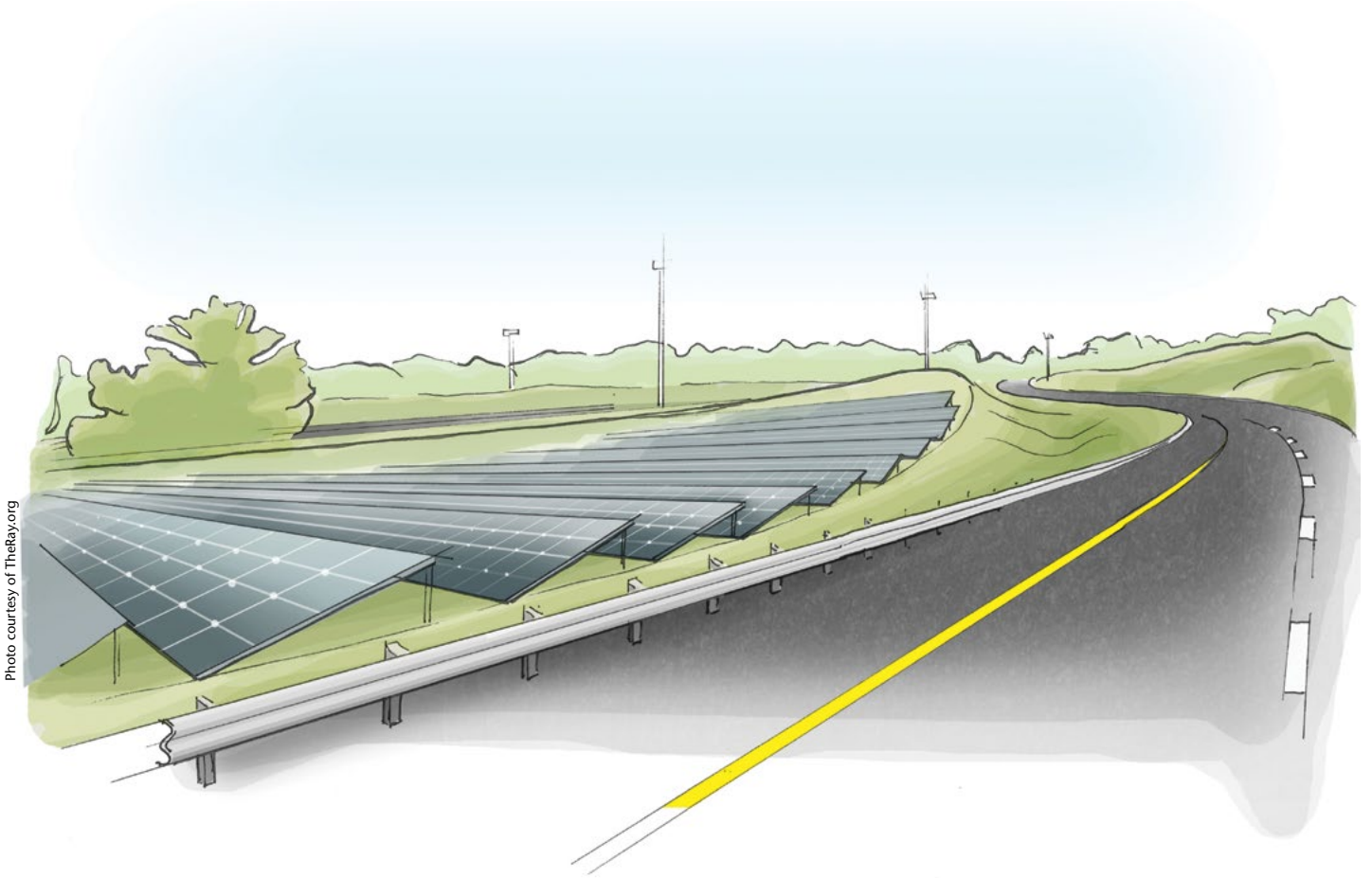


Photo courtesy of TheRay.org

A one-megawatt solar panel installation on The Ray will provide sustainable power via otherwise-unused land near the Interstate.

demand for energy and electrification in the transportation sector and from smart infrastructure. Locally generated energy also enhances a community's resiliency.

RIGHT-OF-WAY SOLAR ARRAY AND PV4EV

New, pioneering technology may be the future, but plenty low-hanging fruit is available even to the most circumspect DOTs. These opportunities lie in the right-of-way (ROW): acres of land and large diamond interchanges that can multitask while preserving their core mission and function. In 2019, Georgia is installing a one-megawatt solar array in and along the shoulder of the Interstate, following successful projects in Oregon and Massachusetts. This ROW solar array is a P4 among Georgia Power, Georgia DOT, the state's public service commission, and The Ray.

"At Georgia DOT, we are charged with the responsibility of being good stewards of our roadways and the right-of-way," commented Georgia DOT Commissioner Russell McMurry. "Installing this one-megawatt solar farm shows just how seriously we take that job. We're embracing the future of transportation and the new opportunities it brings." The one-megawatt installation on The Ray will be the first of its kind in the southeastern United States, as well as the only pollinator-friendly solar highway in the country.

> "What if there was a better way? What if a highway could be a zero-death, zero-waste, and zero-emissions corridor?"

For states in which solar may not be an optimal renewable energy generator, advances in micro–wind turbine technology may offer more renewable energy opportunities for multitasking transportation infrastructure—like bridges and rail overpasses—even in low-wind regions.

It is easy to envision a future where all vehicles are electrically powered. These electric vehicles will need a reliable charging network, preferably supplied by clean, renewable energy. It is critical to plan for this fueling infrastructure now—and coupling electric vehicle charging with a renewable energy system along Interstate highways is a prudent step forward. To this end, The Ray's very first technology demonstration was a DC fast-charging station anchored to a small solar array, known as PV4EV. This addressed a critical gap in charging infrastructure between the state capitals of Georgia and Alabama, a gap that previously had prevented most electric-vehicle drivers from using I-85 to enter Georgia.

Photo courtesy of TheRay.org

A fast-charging station connected to a solar array that will power electric vehicles adds significantly to the charging infrastructure between Atlanta, Georgia, and Montgomery, Alabama.

NOISE BARRIER RESEARCH

Other staples of highway infrastructure have electrification potential. In December 2017, The Ray released research results on solar noise barriers, conducted with Innovia Technology, a United Kingdom–based innovation consultant. This research investigates different designs, key technology providers, and developers, and provides an in-depth cost–benefit analysis of noise barriers manufactured from photovoltaic materials that produce renewable energy while blocking highway noise pollution. The information will be critical for a first U.S. pilot of this technology and will be invaluable to any DOT constructing new noise barriers.

