TR NEWS

November–December 2019 **NUMBER 324**

Climate Change Resilience

CRITICAL TRANSPORTATION ISSUE

PLUS

Short History of TRB

Insights from #TRBAM Twitter Hashtag

Transportation and Health in a Changing Climate

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TR NEWS

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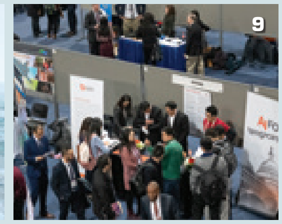

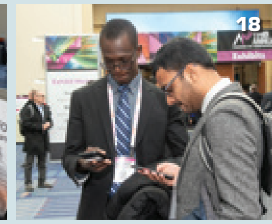

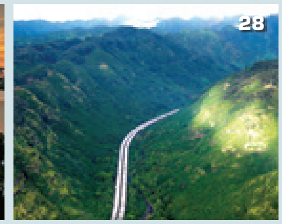

COVER Alaska DOT digs trenches to alleviate flooding along Dalton Highway north of Fairbanks. Climate change and its effects are critical challenges facing transportation and are addressed in this issue of *TR News*. (Photo: Alaska DOT)

Coming Next Issue

The January–February 2020 *TR News* features the annual overview of trends and developments in policy and practice at state departments of transportation and other agencies—particularly research needs, research in progress, and future directions—from the state partnership visits by TRB senior program officers in 2019. Other articles explore the 50th anniversary of the National Environmental Policy Act, the airport at the Burning Man festival in Nevada, and a history of rural public transportation.

Black Rock City airport, the temporary airport used for the annual Burning Man festival in the Nevada desert, in 2018.

Photo: Duncan Rawlinson

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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LETTER FROM THE *TR News* EDITORIAL BOARD

Dear *TR News* Reader,

On paper, 100 years seems like a big number. Just thinking of the achievements in the transportation industry over the past 100 years inspires awe. Even considering how far we have come, however, we still have far to go. In the 1920s, some of the first appointed state and local transportation professionals had to figure out how to accommodate new mobility technologies—primarily automobiles—in their communities. One hundred years later, we are still doing the same thing with even newer technologies—and we are still figuring things out, with the help of transportation experts like you participating in the Transportation Research Board.

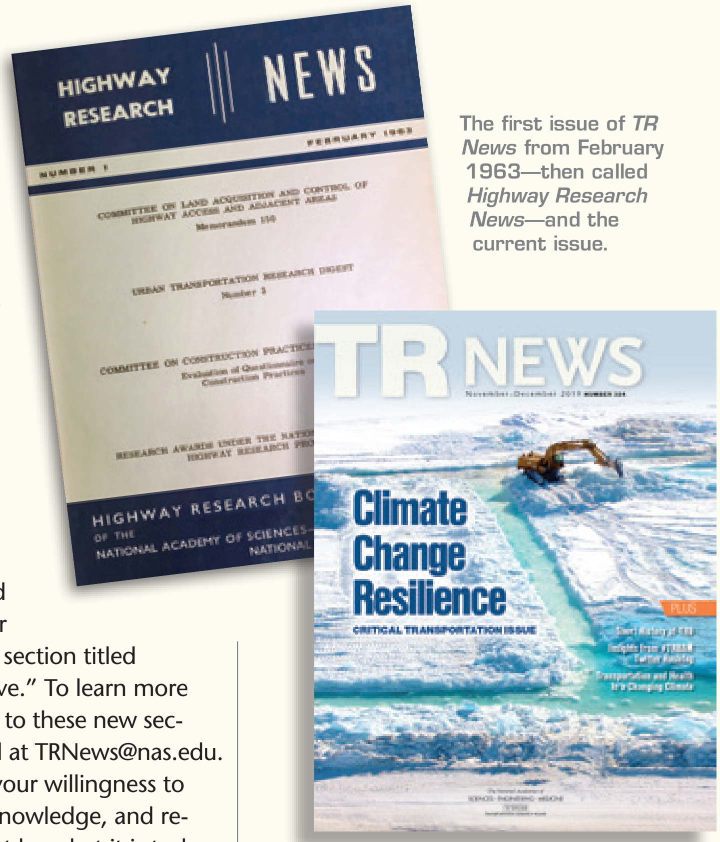
This issue includes a summary of a book that will be circulated to Annual Meeting attendees in January, which includes details and insights into TRB's 100 years of contributions to the transportation industry. We also are launching a new series that will run throughout our yearlong centennial celebration, highlighting stories from the volunteers who make TRB what it is and will become.

TR News began publishing in 1963 as a digest of recent TRB publications and industry issues. We still do this today, but we will continue to make it more interesting and accessible. We changed our look in the past year and now offer you the opportunity to receive this magazine electronically, through www.MyTRB.org.

Additionally, we will launch new sections of the magazine in the coming year to celebrate you—TRB's committee and panel members. We will introduce you to key "Transportation Influencers" involved with TRB's Young Members Council and will share recent career moves through a new section titled "Members on the Move." To learn more about or to contribute to these new sections, send us an email at TRNews@nas.edu.

Without you and your willingness to volunteer your time, knowledge, and resources, TRB would not be what it is today. We hope you will stay connected with TRB to see what the future brings and find ways to successfully transport us all forward.

Sincerely,
The *TR News* Editorial Board



The first issue of *TR News* from February 1963—then called *Highway Research News*—and the current issue.

We'd like to share your stories of what TRB has meant to you and your particular industry. If you would like to participate, please email a short write-up (approximately 250 words) and any supporting pictures to TRNews@nas.edu. With your permission, we will also share your stories through our Centennial website (www.TRB.org/Centennial), which contains additional information regarding TRB's history.

CRITICAL ISSUES IN TRANSPORTATION 2019

CLIMATE CHANGE RESILIENCE

Photo: Alaska DOT

VICKI ARROYO

The author is Executive Director, Georgetown Climate Center and Professor from Practice, Georgetown University Law Center, Washington, D.C., and 2019 TRB Executive Committee Chair.

Above: Alaska DOT conducts trenching work after devastating floods close 28 miles of Dalton Highway. More frequent extreme weather is a critical issue facing transportation, and federal, state, and local leadership—along with TRB—are working to share solutions.

The climate is rapidly changing, bringing more frequent and extreme floods, droughts, and heatwaves, along with stronger hurricanes and more intense wildfires. Each year brings new record-breaking weather extremes; in the first six months of 2019, for example, a record number of U.S. counties flooded. July 2019 was the hottest month ever recorded for the world as a whole (*1*). Climate change is also melting glaciers, reducing the amount of sea ice, and raising sea levels, bringing devastation to coastal areas. From Louisiana to Alaska, many coastal communities are forced to make difficult decisions about whether to relocate to less-vulnerable areas.

As detailed in the Fourth National Climate Assessment, these extremes pose serious threats to transportation systems, making it more difficult for these systems to provide the crucial services relied upon by individuals, communities, and other critical systems (*2*). There is an urgent need for decision-makers at all levels of government and in the private sector to better prepare transportation assets, systems, and workforces for a changing climate. In particular, decision-makers need better information, new tools, innovative best practices, and implementation assistance.

Last year, the Transportation Research Board (TRB) published a new edition of *Critical Issues in Transportation*, which identified climate change—and the need for resilience—as one of the critical issues now facing transportation (*3*). *Critical Issues 2019* poses several key questions: how best to use climate information to improve risk-based decision-making; how to communicate adaptation successes from states and localities; how to build flexibility and adaptability into policies, designs, and standards; how to make the business case for adaptation; and how to facilitate managed retreat and discourage risky investments.

This article describes current work on building resilience to climate change impacts in which states and cities are often

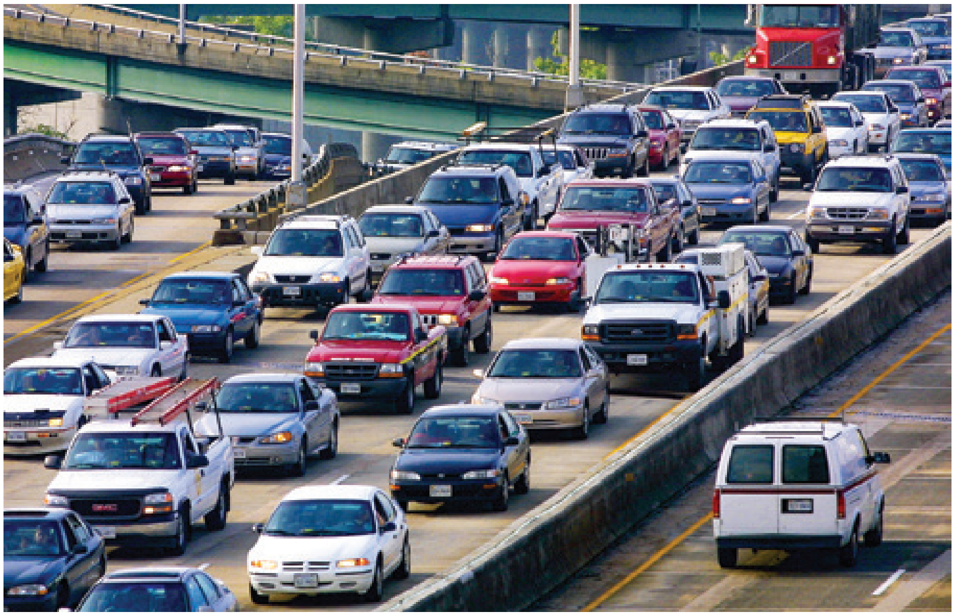


Photo: Virginia DOT

Transportation is vulnerable to climate change, but it also is the largest contributor to the emissions that worsen climate change.

leading the way. It is also important to point out that, in addition to being vulnerable to climate impacts, transportation is now the largest source of greenhouse gas emissions that contribute to climate change. Therefore, immediate action is required to reduce emissions too, with states taking the lead on this work as well.

Federal, State, and Local Action

At the federal, state, and local levels, many transportation agencies have been working to understand climate change's impacts to their systems and to integrate these findings into decision-making processes. As suggested in *Critical Issues 2019*, these experiences should be evaluated and shared to foster a common understanding of how climate change affects transportation systems and what can be done about it.

Federal Activities

FEDERAL HIGHWAY ADMINISTRATION

For more than a decade, the Federal Highway Administration (FHWA) has led efforts to improve the collective understanding of climate change impacts to surface transportation and to develop tools and methodologies that can inform decision-making. FHWA's primary roles have been to support states and regions, to build resources and tools that are informed by lessons from the states, and to accelerate innovation by supporting research pilots.

FHWA has funded five rounds of pilot projects that have allowed state departments of transportation (DOTs) and metropolitan planning organizations (MPOs) across the country to assess and map climate and extreme weather-related vulnerabilities, to evaluate adaptation options (including nature-based options in coastal areas), and to integrate resilience into asset management processes. FHWA has also funded other projects and studies over the years, including the Gulf Coast Study, which evaluated vulnerabilities of transportation infrastructure in the Gulf Coast region; the Transportation Engineering Approaches to Climate Resiliency project, which identified methods for different engineering disciplines to integrate climate considerations into project development within different engineering disciplines; and the Hurricane Sandy Follow-Up Study, which assessed impacts from Sandy and climate-related vulnerabilities to assets in the New York area and identified adaptation strategies. Informed by these pilot projects and research efforts, FHWA has developed an adaptation decision-making framework and a range of complementary tools and guidance documents.[1]

FEDERAL TRANSIT ADMINISTRATION

Other modal administrations within U.S. DOT have contributed to the collective knowledge on climate change effects in the transportation sector as well. For example, the Federal Transit Administration (FTA) report *Flooded Bus Barns and Buckled Rails* documents current and anticipated climate impacts to public transportation systems and assets and transit agencies' efforts to adapt their infrastructure to those impacts (*4*). In 2011, FTA funded pilot projects for transit agencies in seven regions to help

[1] For more information on FHWA's resilience-related work, see www.fhwa.dot.gov/environment/sustainability/resilience.