Safety First

RESEARCH OPPORTUNITIES

The core mission of The Ray is safer transportation—an ultimate goal of zero deaths on highways, Interstates, and roads. By leveraging smart infrastructure already in place and harnessing the full capability of rapidly emerging connected and autonomous mobility technology, it will be possible to meet this goal on The Ray in the near future.

"I was on the board of the Georgia DOT for more than 25 years, and I can assure you that their number-one priority is safety," observed former State Transportation Board member Sam Wellborn. "The innovative approach and first-of-its-kind technology that The Ray is bringing to Georgia will help address our rising highway fatality crisis. This partnership can lead to new norms that will change safety on roadways around the world."

WHEELRIGHT

Because accidents and highway deaths happen every day, projects at The Ray generally focus on what can be done right now as well as development of technologies and capabilities that can save lives in the future. Every year, hundreds of deaths are attributed directly to tire failure. Although this is a small percentage of annual vehicle-related deaths, tire failure is completely predictable and preventable.

The core mission of The Ray is safer transportation—an ultimate goal of zero deaths on highways, Interstates, and roads.

WheelRight is a convenient, drive-through tire safety station that simultaneously measures tire pressure and tread depth. The driver never leaves the vehicle and results from analysis of data captured

Photo courtesy of TheRay.org

The Ray's WheelRight is a drive-through station that measures tire pressure and tread depth to alert drivers to tire issues and maximize safety.

by in-road sensors and a computer visioning system are available in less than 10 seconds.

Seizing the opportunity to innovate, expand, and test new capability in a living lab like The Ray, the WheelRight system now is learning to read tire sidewall information and monitor for tire sidewall damage. Taken together, this critical information on tire inflation, wear, and damage can improve tire maintenance and safety in private fleets and among the general driving public. It also can integrate seamlessly into future autonomous mobility-as-a-service operations in which electric vehicle charging, battery replacement, and tire checks will continue as key maintenance concerns.

Last year, more than 2,500 drivers relied on WheelRight and nearly one in five were alerted that their tires were underinflated. On average, U.S. drivers waste 2 billion gallons of gas every year simply because their tires are not inflated properly—unnecessarily and artificially lowering vehicle fuel efficiency. Although WheelRight on The Ray was the first publicly available station in the United States, the integration of this technology into tire safety stations, freight depots, school bus parking lots, and bus transit systems could provide significant safety benefits nationwide.

Future Projects

In the coming year, The Ray and Georgia DOT will work to launch autonomous and connected vehicle pilot programs, collecting data that could turn into meaningful and actionable information that would enable DOTs to make better traffic management decisions and to respond more efficiently and safely in emergency situations. Because The Ray is a high-speed logistics and industrial corridor located outside the metropolitan Atlanta area, some of the experience and learning will center on freight vehicles. The connectivity of heavy-duty trucks can save time, fuel, and human lives.

Taking connectivity a step further, The Ray has created and patented technology to create the world's first smart road dot marker. The white and yellow painted lines that mark road lanes have tremendous potential for safety improvements. Smart, solar powered, LED-lit road dots can collect important information about road and driving conditions directly from the road itself and can share those data in real time with state DOTs. The dots can even communicate warnings directly to drivers via color, regardless of whether a car is connected.

For example, after an accident, the lit smart road dot could turn amber to warn approaching drivers to slow down. In intense rain and fog conditions, bright-white LEDs could guide drivers safely to their destinations. Dangerous black ice also could be identified by the road itself in real time and at precise locations. This technology is in its beta testing and design process, which will inform future demonstration pilots.

In preparation for the future of autonomous and connected vehicles, innovators, researchers, and policy makers also acknowledge that several decades of a mixed fleet—that is, "smart" and "legacy" cars together on the roads—lie ahead. Many Americans will not be able to afford an autonomous or connected vehicle, whether as a replacement car or as part of a shared-ownership program, and will continue to drive legacy cars. A smart, connected highway can level the playing field and bring equality to the road system so that everyone benefits from new, life-saving technology.

Photo courtesy of TheRay.org

The Ray leverages infrastructure already in place to test innovative research pilots.

Edgardo D. Block

Connecticut Department of Transportation

Edgardo D. Block has been immersed in research, pavement management, and design for 26 years, most of them at the Connecticut Department of Transportation (DOT). Since 2015, he has led the agency's Performance Management Unit. In July 2018, he was asked to lead Connecticut DOT's research program as well.

At Connecticut DOT, Block was instrumental in championing and implementing a pavement preservation program. The program now is a $25 million baseline program—in some years exceeding $70 million—that has increased agency pavement investment by more than 30 percent and has implemented innovative pavement technology such as warm-mix asphalt, crumb-rubber tire chip seals and crumb-rubber-tire gap-graded surface mixes, and high-reclaimed asphalt pavement mixes. Block leads the DOT's Performance Management Unit, which focuses on the agency's move toward a performance-management approach to managing infrastructure, and provides expertise on the agency's pavement management, analysis, and data collection efforts. Block also teaches at Central Connecticut State University.

"Over the course of my career, one of the most salient developments is the transformational role of data availability on our ability to frame the questions that we are able to ask and seek answers to in our field," Block comments. "Research can provide the rigor required to build a solid foundation of knowledge on which to formulate the next hypothesis and test it."

A native of Argentina, Block graduated from the University of Connecticut in 1989 and soon joined Connecticut DOT as a transportation engineer. In the mid-1990s, he worked for a private toll authority in Argentina, researching, evaluating, and implementing emerging asphalt technologies; designing and implementing a pavement management program; and developing an information system to monitor highway project progress and manage materials inventory.

Block rejoined Connecticut DOT in 1999 and received a master's degree in business administration from Rensselaer Polytechnic Institute in 2004, after which he became transportation supervising engineer in Connecticut DOT's Pavement Management Unit. Along with spearheading the implementation of the pavement preservation program, Block recommended and submitted performance measures for state highway network pavement condition that were part of a report to the state legislature and executive branch; developed a strategic plan for the unit, secured resources, created and managed a budget, and more; designed plans for information technology (IT)–intensive aspects of pavement management; and initiated business process redesign efforts for activities related to pavements, pavement investments, and related IT projects.

"Research can provide the rigor required to build a solid foundation of knowledge on which to formulate the next hypothesis and test it."

"Seemingly suddenly, the tools and techniques for analyzing data that I have become familiar with seem inadequate for the nature and quantity of the data that now is accessible for understanding phenomena in transportation engineering," Block observes. "The rapidly increasing complexity of systems and the abundance of data is daunting."