Photo: Paul Meeker, National Guard

Flooding from a rainstorm crippled Louisiana in 2016. FHWA has funded a study to examine vulnerabilities to transportation infrastructure in the Gulf Coast region.

Photo: Metropolitan Transportation Authority, Flickr

Engineers repair rail in New York after Hurricane Sandy.

them analyze risks and, in some cases, develop adaptation strategies (*5*). After Hurricane Sandy, FTA used a portion of its disaster recovery funding to administer a competitive resilience grant program.

State Leadership

States have led the way in preparing their transportation systems for climate change, modifying their transportation planning and programming processes and integrating resilience considerations into state legislation, executive orders, and agency policies. For example, California passed legislation in 2016 requiring the development of a Climate-Safe Infrastructure Working Group to recommend methods to integrate climate science into state project engineering.

In New York, the 2014 Community Risk and Resiliency Act mainstreamed considerations of climate change into state investment decision-making. This included adoption of official statewide sea-level rise projections and development of new criteria for evaluating public infrastructure projects that consider sea-level rise, storm surge, and flood risk mitigation.

Since 2009, Washington State DOT's environmental review process has incorporated guidance for evaluating climate change impacts to transportation projects; more recently, the agency also developed guidance for integrating climate resilience into transportation planning. Washington State DOT also has developed a Community Planning Portal that provides a variety of data for transportation planning purposes.

Other states have begun to assess climate change impacts to their transportation systems and to identify viable adaptation strategies for the future. These efforts have taken the form of preliminary studies and literature reviews (Arizona DOT); transportation vulnerability assessments (Rhode Island DOT); standalone transportation adaptation plans (Oregon DOT and District DOT in Washington, D.C.); and infrastructure chapters in multisectoral, statewide adaptation plans (Pennsylvania).

Local Leadership

Municipalities and regional agencies (MPOs, port authorities, and other agencies) are engaged in adaptation planning, capturing best practices, and developing policies integrating resilience considerations into decision-making. For example, MPOs in Chattanooga, Tennessee; Boston, Massachusetts; and Charlotte County, Florida, have made strides integrating climate resilience into their planning efforts.

Some local governments are incorporating risk mitigation and resilience into project design and other policies and requirements related to infrastructure investment decisions. For example, Broward County, Florida, passed an ordinance requiring the use of "future conditions" maps, which consider sea-level rise effects on the groundwater table, when making decisions to approve drainage or water-management infrastructure projects.

New York City has adopted and updated climate resiliency design guidelines to account for climate-change projections and impacts in the design of city capital projects. San Francisco, California, developed guidance in 2014 for considering sea-level rise in the capital planning process. Communities across the country are also implementing green infrastructure programs to help manage the increasing rainfall- and stormwater-driven flooding often associated with climate change.

TRB's Role in Advancing Transportation Resilience

TRB has been working for more than a decade to advance the transportation community's understanding of how climate change and extreme weather affect this critical sector and how decision-makers can create assets, systems, and processes that are more resilient. As the leading research institution on transportation in

Photo: Washington State DOT

As part of its environmental impact plan, Washington State DOT is exploring options for modifying ferry terminals to adapt to rising sea levels.

Photo: Lawrence G. Miller, Flickr

Chattanooga, Tennessee, and other cities have integrated electric buses into their fleets in response to climate resilience goals.

the United States, TRB plays a vital role in the field of climate resilience and climate change research through its convening, research, and communications activities.

TRB's Executive Committee convened two separate task forces focused on resilience—with the second also focused on sustainability issues more broadly—which developed recommendations on research gaps and strategic actions that TRB could take to further its work in this field.[2] TRB's recently updated 5-year strategic plan was informed by the recommendations of these resilience task forces as well as the needs identified in *Critical Issues 2019*.

In addition, a wide range of National Cooperative Highway Research Program (NCHRP) projects and publications have led to development of information about climate change impacts to transportation, best practices for adaptation, and ways to improve decision-making to reduce risk. These include the ongoing efforts to produce a resilience primer for state DOT CEOs [NCHRP Project 20-59(55)], a research roadmap focused on resilience and implementation [NCHRP Project 20-59(54)], and support tools for state DOTs to facilitate and accelerate the use of existing resilience research and deployment of resilience practices (NCHRP Project 20-117).

Various committees within the Technical Activities Division have promoted research in this area by identifying resilience research needs and sharing research results. The TRB Special Task Force on Climate Change and Energy has helped to coordinate committee activities related to climate change, including resilience-related work.[3]

TRB also elevated the topic of transportation resilience through convening activities and by including resilience as a "hot topic" at recent Annual Meetings. TRB cosponsored the First International Conference on Surface Transportation System Resilience to Climate Change and Extreme Weather Events in 2015, as well as an international exchange in Brussels, Belgium, among experts on transportation resilience in 2016.

In 2018, TRB sponsored the Transportation–Resilience Innovations Summit and Exchange in Denver, Colorado. Building on these activities, TRB cosponsored the Second International Conference on Surface Transportation System Resilience to Natural Hazards and Extreme Weather Events in November, also called TR2019. The conference focused on new developments in transportation resilience to climate change and extreme weather and identified future needs to promote implementation of resilience policies and practices and create and foster a culture of resilience within transportation agencies.

Future Directions for Resilience Research

Although some agencies, states, and academic institutions are developing tools and expertise to evaluate future impacts and prepare systems, many informational, legal, financial, and institutional barriers remain—as do many questions.

There still are more questions than answers on how to align land use, development, and transportation policies and investments with the necessary adaptation strategies. For example: how can communities best implement managed retreat from flood-prone areas? How can solutions be designed and managed to

[2] See, for example, *TRB Executive Resilience and Sustainability Task Force Summary Report for TRB Executive Committee*, May 2018, pp. 54–60. http://onlinepubs.trb.org/onlinepubs/excomm/18-06-AgendaBook.pdf.

[3] For more information, see www.mytrb.org/OnlineDirectory/Committee/Details/3465.

prevent cascading failures from extreme events? How can agencies ensure that resilience solutions advance sustainable and equitable outcomes and address other critical issues?

TRB can play a crucial role in answering these questions, and partners like the American Association of State Highway and Transportation Officials (AASHTO) and the Georgetown Climate Center (see sidebar below) can share best practices and provide forums for regular peer exchange to inform practitioners, reduce barriers, and promote solutions. TRB and AASHTO have provided important support to state DOTs by sponsoring workshops and other events, developing reports and case studies, and hosting a 2018 webinar series on current resilience issues facing state DOTs.

With changes already under way and accelerating, transportation officials at all levels of government and the partners who serve them have important roles to play in promoting a transition to a more resilient, sustainable, and equitable system—and must act quickly.

Photo: North Carolina DOT, Flickr

Storm surges and flooding from Hurricane Sandy caused a main thoroughfare through North Carolina's Outer Banks to buckle.

Georgetown Climate Center

The nonpartisan Georgetown Climate Center (GCC) seeks to advance effective climate and energy policies in the United States and serves as a resource to states and communities working to cut carbon pollution and prepare for climate change. GCC works with states to develop innovative policies that reduce emissions from energy and transportation sectors and that help communities adapt to the impacts of climate change.

For example, GCC facilitates the Transportation and Climate Initiative, a regional collaboration of 13 Northeast and Mid-Atlantic states and the District of Columbia that seeks to improve transportation, develop the clean energy economy, and reduce carbon emissions from the transportation sector. GCC's Adaptation Program helps states and communities prepare for climate change impacts, works to integrate adaptation and resilience planning into all levels of government decision-making, and maintains the Adaptation Clearinghouse, a state-of-the-art database of resources for communities, policymakers, and adaptation professionals. The Clearinghouse has hundreds of entries featuring communities acting on transportation resilience, stormwater management, coastal adaptation, and more.

For more information, visit www.georgetownclimate.org.

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EVERYONE INTERESTED IS INVITED: A Short History of TRB

Photo: Risdon Photography

SARAH JO PETERSON

The author is Principal, 23 Urban Strategies, Washington, D.C. This article is adapted from *The Transportation Research Board, 1920–2020: Everyone Interested Is Invited*, to be published by the National Academies Press in January 2020.

Above: TRB's Annual Meeting draws transportation researchers, practitioners, policy-makers, and others from around the world.

When setting out to write a history of TRB in honor of its centennial, I quickly learned that TRB is many things to many people. More than once, I heard people refer to the parable of the blindfolded men and the elephant: gleaning only what they can detect through briefly touching the animal, each person describes something completely different. TRB, of course, is the elephant.

For some, TRB is an annual professional conference: a great event for networking and keeping up-to-date in their fields and a healthy environment to invite others to engage with their research. For others, TRB is their standing technical committee: a community for support and contribution to the advancement of the field through research needs statements, calls for papers, or specialty conferences.

For practitioners, TRB is the unseen force behind reports and webinars that seem to just appear, ready to assist with a new task or a problem to solve. For those in search of policy-related advice, TRB is

TRB's committees and panels convene transportation experts from a range of backgrounds and professions.

TABLE 1 Key Events in TRB's History

1863	Congress charters the National Academy of Sciences (NAS)
1916	NAS organizes the National Research Council (NRC) to serve the federal government during World War I
1920	Nov. 11: NRC's Division of Engineering and the federal Bureau of Public Roads (BPR) convene the organizing meeting for the Advisory Board on Highway Research
1921	William K. Hatt becomes the Board's first director
1922	First Annual Meeting of the Board is held in January
1924	Charles M. Upham becomes the Board's second director
1925	Jan. 1: Board changes its name to the Highway Research Board (HRB)
1928	Roy W. Crum becomes HRB's third director
1935	HRB organizes its technical committees into departments
1936	Congress funds studies of highway safety, co-managed by HRB and BPR
1944	Federal-Aid Highway Act authorizes a National System of Interstate Highways and authorizes states to spend federal aid on research
1945	HRB launches the Research Correlation Service, funded by the states
1948	American Association of State Highway Officials (AASHO) adopts procedures for states to pool funds for research projects to be administered by HRB
1951	Fred Burggraf becomes HRB's fourth director
1955	AASHO requests that HRB administer the AASHO Road Test
1956	Federal-Aid Highway Act accelerates funding for the National System of Interstate and Defense Highways and expands the AASHO Road Test
1956	HRB launches the Highway Laws Project, with funding from the Automotive Safety Foundation and AASHO
1962	National Cooperative Highway Research Program is established by agreement with AASHO, BPR, and NAS
1964	National Academy of Engineering is organized
1964	D. Grant Mickle becomes HRB's fifth executive director
1966	William N. Carey becomes HRB's sixth executive director
1967	HRB rebrands the Research Correlation Service as the Technical Activities Division
1969	NRC approves a new purpose and scope for HRB that officially includes urban transportation
1970	HRB reorganizes its technical committees into groups defined by transportation system phases
1971	Urban Mass Transportation Administration becomes an HRB sponsor
1974	March 9: Highway Research Board dissolves and the Transportation Research Board (TRB) is born
1977	New TRB sponsors include the Maritime Administration, the Association of American Railroads, and the U.S. DOT's Office of the Secretary, Federal Railroad Administration, Federal Aviation Administration (FAA), and National Highway Traffic Safety Administration
1980	Thomas B. Deen becomes TRB's seventh executive director
1982	TRB takes on the responsibility for policy (consensus) studies
1987	Congress authorizes the Strategic Highway Research Program
1991	Congress authorizes the Transit Cooperative Research Program, to be sponsored by the Federal Transit Administration
1994	Robert E. Skinner, Jr., becomes TRB's eighth executive director
1999	Marine Board joins TRB
2003	Congress authorizes the Airport Cooperative Research Program, to be sponsored by FAA
2003	TRB's standing technical committees reorganize into 11 groups representing modes and system functions
2005	Congress authorizes the second Strategic Highway Research Program
2015	Neil J. Pedersen becomes TRB's ninth executive director
2021	Jan. 24–28: TRB celebrates its 100th Annual Meeting

one of many areas of expertise within the National Academies of Sciences, Engineering, and Medicine that can provide service via consensus study.

For governments, TRB is a trusted institution through which to fund large-scale and continuing research programs. For researchers, TRB is the manager of contracts for compelling work. For officials and administrators, TRB is a community that supports conferring with the best minds before making decisions affecting the travel of millions.

After examining how people and institutions created today's TRB, I concluded that TRB can be best understood as an infrastructure—one that people purposely designed, carefully constructed, and devotedly maintained to share and strengthen knowledge about transportation.

Deep Foundations

The core missions and structures that underpin today's TRB predate its birth. In 1863, Congress chartered the independent National Academy of Sciences (NAS) to advise government upon request. NAS's founders responded to their first federal requests by forming committees, setting the precedent that the expertise required to advise government is found not in the individual but in a group acting collectively. According to the original charter, appointees to the National Academies' committees serve without payment.

In 1879, following the recommendation of an NAS committee, Congress established the U.S. Geological Survey in the Department of the Interior. After this notable success, advising government on its research programs became a continuing activity, including through longstanding committees administered by TRB.

In the 1880s, NAS members conducted a wrenching internal debate over the centralization of science. In the end, the proponents of decentralization won: the National Academies encourages research in the federal government but also in universities, industry, and state and local governments.

NAS leaders founded the National Research Council (NRC) to support the federal government during World War I,

Photo courtesy Ohio State University

Ohio State University researchers examine driver behavior, circa 1960. Early debates concerned the centralization—or decentralization—of research.

and on May 11, 1918, President Woodrow Wilson issued an executive order establishing a continuing, peacetime mission for the council. NRC's first duty was "to stimulate research" in the sciences and "in the application of these sciences . . . with the object of increasing knowledge, of strengthening the national defense, and of contributing in other ways to the public welfare." By the end of 1919, NRC had launched approximately 80 committees, with more than 1,000 participants, and had approved a proposal for six committees grouped under an Advisory Board for Highway Research.

The Problem of Highways

When the organizing conference for NRC's new board on highways convened on November 11, 1920, attendees saw an immense set of problems. The country had agreed that good roads were important in ameliorating rural isolation, and Congress had funneled $75 million to state highway agencies in the Federal Aid Road Act of 1916. In 1919, Congress added another $200 million. Nearly 10 million motor vehicles plied America's roads in 1920, a number that would more than double by 1925.

In addition, World War I had proved that it was feasible to move freight long distances by truck—but to highway builders' dismay, new roads crumbled from the use of heavy vehicles. How were road builders to make decisions about planning, financing, and constructing highways that could withstand the punishing forces of trucks? Should they also ensure that narrow lanes, tight curves, and steep climbs did not inhibit the speed of freight movement? At what cost? The economics of highway building and trucking would be a significant area of concern for decades to come.

TRB's founders understood that highways epitomized a central conundrum that affects all types of transportation to some degree. Strictly speaking, highways are not a mode of transport—they are a type of infrastructure. Moreover, highways, motor vehicles, and freight movement—although deeply interdependent—also are three separate industries. Even more decentralized is the use of roads and vehicles for personal travel.

TRB's founders purposely created an organization that brought experts from academia together with the different industries, organizations, and government agencies connected to roads and highways (see box below). The founders believed that a cooperative approach to stimulating research would help them achieve some degree of voluntary coordination. In addition, sharing research gave the interdependent industries a way to see into each other's future.

After embarking on its first research contract—a study of reinforced concrete funded by private industry—the board rechristened itself the Highway Research Board (HRB) in 1925.

Reflecting its cross-industry cooperative approach to research, HRB was originally organized as a federation of member organizations under the NRC umbrella. Although it became a unit formally appointed by NRC in 1962, the Board used its history as a gathering place for all industries, disciplines, and professions related to transportation to great advantage as it transitioned in the 1970s from highways to what was called "total transportation," including urban transportation and rail, aviation, and marine transportation.

Photo: Missouri DOT

Because of the interdependent nature of such industries as highways, motor vehicles, and freight, TRB's founders wanted to create an organization with a cooperative research approach.

Open Invitation

In 1928, HRB's leaders broke with the National Academy's usual procedure of inviting top experts and leaders to attend the annual meeting of the Board and its technical committees and instead invited "everyone interested." Moreover, HRB leaders wrote to state governments and

Ridge Route Highway cuts through the Tehachapi Mountains, 1920. As trucks began moving freight, road builders had to consider if narrow lanes, steep climbs, and tight curves inhibited freight movement.

MEMBER ORGANIZATIONS

ADVISORY BOARD ON HIGHWAY RESEARCH

Division of Engineering, National Research Council

First Annual Meeting, January 16, 1922

American Association of State Highway Officials
American Concrete Institute
American Institute of Consulting Engineers
American Society of Civil Engineers
American Society of Mechanical Engineers
American Society for Municipal Improvements
American Society for Testing Materials
Association of American State Geologists
Bureau of Public Roads (U.S. Dept. of Agriculture)
Engineering Foundation
National Automobile Chamber of Commerce
National Highway Traffic Association
Society of Automotive Engineers
U.S. Army Corps of Engineers
Western Society of Engineers

SOURCE: Minutes, January 16, 1922, TRB Executive Committee Meeting Minutes Record Group, NAS–NRC Archives.

Photo: Risdon Photography

New attendees gather at TRB's 2019 Annual Meeting.

universities asking them to send anyone involved in highway research to the next meeting in Washington, D.C. This invitation built on a culture that already valued a broad definition of expertise and the ability to contribute to research. From the beginning, the Board's technical committees included researchers, practitioners, and administrators from all over the United States.

Today, the meetings of TRB's roughly 200 standing technical committees still are open to everyone who is interested. Although the number of appointed members of standing technical committees are limited to a few dozen, friends of a standing technical committee may range in number from tens to hundreds. Friends—an organic innovation prominent enough to have reached TRB's *Annual Report* by 1997—may participate in most of a standing technical committee's activities.

"Everyone" also included students and young researchers. For decades, HRB excitedly tracked how many Annual Meeting attendees were first-time presenters. The number was typically around half of all presenters. By midcentury, the January road trip to Washington—by car, recreation vehicle, or chartered bus—was a well-established rite of passage for young researchers. The Annual Meeting has also become a major gathering for awardees of the Dwight David Eisenhower Transportation Fellowship Program, administered by the Federal Highway Administration (FHWA). In addition, the TRB Minority Student Fellows Program, launched in 2009, encourages students, under the guidance of a faculty mentor, to present their research at the Annual Meeting.

The open invitation in 1928 also set the stage for the modern conference and convention functions at the TRB Annual Meeting—the lectern sessions, poster sessions, receptions, and exhibit halls. The January meeting now regularly tops 13,000 attendees from all over the world.

Partnerships with States

During the 1930s, HRB added the identification of research needs to the responsibilities of its technical committees. This established that the selection and promotion of research priorities should also be a collective, cooperative task.

Although the federal Bureau of Public Roads (BPR) was HRB's largest single financial sponsor during its first two decades, the states stepped up in a big way starting in the 1940s. Frustrated with the limits of an organization essentially run by volunteers, in 1944 the state highway departments, working through the American Association of State Highway Officials (AASHO), arranged for legislation allowing federal-aid dollars to be spent on research. State officials then worked with HRB to develop a sponsorship arrangement for the Research Correlation Service, which funded professional staff for HRB's technical committees and for research communications. The sponsorship model that the states pioneered for highways proved foundational for TRB's modal expansion in the 1970s and 1980s and continues to support sponsor relationships with many

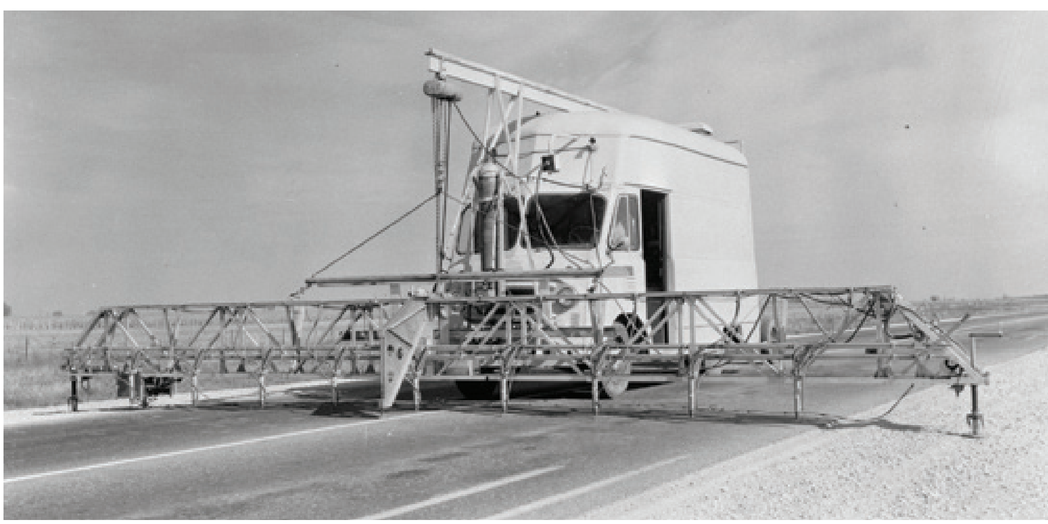


Photo: FHWA

From 1956 to 1962, AASHO conducted a $27 million road test, pioneering modern methods for researching pavement design.

federal agencies and industry organizations. TRB's Technical Activities Division is a direct descendant of the Research Correlation Service.

In 1948, AASHO and HRB negotiated a cooperative research arrangement that was deployed during the 1950s for a series of road tests, culminating in the $27 million AASHO Road Test that ran from 1956 to 1962. Although the road tests aimed at optimizing highways for freight movement and tax revenue from trucking, they produced their biggest impacts in pioneering modern statistical methods for researching pavement design.

Photo: Roger Puta

In the 1960s, transportation research expanded from highways to include urban movement.

Broadening the Scope

AASHO and the Automotive Safety Foundation began supporting studies of highway law in the 1950s, bringing legal research under the HRB's purview. The Automotive Safety Foundation also funded early efforts tackling urban transportation. The Board experimented with different models for conducting these studies. For the laws project, HRB hired additional staff but contracted with experts at universities for the urban research.

Innovations from the 1930s to the 1950s prepared the way for the three-party agreement signed by NAS, AASHO, and BPR in 1962 that founded the National Cooperative Highway Research Program (NCHRP).

Congress had provided the urgency for NCHRP in the massive construction boost it gave to the Interstate Highway System in 1956. In response, HRB staff, technical committees, and state highway officials worked together to produce *HRB Special Report 55: Highway Research in the United States: Needs, Expenditures and Applications* in 1960, which outlined a research program that they then transformed into NCHRP. AASHO selected NCHRP's annual slate of projects, as it had done for the highway laws project; HRB managed research conducted by outside contractors, similarly to its urban research; and states collectively funded the research, as they had done for the AASHO Road Test. In addition to the traditional highway design, materials, construction, finance, management, and maintenance topics, highway law and urban transportation were also part of the new research program.

In 1969, HRB formally expanded its scope to include urban transportation, and the federal Urban Mass Transportation Administration (UMTA) became a sponsor in 1971. It was a time of renewed emphasis on engineering and significant activism related to transportation—including many freeway revolts in urban areas. The National Academy of Engineering had formed within NAS in 1964, and Congress had created the U.S. Department of Transportation (DOT) in 1967. Whether the National Academies should also have a unit with the comprehensive perspective of "total transportation" led to considerable—sometimes heated—debate within the National Academies, federal agencies, and state governments.

In the end, the Board followed its state partners. AASHO became the American Association of State Highway and Transportation Officials (AASHTO) in November 1973; subsequently, the National Academies dissolved HRB and formed the Transportation Research Board on March 9, 1974.