He adds that young researchers are well-equipped to take advantage of the opportunities offered by vast quantities of data and analytical power: "These individuals seem generally very aware of cross-discipline tools and techniques for advancing knowledge in our field, in this new data-abundant paradigm, and are able to bring this to bear on our pressing questions and problems."

For the past 18 years, Block has been highly active in TRB activities. He joined the Standing Committee on Pavement Condition Evaluation in 2001 and Standing Committee on Pavement Management Systems in 2008. He chaired the Pavement Management Systems Committee from 2012 to 2018. Block also has served on several technical panels for National Cooperative Highway Research Program (NCHRP) projects in pavement preservation and maintenance and transportation asset management. Since 2017 he has chaired the NCHRP Project Panel on Measuring the Characteristics of Pavement Surface Images and Developing Standard Practices for Calibration, Certification, and Verification of Imaging Systems.

Block is focused on connecting new and young researchers with traditional public-sector transportation agencies. "Because public agencies are perpetually asked to do more with less, I encourage younger researchers in academia to really work to build the trust of public transportation agencies by focusing on the agencies' pressing problems, however mundane they may seem from a research perspective," he comments. "Not only does this bring appreciation from the agencies, it also sets the groundwork for the agencies to listen more intently to the deep questions that researchers are thinking about and that need to be collectively formulated and pursued."

Julie K. P. Dunbar

Dunbar Transportation Consulting, LLC

Julie K. P. Dunbar attended her first TRB Annual Meeting in 1984. Then a transportation planner with the North Central Texas Council of Governments (NCTCOG), Dunbar was assisting her supervisor, Michael Morris, who is now Director of Transportation for NCTCOG and also served as the 2010 TRB Executive Committee Chair.

"I recall being overwhelmed and energized by the size of the gathering and all of the presentations and meetings that were packed into the week," Dunbar comments. Some aspects of the meeting have changed significantly—for example, the number of women and young professional attendees has increased and the amount of paper hauled back and forth from the meeting has decreased—but she observes that other aspects remain the same: "I imagine that today's first-time attendee is just as overwhelmed and energized as I was back then."

Dunbar received bachelors' degrees in physics and civil engineering from Illinois Wesleyan University and the University of Illinois, respectively. She also has a master's degree in civil engineering from the University of Illinois.

At NCTCOG, Dunbar gained extensive experience with traditional four-step models and used the Dallas–Fort Worth Regional Model to support the successful implementation of passenger rail in the region. She was part of NCTCOG's model development and coordination team in the late 1980s and early 1990s, at a time when NCTCOG and the Texas Department of Transportation worked to form a common modeling platform for projects in the Dallas–Fort Worth region. Dunbar also assisted local governments and other regional transit agencies with corridor and system planning efforts throughout north central Texas.

After more than 18 years at NCTCOG, she formed Dunbar Transportation Consulting, LLC (DTC). As managing principal and owner of the firm, Dunbar specializes in project management, technical analysis, model development and transit corridor analysis. Current projects include evaluating travel forecasts for concepts and alternatives considered in the Los Angeles Metro Sepulveda Transit Corridor Study, forecasting ridership for Los Angeles Metro rail fleet management efforts, evaluating alternatives for Dallas Area Rapid Transit's 2045 Transit System Plan Update, and working with the University of Texas at Austin on the federally funded Multimodal Public Transportation System Connectivity Performance Measures Project to help transit agencies better assess the impacts of service changes on transit constituents.

> "Planning has travel forecasting as a foundational component, and in this niche TRB research has allowed new techniques and processes to come into play in my work."

In 1997, Dunbar joined the TRB Standing Committee on Transportation Planning Applications. She has chaired the committee since 2015 and also is cochair of the subcommittee that plans the Transportation Planning Applications Conference, also known as TRBAppcon.

"The idea behind TRBAppcon is to provide a practice-focused conference setting that also allows researchers and practitioners to connect and share their work with peers," Dunbar notes. "Research ideas often are born out of challenges uncovered in practice."

Dunbar brings a practitioner's perspective to TRB activities. "From the very beginning of my career, I have been about transportation planning; working with local governments, transit providers and departments of transportation to develop comprehensive transportation plans, airport system plans, long range regional transportation plans, long-range transit system plans, corridor development plans and alternatives analyses," she observes. "All of this planning work had travel forecasting as a foundational component, and in this travel forecasting niche TRB research has allowed new techniques and processes to come into play in my work."

Dunbar also has served on the planning committee for the biannual Innovations in Travel Modeling Conference (ITM), first held in 2006, which addresses innovations born of research but focused on practice. ITM tackles new issues in transportation planning with innovative modeling techniques and serves as a venue for networking and sharing among practitioners, researchers, and innovators.

Dunbar is a longtime supporter of the Special Committee for Travel Forecasting Resources in the development of the online Wiki-based Travel Forecasting Resource, or TFResource. "The need for TFResource came from TRB Special Report 288, Metropolitan Travel Forecasting: Current Practice and Future Direction, which identified a knowledge gap between research and practice along with a gap in expertise among practitioners," she comments. "The intent of this effort is to gather travel forecasting–related resources into one place to assist practitioners in identifying the tools they need, to allow researchers to share new tools, and to provide another forum for researchers and practitioners to connect."

Dunbar muses that a common thread among her TRB experiences is connections: "Connecting new young professionals via the Annual Meeting experience to a broader group of colleagues encouraging them to think outside the boundaries of their agency's way of doing things; connecting practitioners via the Transportation Planning Applications Conference enabling them to share work outcomes, challenges and new ideas; connecting modelers via the ITM to discuss and debate innovative ideas and research results; and connecting travel forecasters via TFResource, providing a place to learn and share techniques and tools."

IN MEMORIAM

Michael R. Salamone, 1960–2018

TRB's good friend and colleague Mike Salamone died suddenly in his home in Arlington, Virginia, on December 16, 2018.

Thanks to Salamone's leadership and innovation, the Airport Cooperative Research Program (ACRP) has become an outstanding resource for the airports community. Salamone always was eager to try new approaches that would better serve the interests of the community. ACRP will continue to be guided by his ideas and inspiration and will serve as a fitting legacy for his life's work. Salamone was a mentor to many and touched the lives of all TRB employees and friends in one way or another. Although shocked and saddened by his passing, his colleagues are committed to celebrating Salamone's life and honoring his memory while working through the grieving process.

He is survived by wife Josée and children Genevieve and Michael.