As it had done for urban transportation, the new TRB set out to show rail and aviation interests what it had to offer, in hopes of earning their sponsorship too. The National Academies already had a Maritime Transportation Research Board (see sidebar, page 15). TRB created technical committees, recruited participants, and held conferences and workshops dedicated to specific problems or general research needs. It also arranged to include new modes and emerging topics, such as safety and environmental issues, in TRB's transportation research information system. Developed during the 1960s, this cutting-edge computerized database is the origin of today's TRID, an integrated database of 1.2 million records of transportation research.[1]

By the end of the 1970s, new sponsors included the Association of American Railroads; the Maritime Administration; and U.S. DOT's Office of the Secretary, Federal Railroad Administration, Federal Aviation Administration (FAA), and National Highway Traffic Safety Administration (NHTSA). In addition, a 3-year grant from the U.S. Agency for International Development enabled TRB to develop its first significant international program, on low-volume roads.

[1] To access TRID, visit https://trid.trb.org.

The Lost History of the Marine Board

When the Marine Board joined TRB in 1999, the National Academies introduced it to TRB audiences with a little history in that year's *Annual Report*: the Marine Board dated back to 1965, to a Committee on Ocean Engineering. Among the Marine Board's prominent studies during the 1990s was a series on ship hull design in the wake of the *Exxon Valdez* disaster and a major study on controlling garbage and plastic waste in the oceans.

This illustrious legacy, however, was really only part of a much longer history that had been lost during organizational shifts inside the National Academies.

In 1982, the Marine Board merged with an older board, the Maritime Transportation Research Board. This latter board, formed in 1961, was itself the culmination of a dozen studies produced during the 1950s and early 1960s under the guidance of the Maritime Cargo Transportation Conference. Under a contract with the Office of Naval Research and at the request of the U.S. Departments of Defense and Commerce, the Conference was dedicated to the study of what they called the "unitization" of cargo in "transporters." Today, we call this containerization.

The Conference formed in 1953, 3 years before the first commercial application of containerization, and focused on economic studies of shipping, including reducing ship turnaround times at ports and safety in the stevedore industry. (At the time, the word "conference" meant a group that meets and coordinates efforts around a problem or issue.)

Photo: National Oceanic and Atmospheric Administration

When the Highway Research Board transformed into the Transportation Research Board, it began to incorporate rail and aviation and, eventually, the Maritime Transportation Research Board, which already was a part of NAS.

One could even argue that the ancestors of today's Marine Board and the Marine Group in TRB's Technical Activities Division date to the founding of the National Academy of Sciences in 1863. Two studies requested by the U.S. Navy that year examined ironclad ships, and a third study set standards for publishing technical information related to nautical charts.

Transportation, it turns out, has always been part of the National Academies.

Consensus Studies

In 1982, TRB formally expanded its capacity to manage the process that the National Academies uses to advise the federal government and others. HRB had produced studies for Congress in earlier decades. In the 1930s, HRB and BPR had co-managed a series of congressionally funded studies on traffic safety. HRB also had integrated directions from Congress into the AASHO Road Test.

During the 1970s, however, the National Academies reformed the process for producing policy advice. They incorporated peer review and adopted rules designed to avoid conflicts of interest and balance biases among committee appointees as well as to ensure appropriate representation of a variety of disciplinary and professional perspectives. Today, these studies are aptly called consensus studies.

Since 1982, TRB has produced more than 100 consensus studies on all modes and on a broad range of topics, with final reports ranging in length from a short letter to multiple volumes. Major pieces of federal transportation legislation typically contain congressional requests for studies. Federal agencies also have come to TRB for everything from highly technical analyses to broad policy assessments.

TRB also has pursued self-initiated consensus studies. For these, TRB can follow one of three funding paths: external sponsorship alone, pooled sponsorship with TRB funding, or solely TRB-funded. Most self-initiated studies have required at least some TRB funding, and TRB discovered that pooled sponsorship, if possible, was usually the most desirable route for a self-initiated study. Broader sponsorship, especially from those with authority to advance a study's recommendations, maximized the potential for impact.

Photo: Oregon DOT

Superpave® asphalt design was one of the important accomplishments of the Strategic Highway Research Program.

Strategic Approach to Research

TRB's first policy study was self-initiated in partnership with AASHTO and funded by FHWA. Published in 1984, *Special Report 202: America's Highways—Accelerating the Search for Innovation* not only led to the first Strategic Highway Research Program (SHRP) but also created a model that has since been used to outline and develop support for additional major research programs.

America's Highways made the case for a large, highly targeted program of research to improve highways. It also presented different institutional approaches to managing the research. Congress funded the $150 million, 5-year program in 1987, and the National Academies created a separate unit to manage the program. The Superpave® asphalt pavement design system was only one of SHRP's many accomplishments.

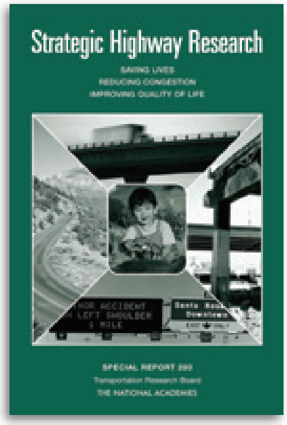
Even before SHRP got under way, TRB was leading another consensus study for strategic transportation research. UMTA sponsored the yearlong study that produced *Special Report 213: Research for Public Transit—New Directions* in 1987. Instead of a big, short-term research program, the report recommended a Transit Cooperative Research Program (TCRP) modeled after NCHRP. Congress authorized TCRP in 1991, and the American Public Transportation Association (APTA) became a TRB sponsor. TRB manages TCRP for the Federal Transit Administration and APTA; annual program budgets have fluctuated between $5 and $10 million.

After decades of interest within the aviation industry, Congress requested a consensus study outlining an airport research program in 2000. The legislation specifi-

Photo: Thomas Hawk, Flickr

In 1991, Congress authorized the Transit Cooperative Research Program, a transit-centered program modeled after the highway research program.

cally directed the study to evaluate the applicability of NCHRP and TCRP, and the 2003 *Special Report 272: Airport Research Needs—Cooperative Solutions* emphasized that airport operators should be directly involved in every phase of such a research program. Congress authorized the Airport Cooperative Research Program (ACRP) in 2003. Sponsored by FAA and funded today at $15 million annually, ACRP follows the NCHRP and TCRP model and produces solutions to practical problems.



The cooperative research program model, in which industry members select annual research programs and guide the research process, also has been deployed for shorter-term programs producing practical solutions for freight and hazardous materials transportation and commercial truck and bus safety. A new cooperative research program on behavioral traffic safety launched in 2017.

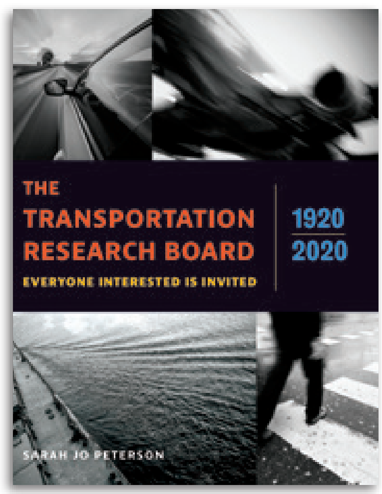
NCHRP continues too. Celebrating its 50th anniversary in 2012 and currently funded at nearly $42 million annually, the program remains true to its founders' vision. One of its unanticipated uses, however, has been helping plan and implement the first and second Strategic Highway Research Programs.

In 1998, Congress requested a consensus study for a future strategic highway research program. This resulted in the 2001 publication *Special Report 260: Strategic Highway Research—Saving Lives, Reducing Congestion, Improving Quality of Life*. The report outlined a research program built around four goals: accelerating the renewal of America's highways; making a significant improvement in highway safety; providing a highway system with reliable travel times; and providing highway capacity in support of the nation's economic, environmental, and social goals. Congress authorized SHRP 2 in 2005; the legislation referenced the consensus study by name and summarized the four goals. In operation from 2006 to 2015, SHRP 2 received $217 million in funding and produced 130 promising products.

Leaders, Volunteers, and Staff

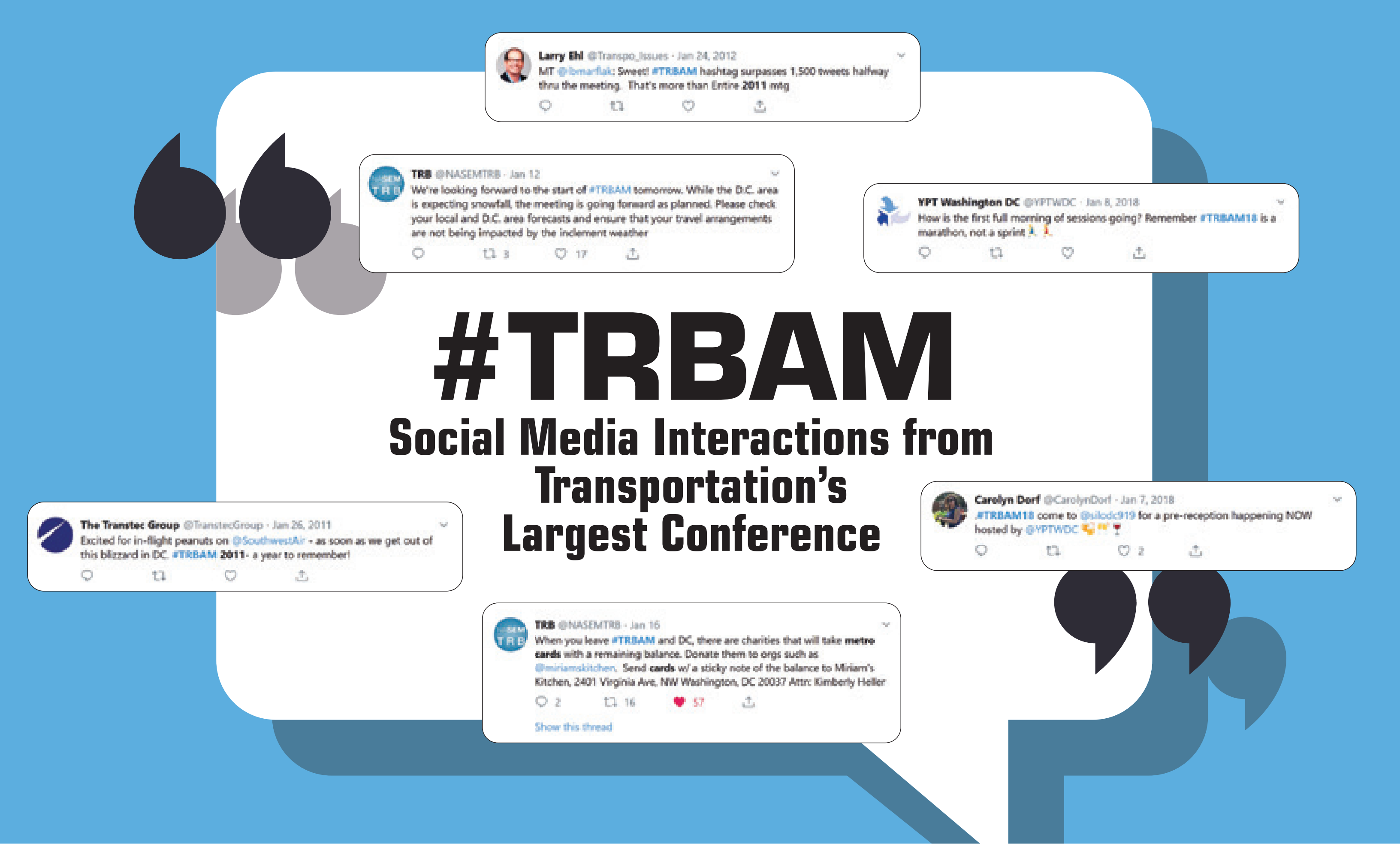
I've written this entire brief history of TRB without referring to a single person by name.[2] This is intentionally ironic because, if anything, the history of TRB reinforces how much individuals matter—people of strong character, commitment, and curiosity, with a willingness to work together.

TRB has always operated with a committed and passionate staff that is small relative to its corps of volunteers. Today, thousands of volunteers populate TRB's standing technical committees, research program panels, and consensus study committees. Over the decades, these volunteers have become more diverse in expertise, backgrounds, and perspectives. At its most successful, TRB has taken the initiative to reach out to new communities of experts and practitioners as demanded by its mission to stimulate research that contributes to the public welfare. The select appointment to its committees is in nearly perfect balance with the open invitation to everyone interested.



[2] The book, however, names names.

#TRBAM
Social Media Interactions from Transportation's Largest Conference



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The author is Associate Transportation Researcher, Texas A&M Transportation Institute, College Station.

Above: The use of a Twitter hashtag gives the TRB Annual Meeting a social media platform both to connect attendees and to reach out to transportation professionals.

The TRB Annual Meeting offers attendees the opportunity to interact with other transportation professionals across the globe by providing unique communication, educational, and business opportunities. The incorporation of Annual Meeting attendee microblogging via Twitter has furthered growth in the event's influence and communications, beyond conference attendees and into the broader mainstream.

Using communications to facilitate co-learning at and from conferences is a key instrument for researchers, individuals, industries, and communities to share experience and knowledge, adapt to new revolutions, and become familiar with modern concepts and options. Using the hashtag #TRBAM as a case study, this article examines how Twitter as a platform has been used as a useful tool to distribute social interactions among transportation professionals and offers insights on Twitter use by conference attendees, including communication, trends, and focus over time. The interactions surrounding this hashtag can shed light on communication persistence and knowledge dissemination among transportation engineering communities.

History of #TRBAM

The TRB Annual Meeting is one of the largest gatherings of its kind in the world for transportation professionals, consistently drawing more than 13,000 attendees and featuring more than 5,000 presentations, 200 committee meetings, and 800 sessions at the five-day event (*1*). The first Annual Meeting was held in January 1922 by the recently created National Board of Highway Research. The Federal Aid Road Act of 1916 and a booming motor vehicle population necessitated the construction of roadways across the nation and with it the management of newly provided funding. At its first meeting, the Board sought to facilitate dialogue in a group environment of key stakeholders, including highway departments, universities, and highway industries. Some of the goals of the meeting included identifying needs

The first Annual Meeting, 1922. Although attendance has grown considerably, the mission—to identify transportation needs, collect and disseminate research, and connect professionals—remains the same.

in highway research, correlating research activities, collecting and disseminating research findings, and pooling resources and knowledge among attendees (*1*).

The Annual Meeting grew significantly in the decades that followed. Academic conferences now encourage attendees to use official conference hashtags in order to enhance learning and networking opportunities. The hashtag #TRBAM was first used by the TRB official Twitter handle, @ NASEMTRB, on June 8, 2010. The tweet read: "What are you planning to submit for the 2011 #TRBAM? Send us a tweet! Paper submission site is open until Aug. 1."

Data Collection

As of the first quarter of 2019, Twitter has an average of 330 million monthly active users (*2*). Also known as a tweet, a Twitter post is a short, publicly available statement or note, limited to 280 characters, that is generated from a Twitter user's profile. Twitter users choose a name for their profile, also known as a handle; this username is preceded by the @ symbol (for example, @NASEMTRB is the Twitter handle for the official TRB Twitter account). Hashtags—user-specified strings prefixed with a # symbol—are used widely to identify topics of discussion on Twitter.

To access data related to the #TRBAM hashtag, the author used the Twitter Developer platform with Open Authorization, an authentication mechanism that allows applications or tools to provide client functionality to a web service without granting an end user's information to the client itself (*3*). For this study, the author used several natural language processing (NLP) tools along with five different open-source R software packages to perform NLP tasks (*4*).

Photo: Risdon Photography

An average of 330 million people use Twitter each month, using hashtags to identify and easily follow topics of interest. #TRBAM was first used in 2010.

Descriptive Analysis

On Twitter, when a user posts something originally from that user's own handle, it is known as an original tweet. If a user shares the same content by using the Twitter sharing option, this is called a "retweet." Some key Twitter-related terms include the following:

- Engagements: number of Twitter interactions; total click counts anywhere on the tweet.
- Impressions: number of times users are shown a tweet, either in the Twitter timeline or in search results.
- Engagement rate: number of engagements divided by the number of impressions.
- Likes or favorites: number of people who "like" the tweet.
- Retweets: number of times users share a tweet created by another user.
- Replies: comments in answer to or related to a tweet created by another user.

An analysis of the frequencies of original tweets, retweets, and favorites

Photo: Risdon Photography

Attendees at the 2019 Annual Meeting connect between workshops, check online meeting schedules, and tweet about their experiences.

associated with #TRBAM indicate that the number of favorites has increased significantly in recent years. It is worth noting that adoption of Twitter in general rose significantly and steadily since 2011 and that many Annual Meeting participants who had never explored Twitter as a learning or networking tool slowly have embraced the platform. Though hard to measure, this effect is undeniably impactful for conference attendees, with many new participants adding their views and opinions to the topics discussed.

Retweeting indicates that a user prefers to see further interactions as well as to keep the information accessible for future use. The number of original tweets and retweets was higher in 2016 compared with 2017 because of the partial access of the data, which were obtained up through June 30, 2017 (see Figure 1, below).

Co-learning from conferences through communication is a key instrument for researchers, individuals, industries, and communities to share experience and knowledge, adapt to technological revolutions, and become familiar with modern concepts and options. Attending an academic conference has three major benefits: to promote one's own research, to gain knowledge on a wider variety of research topics, and to take advantage of networking opportunities. In general, energy and enthusiasm for a speaker or session associated with the front area (e.g., the physical conference) gain more consideration than an extensive back area (e.g., Twitter and other social media) in distributing information to known and unknown audiences (*5*).

TABLE 1 Rate of Twitter Posts for Three Periods

When	Number of Days (2011–2017)	Number of Original Tweets	Original Tweets/Day
Before Meeting[1]	1,380	2,611	1.89
During Meeting[2]	35	16,978	485.08
After Meeting[3]	1,142	915	0.80

[1] July 1–Jan. 22, 2011; July 1–Jan. 21, 2012; July 1–Jan. 12, 2013; July 1–Jan. 11, 2014; July 1–Jan. 10, 2015; July 1–Jan. 9, 2016; July 1–Jan. 7, 2017.
[2] Jan. 23–Jan. 27, 2011; Jan. 22–Jan. 26, 2012; Jan. 13–Jan. 17, 2013; Jan. 12–Jan. 16, 2014; Jan. 11– Jan. 15, 2015; Jan. 10–Jan. 14, 2016; Jan. 8–Jan. 12, 2017.
[3] Jan. 28–June 30, 2011; Jan. 27–June 30, 2012; Jan. 18–June 30, 2013; Jan. 17–June 30, 2014; Jan. 16–June 30, 2015; Jan. 15–June 30, 2016; Jan. 13–June 30, 2017.

It is not surprising that a higher number of tweets are generated during the Annual Meeting. From 2011 to 2017, the rate of tweets was 485 per day during the days of the conference; before and after the conference, the rate was much lower, at 1.89 and 0.80 per day, respectively (see Table 1, above). This pattern is consistent in the yearly analysis (p <0.001 in all years; pairwise t-test). This observation indicates that continuation of knowledge sharing pre- and post-meeting is limited.

Using a similar hashtag for a longer period offers an understanding of the user network and knowledge sharing over the years. The top 20 Twitter handles generate 3,307 tweets—16% of total tweets; average, 165; interquartile range (IQR), 102–195—and the top 20 hashtags generate 2,566 tweets (13% of total tweets; average, 128; IQR, 40–133). It is anticipated that the use of a common hashtag is beneficial in extracting a larger amount of relevant data.

Because social media mining techniques can collect the timestamp associated with a tweet, using a year-related hashtag is redundant in many cases. For example, hashtags that include the year (for example, #TRB2013 or #TRB2014) generate nearly 8% of total tweets. The findings indicate that following a proper hashtag would be beneficial in knowledge discovery (see Figure 2, page 21).

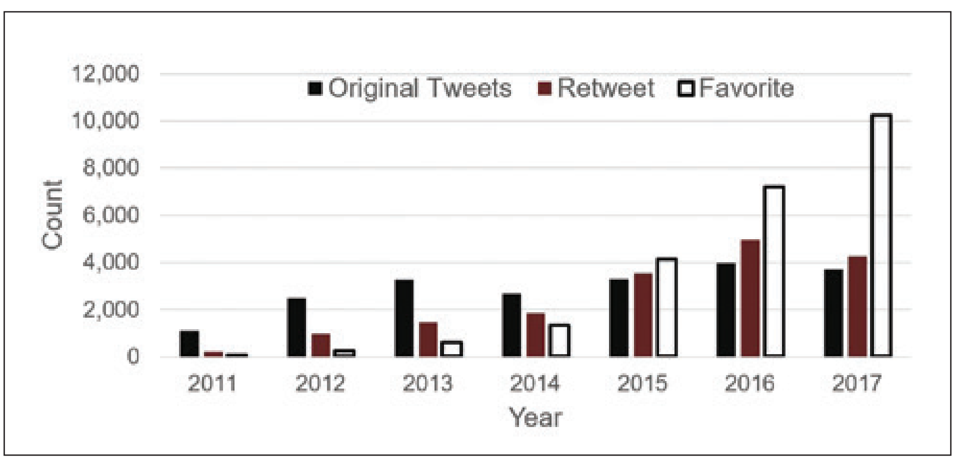

FIGURE 1 Frequencies of Twitter posts using #TRBAM and related hashtags.

Natural Language Processing

Analysis of Twitter data is challenging because it uses a variety of strategies to make a limited and sensible exploratory deduction from collections of public web texts. As the transportation engineering field changes rapidly because of automated and connected vehicle technologies and artificial intelligence, it is important to examine the trends of topic distribution over the years. Applied here are several NLP methods to understand these trends: 1) term frequency–inverse document frequency (*tf-idf*) analysis, 2) topic modeling, and 3) network analysis.

TERM FREQUENCY–INVERSE DOCUMENT FREQUENCY

A word or term frequency is defined as the number of times a particular word appears in a document in a collection of documents, or corpus. For example, one tweet can be considered a document and all collected tweets using #TRBAM can be

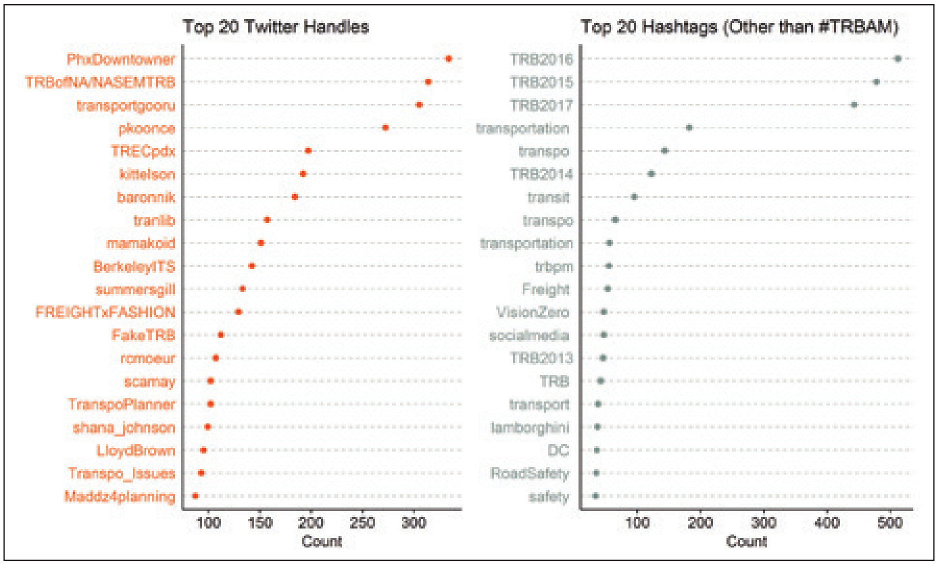

FIGURE 2 Top 20 Twitter handles and hashtags related to #TRBAM.

considered a corpus. Document frequency is the count of documents that contain a common word. Term frequency (*tf*) is critical in extracting aggregated features. For performing time series analysis or cluster analysis, the relative frequency cannot be measured by term frequency. Instead of using a word or word group frequency, another method involves examining a term's inverse document frequency (*idf*). This approach decreases the weight of commonly used words and of stop words (for example, articles, modal auxiliaries, or punctuation) and increases the weight of words that are not used frequently in all documents. This statistic can be combined with term frequency to calculate a new statistic, *tf-idf*, which determines how relevant a word is to a document in a corpus of documents. The *tf-idf* statistic aims to find terms or words that are important in text but that are not too common.