Salamone joined the National Academies in 2006, and his primary responsibilities involved managing cooperative research projects, supervising ACRP research processes, directing communications within the airport industry, and disseminating ACRP research results. Salamone was active in the airport industry since 1978, and he held several senior management positions at airports in Iowa, Florida, and California. He received a B.S. degree in Aviation Administration from California State University and an M.B.A in Aviation from Embry Riddle Aeronautical University. In addition to his love of aviation, Salamone loved spending time with his dogs, Maurice and Pablo.

COOPERATIVE RESEARCH PROGRAMS

Seismic Site Response Analysis

After the publication of *NCHRP Synthesis 428: Practices and Procedures for Site-Specific Evaluations of Earthquake Ground Motions,* concerns were raised about the applicability of the analysis for sites that have soft soil, are liquefiable, or are subject to strong shaking. New guidance is needed for effective, economical seismic design for all types of highway structures.

Photo: Pixnio

GeoLogic Associates Inc. has been awarded a $640,000, 38-month contract [National Cooperative Highway Research Program (NCHRP) Project 12-114, FY 2018] to develop guidelines for the use and selection of analytical methods to quantify the effects of site-specific conditions on earthquake ground response.

For more information, contact Waseem Dekelbab, TRB, at 202-334-1409 or wdekelbab@nas.edu.

Bridge Cable Guidelines Updated

Significant progress has been made advancing risk-based inspection methods, nondestructive evaluation techniques, structural health monitoring, and strength evaluation methods since *NCHRP Report 534: Guidelines for Inspection and Strength Evaluation of Suspension Bridge Parallel-Wire Cables* was published in 2004. These advances need to be incorporated into current inspection practices.

Modjeski & Masters has been awarded a $470,000, 32-month contract (NCHRP Project 12-115, FY 2018) to develop guidelines for risk-based inspection and strength evaluation of suspension bridge main cable systems.

For more information, contact Waseem Dekelbab, TRB, at 202-334-1409 or wdekelbab@nas.edu.

Photo: Robert Du Bois, Flickr

Photo: PxHere

Sign Structure Safety Revisited

Highway signs play an important role in safety, and their use in communications is increasing. Because new signs generally are heavier than previous typical signs and because wind is the greatest load affecting these structures, current specifications on the effect of wind drag on highway signs must be updated.

University of Iowa has received a $300,000, 27-month contract (NCHRP Project 15-67, FY 2018) to develop a methodology and design examples to calculate revised wind drag coefficients for signs and supporting members.

For more information, contact Waseem Dekelbab, TRB, at 202-334-1409 or wdekelbab@nas.edu.

Transportation Research Thesaurus

TRID Tool for Better Searches

JANET S. DALY

The author is Indexing Manager, Information Technology and Research Services, Transportation Research Board, Washington, D.C.

Many research tasks in the transportation sector—from finding literature to text mining—could benefit from the use of a standardized set of terms. The Transportation Research Thesaurus (TRT), a controlled vocabulary of transportation-related terms, can help meet this need. Because TRT provides a common, consistent language between producers and users of transportation information, it can be used whenever there is a need to find and organize knowledge.

The TRT is

- Large, containing more than 12,000 terms;
- Comprehensive, covering all modes and aspects of transportation;
- Targeted, focusing only on the transportation sector;
- Organized, with terms are arranged in hierarchies from very broad to very specific; and
- Flexible, since it can be searched directly from TRB's Transportation Research Information Service databases, browsed from the TRT website at trt.trb.org, or downloaded for use in other databases or systems.

New terms are added regularly to ensure that the TRT reflects cutting-edge topics. Many terms include definitions or descriptions.

All records in the TRIS Databases—TRID, Research in Progress, Publications Index, and Practice Ready Papers—have been tagged with index terms taken from the TRT. Using a TRT term in a literature search—rather than simply conducting a simple keyword search—can reduce the retrieval of unrelated records and narrows the usage to only those results that really are about a specific topic.

Conversely, TRT also can help a searcher find more terms that might prove useful in a particular search. For example, if a searcher is looking at the term "smart growth," the TRT hierarchy also will help the searcher locate broader terms, such as "land use planning," or more specific terms, like "livability." TRT also will point the user to closely related terms that may also be of interest, such as "sustainable development" or "urban growth."

Although TRT first was developed to index records in TRIS databases, its use has

Top Terms > Transportation > Transportation modes > Water transportation > **Shipping**

Shipping (Aesb)

Definition
A mode of transportation that involves passage or transportation on a ship. (Source: Team)

Broader Term
Water transportation (aes)

Narrower Terms
Ocean shipping (Aesbb)
Coastwise shipping (Aesbc)
Short sea shipping (Aesbe)

Related Terms (Heirarchical)
Ferry service (Aesf)
Inland water transportation (Aesi)

Related Terms (Associative)
Water traffic (Btaw)

FIGURE 1 Example of a TRT term, including definition, broader and narrower terms, and related (similar) terms.

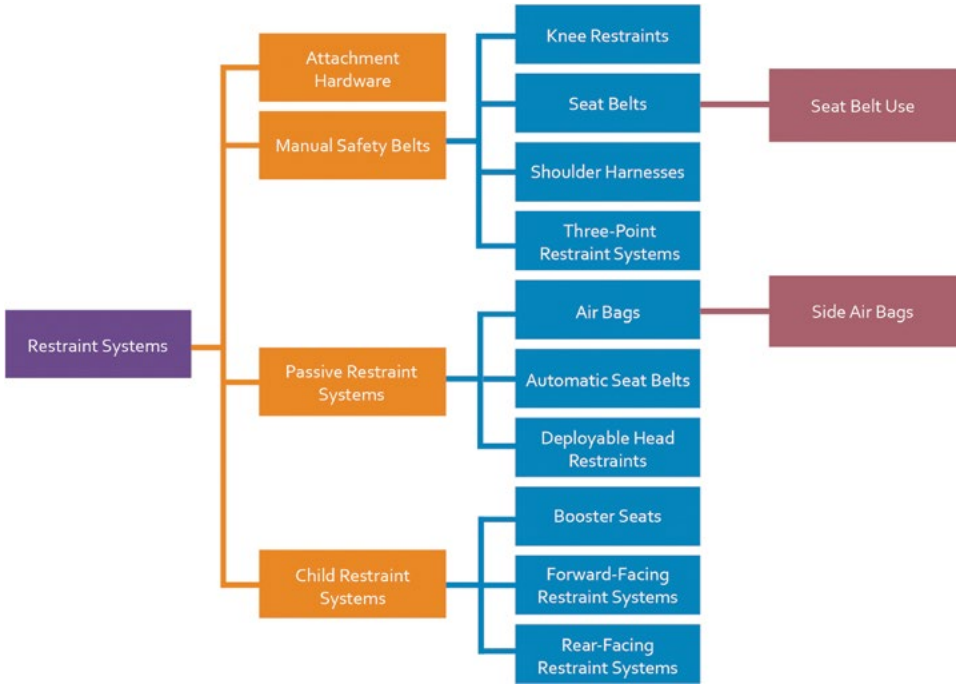


FIGURE 2 TRT hierarchy for the term "restraint systems."

expanded over the years. Transportation agencies and universities use TRT to organize information: standardizing a vocabulary for their own library databases, creating subject access to an intranet database of agency policies, indexing photographic archives, and seeding taxonomies for content management systems. These organizations also use TRT to find information—including teaching patrons and customers how to search—and in text mining projects to uncover trends and patterns in research.