The advantage of *tf-idf* is that it can extract rare but significant knowledge from a large body of texts. For each year, the terms in the *y*-axis are relatively important compared to other years' documents. For example, the term "googleglass" is found to have higher *tf-idf* for the 2014 document (all 2014 tweets associated with #TRBAM), which may be because, in 2013, Google released a limited-edition version of Google Glass to a select number of individuals (*6*). As a hot topic with possible use in the transportation field, this term had a higher significance in the 2014 document. Some of the dominating terms were "foursquare," "googleglass," "my first TRB," "Vision Zero," and "Six-Minute Pitch." Many terms related to research institutes, affiliates, and groups also had high *tf-idf* values. The presence of these names indicated higher levels of communication and information sharing by the specific groups or entities over the years (see Figure 3, below).

TOPIC MODELING

Probabilistic topic modeling is a robust method for data analysis in machine learning and applied statistics. It represents collections of documents as a document–word co-occurrence matrix, in which each element is the number of words in the document.

Latent Dirichlet allocation (LDA) is the most commonly used method for fitting a topic model. It considers each document as a mixture of topics and each topic as a mixture of keywords. The LDA procedure allows documents to overlap each other regarding content, rather than being separated into discrete groups, in a way that mirrors the typical use of natural

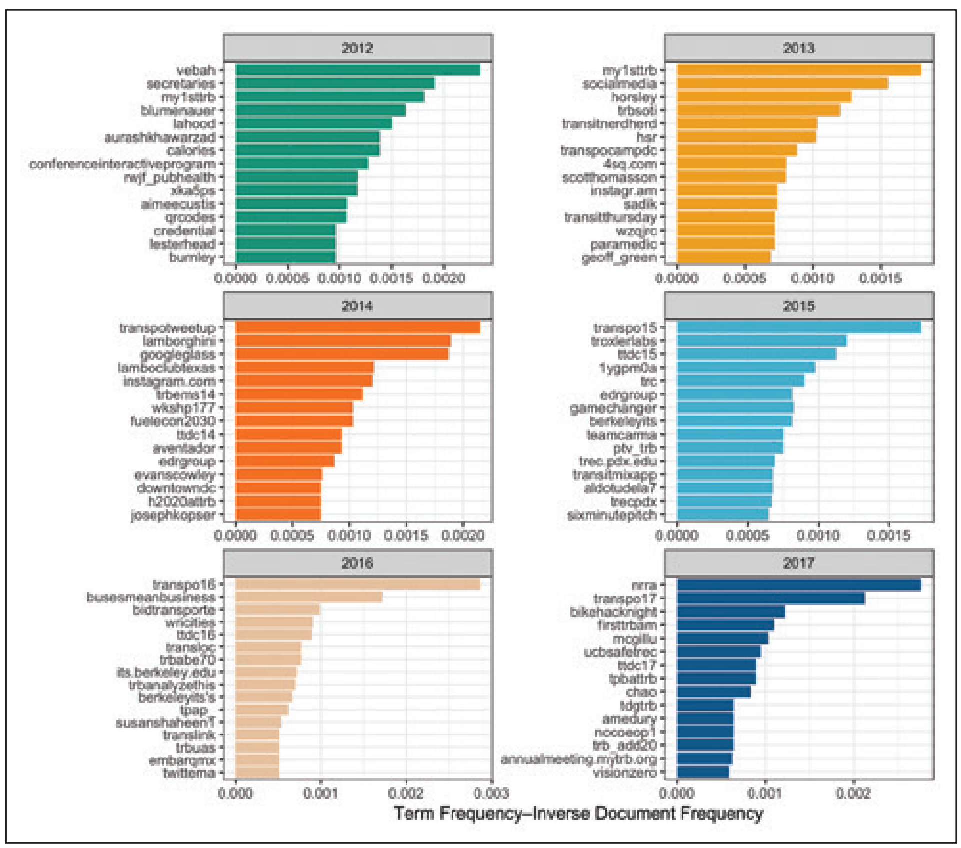

FIGURE 3 Term frequency–inverse document frequency.

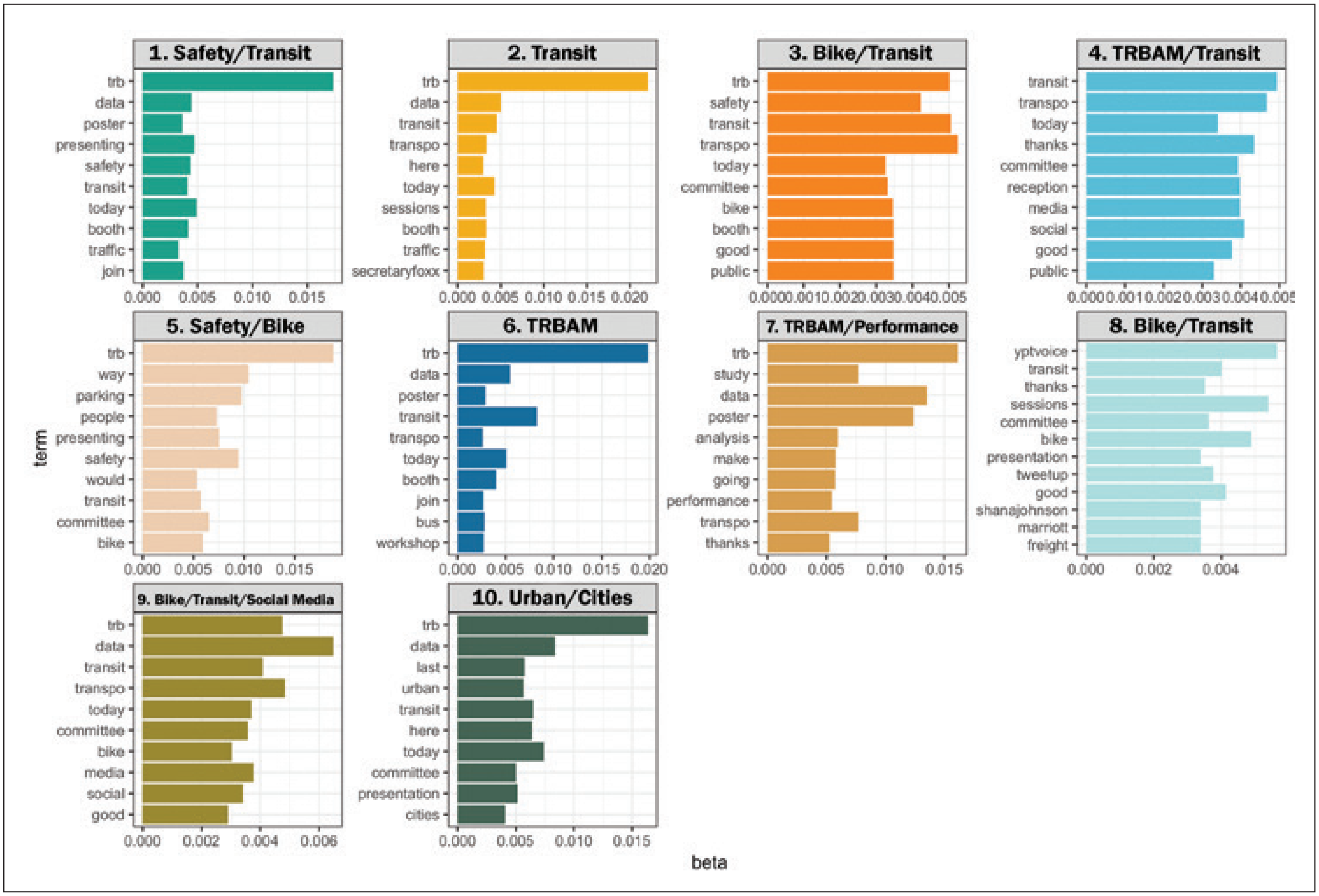

FIGURE 4 Top 10 topic models.

language. For example, in the 10-topic model, year-based documents have different percentages of presence for individual topics. For example, the 2014 document is more likely to have Topics 2, 3, and 4 with a higher presence (30%, 22%, and 13%, respectively).

The statistic represents the per-topic–per-word probabilities. The term “transit” was found to be a key term in all of the generated topics, and several transit-related words were found in some of the top 10 topics (see Figure 4, above). These words were “public,” “transpo,” “bus,” “urban,” and “cities.” Three other key terms in the top 10 topics were “safety” (in Topic 1 and Topic 5), “bike” (in Topic 3, Topic 5, Topic 8, and Topic 9), and “annual meeting” (in Topic 4, Topic 6, and Topic 7).

The term “data” was also a key signifier for several topics (in Topic 1, Topic 2, Topic 6, Topic 7, Topic 9, and Topic 10).

NETWORK ANALYSIS

In general, a network is a collection of people or entities that connect or interact via some standard criteria or situation. Network analysis visualizations offer an overview of the interaction patterns with some quantifications. The Twitter handles are the people or entities, and the connections are the followers.

The current communication pattern defined in this article is based on the standard criteria of 1) involving the usage of #TRBAM and 2) mentioning someone in the same tweet. The purpose is to identify the influential handles in the Twitter network and their individual influence zones. Doing so allows for the quantification of an account’s influence. The final data set reveals 6,748 unique interactions in the form of comments or mentions:

- Single interaction (5,625; 83% of total interactions);
- Two interactions (691; 10% of total interactions);
- Three interactions (219; 3% of total interactions);

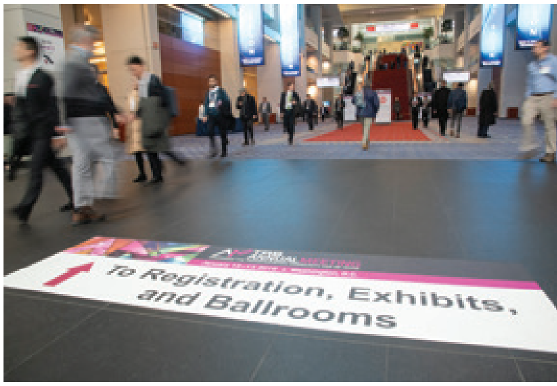

Photo: Risdon Photography

Studies suggest that following one main hashtag, rather than including year-based hashtags, assists more effectively in knowledge discovery.

- Four interactions (89; 1% of total interactions); and
- Five or more interactions (124; 2% of total interactions).

A chord diagram visualizes the interrelationships among entities (see Figure 5, below), displaying commonality of information or interests. The diagram shows nodes and edges of retweet networks using the conference hashtag and captures relationships among community size, communication association, and social media engagement. Nodes are arranged in a circle, with the relationships between points connected to each other either with arcs or with curves. Values, assigned to each connection, are represented proportionally by the size of each arc. The colors group the data into different categories that aid in making comparisons and distinguishing groups.

Figure 5 indicates that some of the key Twitter handles (@NASEMTRB, @EDRGroup, @Transpoplanner, @transportgooru, @RTSMO, and @pkoonce) are significant in communicating; however, the overall communication pattern distribution was small group– or interest-based. Although Figure 5 indicates communication patterns among Twitter handles, the inclusion of "my1sttrb" into the plot suggests that new users sometimes mention the TRB handle (@TRB) instead of using the hashtag. The patterns show that the conversations tend more to be two-way, rounded interactions based on tweeting and retweeting.