To ensure TRT's ongoing value to the transportation community, a recent National Cooperative Highway Research Program project titled "Enhancement of the Transportation Research Thesaurus" developed a strategic plan and action plan that address both its original purposes and these expanded uses.[1] Based on the findings from the study, potential future directions for TRT include 1) acquiring new thesaurus management software to support a standards-based thesaurus, 2) adding or revising terminology to reflect current trends and topics, 3) increasing engagement of subject-matter experts in terminology development, and 4) adding the ability for users to create customized TRT segment reports.

[1] More information on NCHRP Project 20-109 can be found at the link http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=4061.

Interested in learning more about TRT? Visit the website at trt.trb.org and find two short video tutorials on how and why to use the tool. Or contact TRB's Transportation Research Information Services staff, who will be happy to assist in finding TRT terms to help in any information search.

NASEM WORKSHOP

Human–Automation Interaction Considerations for Unmanned Aerial System Integration into the National Airspace System

DANIEL E. J. TALMAGE, JR.

The author is Program Officer, Board on Human–Systems Integration, National Academies of Sciences, Engineering, and Medicine.

What issues related to human–systems interaction affect the ease and effectiveness of managing and controlling unmanned aerial systems (UAS) within the complex National Airspace System? This question was the motivation for a two-day workshop in Washington, D.C., in January 2018.

Workshop steering committee chair Nancy Tippins, CEB Valtera, welcomed the participants and explained the workshop's focus on human–systems integration considerations relevant to the design and operations of UAS technology, particularly within the context of implementing automation capabilities within ground-control stations. Jay Shively, representing the workshop sponsor National Aeronautics and Space Administration (NASA), laid out the event's goals from NASA's perspective: 1) to identify human–automation issues, current and future; 2) to identify future research; and 3) to make and solidify connections among participants. Shively emphasized the increasing concern about the role of human intervention with automated systems during problem scenarios, noting that the rush to "automate everything we can" is a potentially troubling trend and "not necessarily a great design plan."

Photo: Marco Verch, Flickr

Research on unmanned aerial systems in the National Airspace System was examined at a National Academies workshop last year.

RESEARCH NEEDS AND KNOWLEDGE GAPS

Several presentations touched on research needs and skill set identification, including the following:

- Kathy Abbott, Federal Aviation Administration, offered a list of lessons learned. First, she emphasized the role of automation in terms of the advantages that have been realized in safety, operational efficiency, and precise management. She also made the argument that significant differences exist among different types of automated systems and the issue that requires the most attention may be the complexity of the automated system. Relying too much on automated capabilities that may work extremely well during normal situations can lead to a degradation of human skills that are called upon during abnormal situations. Designing systems to optimize human contributions in every possible situation is a very hard thing to do; moving forward, caution is warranted to manage risk.
- Mica Endsley, SA Technologies, Inc., discussed human–automation integration research needs, as well as research gaps in transparency, predictability, context and consistency, dependence, annoyance, operating at cross purposes, responsibility, and training.
- Missy Cummings, Duke University, noted that different skill sets are needed for different types of UAS operations.
- John Hansman, Massachusetts Institute of Technology, concluded by pointing out that there are very different types of UAS operations and that human-factors issues will be dependent on the UAS architectures and concepts of operation.

OVERALL THEMES

Tippins proposed a list of potential themes that she had heard throughout the presentations and discussions and encouraged participants to comment on them. This resulted in four overall themes:

- **Theme 1: controllers must be involved in the solutions.** Several participants noted that air traffic controllers are a critical part of any solution. Many participants stated that a reflexive approach to thinking about automation tends to focus on pilots and operators and pointed out that the roles of pilot, operator, and air traffic controller increasingly are integrated for UAS operation. As a result, some of the important functions that are critical to consider for human–systems interaction design for automation are control-focused activities.
- **Theme 2: the system is changing, which requires planning.** Several participants observed that the traditional roles of the controller, pilot, and operator are blurring or being subsumed into alternative structures. This change is important to consider from multiple perspectives, including those related to certification, regulation, policy guidance, and the development of the mental models shared by all members of the system. The language used to describe human–automation interaction is changing as well, perhaps reflecting the changing mental models, participants noted. Participants also pointed out that all of these issues have implications for the design of new systems, the design of future control structures, and the transition from the existing NAS environment to the future NAS environment.
- **Theme 3: training and procedures will become increasingly important.** A few speakers stressed the importance of training and procedures for integrated operations. Some of them also noted that designs that are focused on assisting humans to be successful will reduce the need for repetitive training and memorization and will contribute to overall excellence in systemwide performance.
- **Theme 4: there will be bad guys, surprises, and unexpected behaviors.** A few workshop participants commented on the necessity to consider the illicit use of UAS in controlled airspace. They mentioned recent examples of problems, including hobbyist systems creating incursions into controlled airspace, criminals using UAS systems to aid or execute illegal activities, and the use of UAS for violating state and federal laws as well as privacy and other social norms.

The Board on Human–Systems Integration (BOHSI) is a division of the National Academies of Sciences, Engineering, and Medicine that provides new perspectives on theoretical and methodological issues concerning the relationship of individuals and organizations to technology and the environment; identifies critical issues in the design, test, evaluation, and use of new human-centered technologies; and advises sponsors on the research needed to expand the scientific and technical bases for designing technology to support the needs of its users. For copies of the workshop proceedings and report highlights, visit the National Academies Press website at www.nap.edu or visit http://sites.nationalacademies.org/DBASSE/BOHSI/Human-Automation_Interaction_for_UAS/index.htm.

High Cost of Insufficient Infrastructure Investment

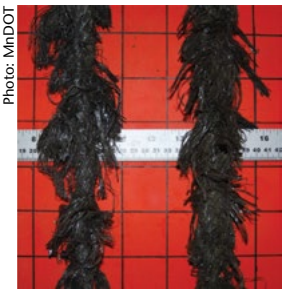
Decades of insufficient investment in the nation's public bus and rail transit infrastructure have resulted in a $340 billion loss of business revenue over the past 6 years, according to a new study from the American Public Transportation Association. Researchers studied six transit systems, including those in Chicago, Atlanta, San Francisco, and Washington, D.C., and examined modernization needs in other bus systems and facilities. Interviews were conducted and open-source literature analyzed to ascertain the specific ways that transit affects local and regional economies and how transit deficiencies are passed on to system users.

Besides the loss of business revenue in the U.S. economy, infrastructure deficiencies caused an estimated loss of 162,000 jobs and a $109 billion hit to household incomes.

For more information, visit www.apta.com/mediacenter/pressreleases/2018/Pages/Modernize-Public-Transportation.aspx.

Mussel Spat Rope Eases Culvert Barriers

Photo: MnDOT



Super Xmas Tree mussel spat rope.

Although culverts create a water passage for streams that are intersected by roads and railroads, they create a barrier to the passage of fish and aquatic organisms. The smooth surface of culverts and high water velocity combined with low water depth make passage difficult. Many methods of alleviating these barriers—like retrofitting culverts with baffles—can be costly and difficult to maintain. Concerned about the effect on the state's fisheries, the Minnesota Department of Transportation (DOT) explored options to mitigate the obstacles created by culverts.

Building on research from New Zealand, Minnesota DOT researchers experimented with installing mussel spat rope—the ropes used to collect mussel seed—in culverts with steep inclines or high velocity flow. Combining physical laboratory measurements of rope hydrodynamics, fish laboratory experiments, and field demonstrations, researchers created low-velocity areas and covers that help small fish navigate the passage more effectively.

In the experiments, 75 percent of the fish used the mussel spat rope either as cover or as flow refugia. The ropes also created minimal change to water flow. Although the rope is less useful to small fish species and would need to be monitored yearly for debris, it comprises a low-cost, low-maintenance method to facilitate fish passage.

To read the entire report, visit www.dot.state.mn.us/research/reports/2018/201813.pdf.

Every Day Counts Names 2019–2020 Innovations

Project bundling, the use of crowdsourced and unmanned aerial systems data, and collaborative hydraulic modeling are some of the 10 new innovations advanced by the Federal Highway Administration's Every Day Counts (EDC) program for 2019 and 2020.

EDC promotes underused but proven technologies and practices for rapid deployments by states to shorten project delivery time, enhance roadway safety, and protect the environment. Summits offer transportation leaders the opportunity to review the innovations and identify ones fitting the needs of their programs.

For more information and to see the entire list of EDC-5 innovations, visit www.fhwa.dot.gov/innovation/everydaycounts/edc_5/index.cfm.

INTERNATIONAL

Mass Transit Systems Grow Globally

Urban mass transit systems have exploded worldwide, carrying a total of 53 billion passengers in the past year. Half of those passengers—nearly 26 billion—traveled on Asian transit systems. North American networks transported the fewest passengers—3.7 billion annually.

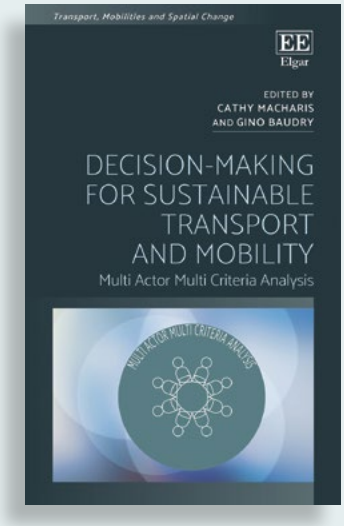
Photo: Patrick Rasenberg

Metro Uttam Nagar East station on the Delhi Metro's Blue Line in New Delhi, India.

A new research study from the International Association of Public Transport examined mass transit systems across 182 cities around the world to chart the growth and types of service and predict future trends. Research data focused on high-capacity urban rail systems.

Only one North American transit system (New York's subway) makes it into the top 10 busiest transit systems in the world. Many cities in the United States and Europe experienced a steep decline in ridership in the past year. In the past two years, 30 percent of newly constructed track comprised new metro systems in China, India, and Iran.

For more information, visit www.citylab.com/transportation/2018/09/the-global-mass-transit-revolution/570883/.



Decision-Making for Sustainable Transport and Mobility
Edited by Cathy Macharis and Gino Baudry. Edward Elgar Publishing, 2018; 256 pp.; $121.50; 978-1-78811-179-9.

The book presents Multi-Actor Multi-Criteria Analysis, also known as MAMCA. This application assists transportation, mobility, and logistics decision makers in incorporating stakeholder interests when deploying sustainability initiatives.

The title in this section is not a TRB publication. To order, contact the publisher listed.

TRB PUBLICATIONS

Systems Security, Resilience, and Emergency Management 2018
Transportation Research Record 2672, Issue 1

The vulnerability of the traffic control system to cyberattacks with falsified data, learning to build resilience into transportation systems, spatially clustered autonomous vehicle malware, and other topics are investigated in this issue.
2018; 208 pp. For more information, visit http://journals.sagepub.com/home/trr.

Climate Change and Decarbonization 2018
Transportation Research Record 2672, Issue 2

Topics explored in this issue include recent and future outlooks for nuisance flooding impacts on roadways on the East Coast, modeling the impacts of climatic extremes on the interregional freight-transportation system, and urban transportation mode choice and carbon emissions in Southeast Asia.
2018; 67 pp. For more information, visit http://journals.sagepub.com/home/trr.

Socioeconomic, Sustainability, Health, and Human Factors 2018
Transportation Research Record 2672, Issue 3

Authors present research on changes in individual economic activities and regional market structures caused by rural road improvements in Cambodia; the impact of major road supply on individual travel time expenditure; and a Toronto, Canada, case study on the role of spatial configuration in commuting trade-offs of two-worker households.
2018; 205 pp. For more information, visit http://journals.sagepub.com/home/trr.

Revenue and Economics 2018
Transportation Research Record 2672, Issue 4

Topics including 40 years of local option transportation sales taxes in California, the implication of replacing the federal and state fuel taxes with a national vehicle miles traveled tax, and a review of handback experience with public–private partnerships are examined in this issue.
2018; 89 pp. For more information, visit http://journals.sagepub.com/home/trr.