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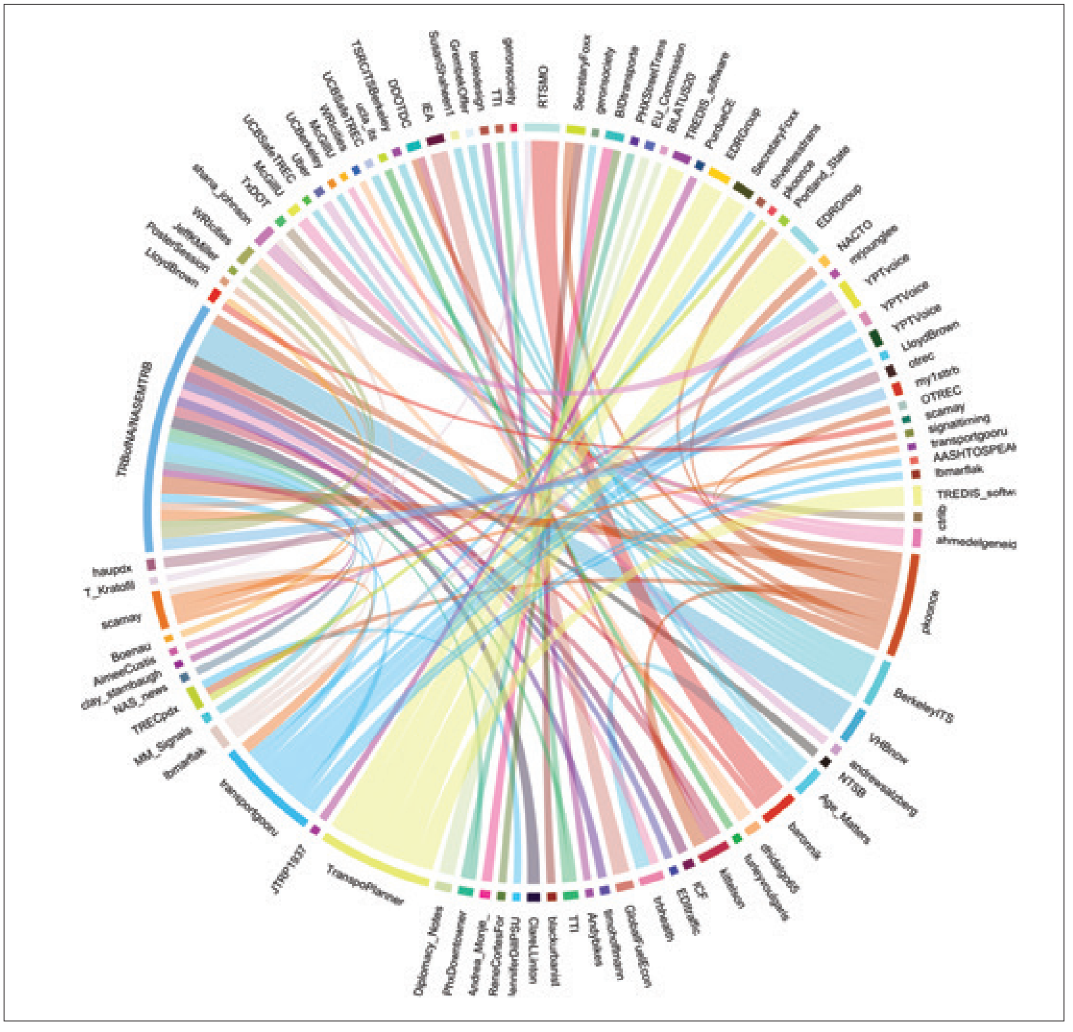

FIGURE 5 Chord diagram of Twitter mentions related to #TRBAM and associated hashtags.

PROTECTING THE HEALTH AND WELL-BEING OF COMMUNITIES IN A CHANGING CLIMATE

Photo: David Kidd, Flickr

ALINA B. BACIU, LESLIE A. PRAY, AND KATHLEEN R. STRATTON

Baciu is Senior Program Officer and Stratton is Scholar, Health and Medicine Division, National Academies of Sciences, Engineering, and Medicine, Washington, D.C. The late Pray was a science writer based in Claremont, California.

Above: Recent roundtable workshops seek health, environmental, and transportation strategies to combat the health effects of climate change in cities, particularly those with heat islands like Louisville, Kentucky.

In March 2017, the Roundtable on Environmental Health Sciences, Research, and Medicine and the Roundtable on Population Health Improvement convened a joint public workshop in Washington, D.C., to explore strategies for public health, environmental health, health care, and stakeholders to help communities and regions address and mitigate the health effects of climate change (see box, page 25).

Workshop objectives were to 1) receive an overview of the health implications of climate change; 2) explore mitigation, prevention, adaptation, and resilience-building strategies deployed by different sectors at various levels locally and nationally; and 3) discuss aspects of collaboration on climate and population health issues among community-based organizations, health care systems, businesses, and public health and other local government agencies, along with lessons learned.

Although the workshop was not planned with a specific transportation-related objective, the role of transportation emerged during some of the presentations and discussions. This article highlights parts of the workshop proceedings that discuss transportation as related to community health and climate issues.[1]

Opportunities to Improve Health

Jonathan Patz, University of Wisconsin–Madison, identified three sectors in which he sees opportunities for a health-based policies approach to combat climate change: 1) the energy sector, 2) food systems, and 3) transportation and urban planning.

Patz discussed a 2016 study published in *The Lancet* on noncommunicable disease risk factor collaboration, in which members reported on the increasing numbers of obese people around the world (*1*). Patz asserted that although this global trend is partly food-related, it is also related to how cities are designed.

[1] To read the full publication, visit https://www.nap.edu/download/24846.

Photo: Seattle DOT

Transportation and urban planning is a major sector in which implementing health-based policies can help combat climate change.

Pucher et al. reported that U.S. cities with the highest rates of walking and cycling to work have 20% lower obesity rates and 23% lower diabetes rates, compared with the U.S. cities with the lowest rates of walking and cycling (*2*). "It is high time that we design cities for people, rather than for motorized vehicles," Patz said.

In addition, Patz described how he and colleagues are modeling the health effects of walking time, with preliminary data suggesting that increasing people's walking time by just 10 minutes per week, or two minutes per workday, may save the state of Wisconsin $30 million in health care and absenteeism costs.

Addressing Health Through Infrastructure

"What a golden opportunity for public health," Patz said, referring the Trump administration's discussion of a trillion-dollar investment in infrastructure. Patz added that infrastructure is not just highways and bridges but also includes bike trails and green communities. Patz emphasized that addressing the global climate crisis through a low-carbon economy—especially across the energy sector, food systems, and transportation and urban planning—can help make people healthier and save money. "Doing something urgently about the global climate crisis could be the largest public health opportunity we've had in a very long time," he noted.

Lynn Goldman, George Washington University, commented on the need to consider both how to train people going into public health careers and how to create opportunities for communities to engage public health agencies in decision-making around infrastructure. Goldman remarked

About the Roundtables

The Roundtable on Environmental Health Sciences, Research, and Medicine addresses current and emerging issues in environmental health through discussions related to science, research gaps, and policy implications. The roundtable has held workshops on a range of issues of domestic and international importance, such as climate change, sustainable drinking water, ecosystem services, the health impact assessment of shale gas extraction, the science of obesogens, sustainable development, and data for environmental health decision-making.

The Roundtable on Population Health Improvement brings together multiple sectors and disciplines to broaden the national conversation about the factors that shape health and to support cross-sector relationships and engagement to transform the conditions for health across U.S. communities. To inform and catalyze actions that help build a strong, healthy, and productive society that cultivates human capital and equal opportunity, the roundtable has explored a range of issues, including collaboration between the education and health sectors and partnerships between faith-based and health sector entities to address health-related social needs and support health-promoting efforts. Recently, the roundtable explored the shifting definitions of value that help reorient investments in the health care and business sectors toward health and well-being.

Both roundtables are located in the Board on Population Health and Public Health Practice of the Health and Medicine Division of the National Academies of Sciences, Engineering, and Medicine.

Photo: Xicotencat, Wikimedia

City greening can reduce heat by 2°F, but it is resource-intensive.

Photo: Brent Moore, Flickr

Louisville City Hall. A pilot project in the building's parking lot combines trees and porous pavement to further the city's greening efforts.

that, in addition to walkability and bikeability, there are many other components of infrastructure. For example, when roads are addressed, too often no one pays attention to what runs under those roads—namely, drinking water and liquid waste. Referring to a recent National Academies of Sciences, Engineering, and Medicine report that attributes many severe weather events to climate change, Goldman pointed out that infrastructure also encompasses aspects that are important for protection from severe weather events (*3*).

Urban Heat Mitigation

Terry Allan, Cuyahoga County, Ohio, Board of Health, remarked that there has been a lot of recent dialogue in urban planning circles about tree canopy spread as a mitigation strategy for higher temperatures. Doing so plays a very important role in reversing the urban heat island effect seen in built-up areas that experience higher temperatures because of pavement and roofs that limit vegetation and moisture.

CITY OF LOUISVILLE

Maria Koetter, Louisville (Kentucky) Metro Government, cited a study by Stone that found that Louisville had the most rapidly growing heat island in the country from 1961 to 2010 (*4*). According to Koetter, this finding prompted the city of Louisville to apply for a grant from Partners for Places, a program that builds partnerships between local government sustainability offices and place-based foundations. The city was awarded the grant and hired Stone to conduct an in-depth analysis of its urban heat island issues and to model strategies to help manage the heat.

The urban heat management strategies that Stone modeled covered greening methods, cooling methods, and all methods combined. His results showed that greening certain areas of the community can reduce heat by more than 2°F. Greening is more resource-intensive, however, and involves planting hundreds of thousands of trees. Similar benefits could be achieved with employing cooling methods. These methods include installing energy-efficient roofing anytime roof replacement is needed, along with paving miles of road, surface area, parking lots, and other areas with cooling materials.

PLANTING TREES

Koetter described Green for Good, another recently completed project within her office that was also funded by a Partners for Place grant. The goal was to install a densely vegetated buffer between a population of people and a heavily trafficked road, and evaluate particulate matter in the air and conduct biomarker sampling in volunteers both before and after installation of the buffer.

The city chose an elementary school as the study site because it was known to have high-traffic pollution and because it had space for planting the buffer. A densely vegetated buffer (that is, bushes) was planted between the street and the school population, with part of the school yard left unbuffered to serve as a control. The air monitoring showed a 60% reduction in particulate matter behind the buffer, compared with the front of the street.

NEXT STEPS FOR LOUISVILLE

Koetter listed several next steps for Louisville. Among other projects, her office is conducting a citywide cool-paving pilot project. Koetter commented that many materials are cooler or more highly reflective than concrete or asphalt. The pilot project aims to set an example of what materials can be used and how such materials can be laid successfully to withstand four-season weather.

Another pilot project under way is tree planting in the center of the parking lot across from the Louisville City Hall. The area where the trees were planted was topped with porous paving materials so that cars can drive over the parking lot without damaging the trees. Although this is a small-scale project, Koetter noted that it demonstrates to private property owners what they can do to green their parking lots without losing any parking spots.

In addition to paving projects and tree canopy work, the city of Louisville has focused on messaging. For example, the city advertises on city buses not only to promote awareness of extreme heat events but for all greening, cooling, and other energy conservation programs across the city.

Role of Health Care Organizations

Health care organizations "wear a lot of different hats," observed Kathleen Gerwig, Kaiser Permanente, who discussed how these organizations' efforts to prioritize community health needs can also address climate-related health issues by engaging with communities in multiple ways. For example, most facilities listed obesity as the first, second, or third most important community health need. Addressing obesity by promoting physical activity affects climate action as well—walkable communities, bike-sharing programs, bicycle paths, active transportation, and mass transit all have obesity prevention and climate co-benefits.

Gerwig discussed economic security as another example in which health care organizations' efforts to address a community need could yield co-benefits. Reiterating that hospitals are big purchasers, she explained that more purchasing from local sources has positive effects both on the economic security of a community and on the climate. Greater use of local sources increases local jobs, and local jobs mean shorter commutes. This in turn reduces fossil fuel use and greenhouse gas emissions. Gerwig noted that strategies to address asthma by reducing traffic and particulate matter also reduce fossil fuel emissions.