Finance and Pricing 2018
Transportation Research Record 2672, Issue 5

An econometric analysis of usage patterns of Hong Kong's cross-harbor tunnels, choice of high-occupancy toll lanes under alternative pricing strategies, and unexpected traveler response to pricing on managed lanes are addressed in this issue.
2018; For more information, visit http://journals.sagepub.com/home/trr.

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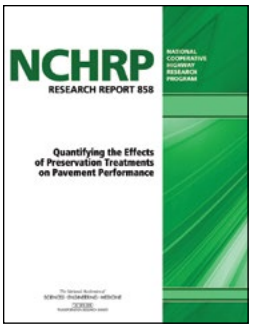


Quantifying the Effects of Preservation Treatments on Pavement Performance
NCHRP Research Report 858

Presented in this volume is a proposed framework that uses performance measures to quantify pavement performance changes: condition, service life, and life-cycle costs.
2018; 112 pp.; TRB affiliates, $55.50; nonaffiliates, $74. Subscriber categories: maintenance and preservation, materials, pavements.

Return on Investment in Transportation Asset Management Systems and Practices
NCHRP Research Report 866

This report explores how transportation agencies manage their transportation assets and provides guidance for evaluating the return on investment for adopting or expanding transportation asset management systems in an agency.
2018; 180 pp.; TRB affiliates, $66.75; nonaffiliates, $89. Subscriber categories: administration and management, economics, policy.

Guide to Creating and Sustaining a Culture of Innovation for Departments of Transportation
NCHRP Research Report 885

This report offers guidance to transportation agencies in assessing innovation, identifying adaptability, and sustaining responsiveness to evolving technology, workforce, and public priorities.
2018; 68 pp.; TRB affiliates, $48; nonaffiliates, $64. Subscriber categories: administration and management, education and training.

Field Evaluation of Reflected Noise from a Single Noise Barrier
NCHRP Research Report 886

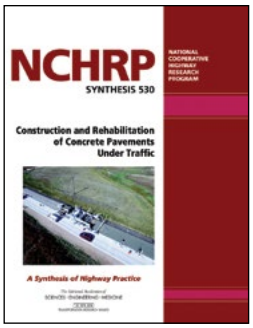
Reflected noise from sound-reflecting barriers and from barriers with a sound-absorptive surface are compared and analyzed. A barrier reflection screening tool and guide accompany the report.
2018; 432 pp.; TRB affiliates, $81; nonaffiliates, $108. Subscriber categories: design, environment.

Guidance for Underwater Installation of Filter Systems
NCHRP Research Report 887

Design procedures, material testing requirements, installation alternatives, and quality checklist items for granular and geotextile filters are examined in this report.
2018; 112 pp.; TRB affiliates, $55.50; nonaffiliates, $74. Subscriber categories: bridges and other structures, hydraulics and hydrology.

Using Recycled Asphalt Shingles with Warm-Mix Asphalt Technologies
NCHRP Research Report 890

This report documents the development of a design and evaluation procedure for asphalt mixtures incorporating warm-mix asphalt technologies and recycled asphalt shingles.
2018; 208 pp.; TRB affiliates, $68.25; nonaffiliates, $91. Subscriber categories: construction, design, materials, safety and human factors.



Construction and Rehabilitation of Concrete Pavements Under Traffic
NCHRP Synthesis 530

Presented are 16 case examples of construction and rehabilitation practices from projects representing a range of conditions and techniques.
2018; 92 pp.; TRB affiliates, $52.50; nonaffiliates, $70. Subscriber categories: highways, maintenance and preservation, pavements.

Using Existing Airport Management Systems to Manage Climate Risk
ACRP Research Report 188

This report identifies ways to reduce airport vulnerabilities to the present and future impacts of climate change, including extreme weather events. A quick-start guide helps airports focus on the most critical issues and a template helps practitioners apply the guide to their specific airport. A PowerPoint also is available.
2018; 64 pp.; TRB affiliates, $45; nonaffiliates, $60. Subscriber categories: aviation, environment, operations and management.

Design Considerations for Airport EOCs
ACRP Research Report 189

This report provides emergency operations center (EOC) design considerations—physical space, technology, function, operations, and governance—and includes lessons learned, a concept and development planning decision tree flow chart, as well as various checklists.
2018; 100 pp.; TRB affiliates, $52.50; nonaffiliates, $70. Subscriber categories: aviation, design, security and emergencies.

Common Performance Metrics for Airport Infrastructure and Operational Planning
ACRP Research Report 190

Presented in this report is information on how to interpret performance metrics that can be used for analysis among airports, airlines, and air traffic control. An interactive tool with information about specific performance metrics is included.
2018; 180 pp.; TRB affiliates, $66.75; nonaffiliates, $89. Subscriber categories: aviation, operations and traffic management, planning and forecasting.

A Primer to Prepare for the Connected Airport and the Internet of Things
ACRP Research Report 191

This report introduces the concept of the Internet of Things within the airport

environment to leverage current and emerging technologies.
2018; 86 pp.; TRB affiliates, $52.50; nonaffiliates, $70. Subscriber categories: aviation, data and information.

Strategies for Airports to Reduce Local Stormwater Utility Fees
ACRP Research Report 193
Presented is guidance for managing the stormwater-related utility fees that many local governments charge to help finance their capital and operating expenses.
2018; 88 pp.; TRB affiliates, $52.50; nonaffiliates, $70. Subscriber categories: aviation, environment, finance.

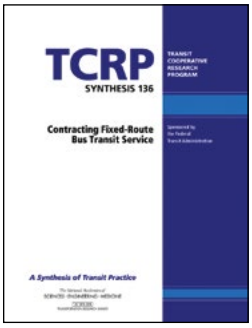
The Relationship Between Transit Asset Condition and Service Quality

TCRP Research Report 198
Accompanied by three Excel spreadsheet tools, this report offers a quantitative method for characterizing service quality and demonstrates how this measure varies with changes in asset condition.
2018; 116 pp.; TRB affiliates, $55.50; nonaffiliates, $74. Subscriber category: public transportation.

Contracting Commuter Rail Services, Volumes 1–2
TCRP Research Report 200
This two-volume report evaluates the advantages and disadvantages of potential approaches for commuter rail service. Volume 1 describes the primary functions of commuter rail delivery and summarizes the current trends for contracting rail service. Volume 2 describes the 31 commuter rails services in the United States and their various approaches.
2018; Volume 1: 186 pp.; TRB affiliates, $66.75; nonaffiliates, $89; Volume 2: 138 pp.; TRB affiliates, $58.50; nonaffiliates, $78. Subscriber categories: public transportation, railroads.

Understanding Changes in Demographics, Preferences, and Markets for Public Transportation
TCRP Research Report 201
This report explores how changes in demographics, traveler preferences, and markets for public transportation affect transit ridership.
2018; 92 pp.; TRB affiliates, $52.50; nonaffiliates, $70. Subscriber categories: planning and forecasting, public transportation.

Handbook for Examining the Effects of NEMT Brokerages on Transportation Coordination
TCRP Research Report 202
Explored in this report are the different models available to states for providing nonemergency medical transportation (NEMT) for Medicaid beneficiaries.
2018; 166 pp.; TRB affiliates, $62.25; nonaffiliates, $83. Subscriber categories: public transportation, passenger transportation.



Contracting Fixed-Route Bus Transit Service
TCRP Synthesis 136
This synthesis assists transit agencies in the decision-making process as they consider contracting fixed-route transit services instead of directly operating the service.
2018; 152 pp.; TRB affiliates, $62.25; nonaffiliates, $83. Subscriber categories: public transportation, administration and management.

To order the TRB titles described in Bookshelf, visit the TRB online bookstore, www.TRB.org/bookstore, or contact the Business Office at 202-334-3213.

TRB MEETINGS

March

10–15 Inaugural African Conference for Linear Infrastructure and Ecology*
Kruger National Park, South Africa

24–27 8th International Conference on Case Histories in Geotechnical Engineering*
Philadelphia, Pennsylvania

31–April 2 Lifesavers*
Louisville, Kentucky

April

7–9 14th National Light Rail and Streetcar Conference
Jersey City, New Jersey

9–10 Innovations in Freight Data Workshop
Irvine, California

15–17 International Conference on Demand Responsive and Innovative Transportation Services
Baltimore, Maryland

23–25 2nd International Intelligent Construction Technologies Group Conference*
Beijing, China

June

2–5 17th National Transportation Planning Applications Conference
Portland, Oregon

12–14 7th International Conference on Bituminous Mixtures and Pavements*
Thessaloniki, Greece

25–27 17th Biennial National Harbor Safety Committee Conference
Houston, Texas

July

20–25 58th Annual Workshop of Transportation Law
Cleveland, Ohio

22–24 Bridge Engineering Institute Conference 2019*
Honolulu, Hawaii

August

4–7 9th International Conference on Structural Health Monitoring of Intelligent Infrastructure*
St. Louis, Missouri

September

10–13 6th International Conference on Women's Issues in Transportation
Irvine, California

12–18 12th International Conference on Low-Volume Roads
Kalispell, Montana

15–19 Conference on Performance and Data in Transportation Decision Making
Atlanta, Georgia

29–Oct. 2 3rd International Conference on Information Technology in Geo-Engineering*
Guimaraes, Portugal

Additional information on TRB meetings, including calls for abstracts, meeting registration, and hotel reservations, is available at www.TRB.org/calendar, or by e-mail at TRBMeetings@nas.edu.

Upcoming Webinars

March

5 Leading Future Improvements in Transportation Safety*

6 The Renewal of Stormwater Systems Using Trenchless Technologies

12 Getting Served: Legalities and Risks of Airport Contractual Agreements

20 Energetic Value: The Design and Economics of Microgrids at Airports

21 Four Databases with a Common Goal: Promoting Transportation Research

25 Improved Analysis of Two-Lane Highway Capacity and Operational Performance

26 Waterborne Traffic Paint Application, Materials Selection, and Testing

27 One Federal Decision: Requirements and Tips for Achieving This Goal

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* TRB is cosponsor of the meeting.

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TR NEWS

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FEATURES are timely articles of interest to transportation professionals, including administrators, planners, researchers, and practitioners in government, academia, and industry. Articles are encouraged on innovations and state-of-the-art practices pertaining to transportation research and development in all modes (highways and bridges, public transit, aviation, rail, marine, and others, such as pipelines, bicycles, pedestrians, etc.) and in all subject areas (planning and administration, design, materials and construction, facility maintenance, traffic control, safety, security, logistics, geology, law, environmental concerns, energy, etc.). Manuscripts should be no longer than 3,000 words (12 double-spaced, typed pages). Authors also should provide charts or tables and high-quality photographic images with corresponding captions (see Submission Requirements). Prospective authors are encouraged to submit a summary or outline of a proposed article for preliminary review.

RESEARCH PAYS OFF highlights research projects, studies, demonstrations, and improved methods or processes that provide innovative, cost-effective solutions to important transportation-related problems in all modes, whether they pertain to improved transport of people and goods or provision of better facilities and equipment that permits such transport. Articles should describe cases in which the application of project findings has resulted in benefits to transportation agencies or to the public, or in which substantial benefits are expected. Articles (approximately 750 to 1,000 words) should delineate the problem, research, and benefits, and be accompanied by one or two illustrations that may improve a reader's understanding of the article.

NEWS BRIEFS are short (100- to 750-word) items of interest and usually are not attributed to an author. They may be either text or photographs or a combination of both. Line drawings, charts, or tables may be used where appropriate. Articles may be related to construction, administration, planning, design, operations, maintenance, research, legal matters, or applications of special interest. Articles involving brand names or names of manufacturers may be determined to be inappropriate; however, no endorsement by TRB is implied when such information appears. Foreign news articles should describe projects or methods that have universal instead of local application.

POINT OF VIEW is an occasional series of authored opinions on current transportation issues. Articles (1,000 to 2,000 words) may be submitted with appropriate, high-quality illustrations, and are subject to review and editing.

BOOKSHELF announces publications in the transportation field. Abstracts (100 to 200 words) should include title, author, publisher, address at which publication may be obtained, number of pages, price, and ISBN. Publishers are invited to submit copies of new publications for announcement.

LETTERS provide readers with the opportunity to comment on the information and views expressed in published articles, TRB activities, or transportation matters in general. All letters must be signed and contain constructive comments. Letters may be edited for style and space considerations.

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- ◆ All manuscripts should be supplied in 12-point type, double-spaced, in Microsoft Word, on a CD or as an e-mail attachment.
- ◆ Submit original artwork if possible. Glossy, high-quality black-and-white photographs, color photographs, and slides are acceptable. Digital continuous-tone images must be submitted as TIFF or JPEG files and must be at least 3 in. by 5 in. with a resolution of 300 dpi. A caption should be supplied for each graphic element.
- ◆ Use the units of measurement from the research described and provide conversions in parentheses, as appropriate. The International System of Units (SI), the updated version of the metric system, is preferred. In the text, the SI units should be followed, when appropriate, by the U.S. customary equivalent units in parentheses. In figures and tables, the base unit conversions should be provided in a footnote.

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