Gerwig also cited road density in Riverside County in Southern California, where the total road network density (that is, road miles per acre) is 5.68, compared with 2.02 across California and 1.45 nationally. She quoted an assessment respondent: "The lack of jobs available in Riverside County also increases commutes for residents, increasing the use of cars on the road and more pollution in the air." Gerwig observed that this example illustrates the connection between a lack of local jobs, which means longer commutes, and climate impacts. More local jobs would mean shorter commutes, improved community economic security, and decreased air pollution.

Photo: Basil D. Soufi, Wikimedia

The lack of local jobs in Riverside County, California, demands residents commute, putting more cars on the road for further distances.

Conclusion

Examining the role of transportation in mitigating the health implications of climate change, communities have many strategies they can deploy. Often the most obvious strategy is enabling and encouraging modes of active transportation, which has the dual benefit of decreasing carbon emissions and allowing people to reap the many benefits of exercise.

Another strategy used in various communities involves examining the placement of trees in relation to the pavement and the role that pavement plays in contributing to heat islands in communities. When implementing strategies, it is essential for community leaders to build a base of support among community members and to communicate the urgency of action in a nonpartisan, nontechnical manner.

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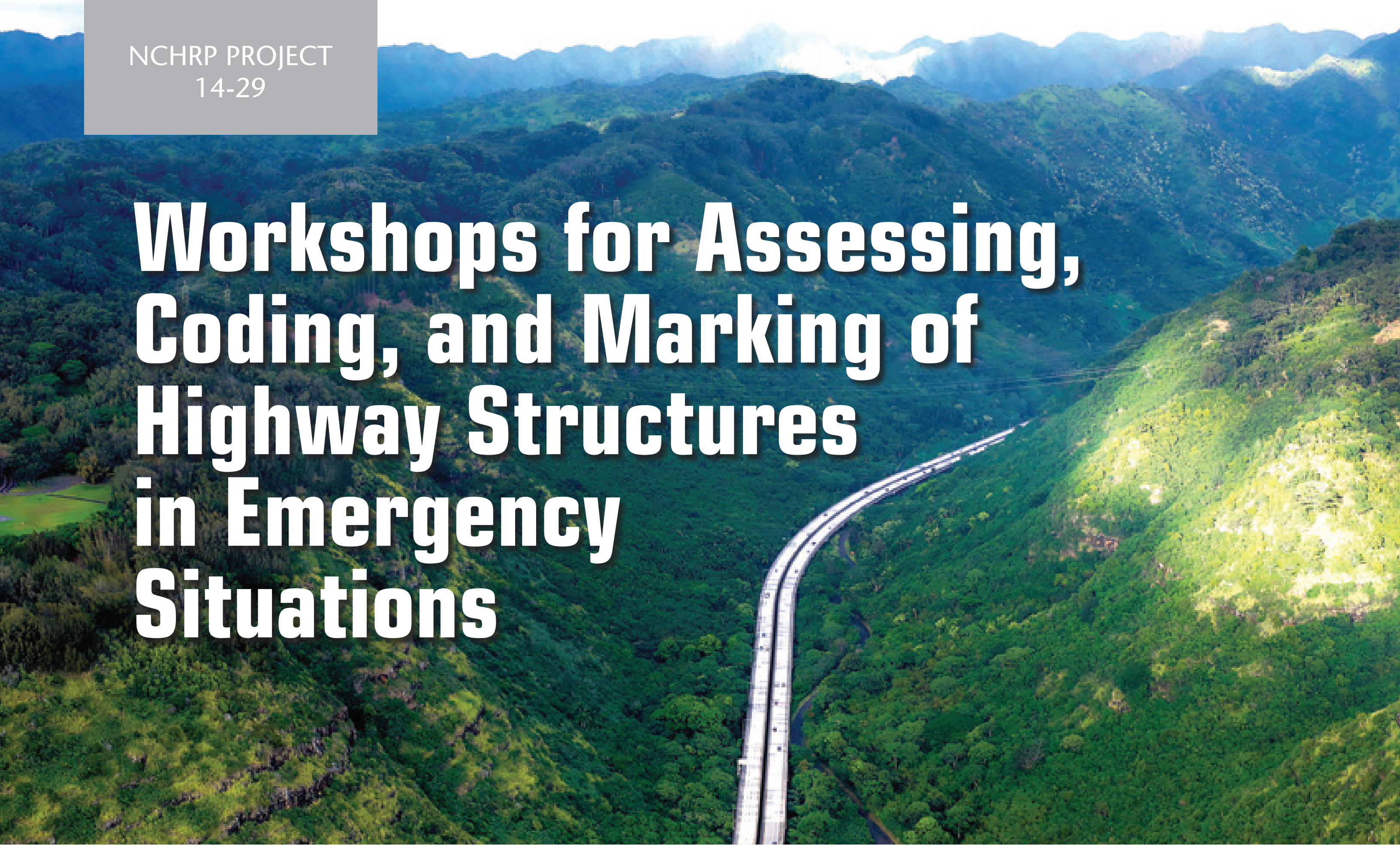
NCHRP PROJECT 14-29



Workshops for Assessing, Coding, and Marking of Highway Structures in Emergency Situations

Photo: Chelsey Horne, Pexels

GENE V. ROE, MICHAEL J. OLSEN, ANDRE BARBOSA, AND MARC VELETZOS

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Above: Hawaiian highways face threats from volcanos, tsunamis, hurricanes, and earthquakes. Emergency events require state DOTs to respond to unique situations, which were addressed by recent NCHRP project training courses.

State departments of transportation (DOTs) must ensure that highway structures are safe for the public after an emergency event. First responders from the DOT—typically site engineers, inspectors, and maintenance professionals—must assess, code, and mark each highway structure, either physically or digitally or both, to communicate the status of the structure to other responding agencies and personnel. Within the past decade, some state DOTs began developing formal processes for assessing, coding, and marking highway structures after emergencies resulting from natural or man-made disasters.

These individual efforts, however, did not offer a uniform means for conducting these assessments or a consistent form of coding and marking the structures during or after an emergency event. For example, Washington State DOT uses

Photo: Michael J. Olsen

Damage to a bridge approach near the Bio Bio bridge in Concepción, Chile, after the 2010 Maule earthquake.

Photo: Michael J. Olsen

Olsen discusses *NCHRP Research Report 833* at a workshop in Hawaii in December 2018. Each attendee received all materials from the report and used these materials throughout the event.

four coding options to classify the status of its bridges following an earthquake: red or orange for "unsafe," yellow for "limited entry," and green for "safe." Caltrans, on the other hand, uses three coding options: "open," "collapsed," and "closed needing Structure Maintenance and Investigations inspection."

These processes generally did not address the many different types of highway structures—bridges, tunnels, culverts, retaining walls, embankments, or overhead signs—or the ranges of traffic levels associated with each structure. In addition, many of these individual processes did not explicitly consider the practices of other local, state, or federal organizations that often help respond to such emergencies. These issues tended to impede the effectiveness of responding organizations in dealing with damaged and unsafe structures.

It is vital to assess, code, and mark highway structures to ensure the safety of emergency responders and the public. As the regional footprint of emergency events grows, with impacts beyond state boundaries, uniform processes are needed for conducting these assessments as well as national-level coding and marking guidelines. In early 2013, the National Cooperative Highway Research Program (NCHRP) initiated a project to address this need. Oregon State University of Corvallis received a contract to develop a process for assessing highway structures in emergency situations, guidelines for coding and marking, and selected training and implementation material.

When NCHRP Project 14-29 began in November 2013, a widely accepted, uniform process was not available. With the goal of developing a nationally recognized process for assessing highway structures and guidelines for related coding and marking, the research team aimed to assist highway agencies and other organizations deal more effectively with emergency events and provide safer conditions for the traveling public.

Research Products

The research and deliverables for NCHRP Project 14-29 were completed in November 2016: 1) *NCHRP Research Report 833: Assessing, Coding, and Marking of Highway Structures in Emergency Situations, Volume 1—Research Overview,* which summarized the research process and rationale; 2) an assessment process manual; 3) coding and marking guidelines; 4) a Smart App Developer's Guide; 5) assessment forms; and 6) supporting training materials.

Intended for managers who oversee emergency response, Volume 2 of *NCHRP Research Report 833* identifies technologies that are appropriate for each structure type and addresses prioritization, coordination, communication, and redundancy. It also provides planning and preparation strategies and background on emergency events.

Published as Volume 3 of *NCHRP Research Report 833*, the *Coding and Marking Guidelines* are intended to be a field manual for preliminary damage assessment responders who must evaluate highway structures. This provides detailed, step-by-step procedures for performing the assessments and example photographs to help with coding procedure.

In addition, NCHRP Project 14-29 produced preliminary damage assessment forms for each structure type, development guidelines for creating a smart app for automating the assessment process, and four types of training materials to help highway agencies and other emergency response organizations implement the developed manual and guidelines.[1] These

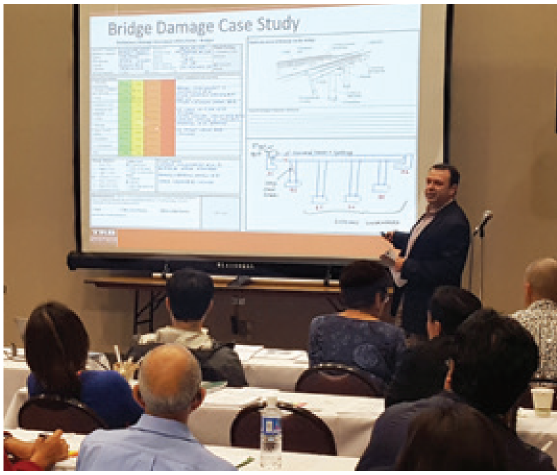

Photo: Michael J. Olsen

Barbosa discusses research implementation with bridge engineers and inspectors at the workshop.

[1] For more on *NCHRP Web-Only Document 223: Guidelines for Development of Smart Apps for Assessing, Coding, and Marking Highway Structures in Emergency Situations,* visit www.trb.org/Main/Blurbs/175321.aspx.

Photo: U.S. Geological Survey

Lava flows cover a Hawaii highway.

training materials include training for a general audience who work with those involved in the assessment process, basic training for damage assessment responders, specialized training for managing engineers, and a quick refresher for damage assessment responders on the most relevant procedures for preliminary damage assessment.

National Training

In February 2016, shortly after the publication of *NCHRP Research Report 833*, approximately 30 senior bridge engineers and inspectors from across the United States attended a two-day, in-person training course. The research team presented a high-level overview focusing on the management issues needed to implement the recommendations of the report within a state highway agency. The information was well-received, with valuable feedback offered on implementation concerns from represented transportation agencies. In particular, attendees felt well-equipped to handle the more frequent, smaller emergencies but began to think more broadly in terms of large emergency events that can exhaust resources quickly.

Hawaii Training

In June 2017, TRB hosted a webinar that featured an overview of *NCHRP Research Report 833*.[2] Domingo Galicinao of the Department of Design and Construction at the City and County of Honolulu, Hawaii, then contacted the project's principal investigator, Michael Olsen. Galicinao thought that the assessing, coding, and marking recommendations would be an effective way to establish uniform emergency response procedures between the City and County of Honolulu, the State of Hawaii DOT, and other state agencies across the islands that comprise the State of Hawaii.

According to Galicinao, each of the islands would bring unique concerns to such a training. Foremost in everyone's mind were the extensive lava flows occurring on the Big Island at the time. This devastating natural event was not something that the project team had specifically considered; however, since the process was designed to be general, many of the procedures still applied.

[2] For details on the June 2017 webinar, visit https://webinar.mytrb.org/Webinars/Details/1075.

The threat of tsunamis and rising sea levels surround each Hawaiian island—literally—and threaten their inhabitants and infrastructure on a daily basis. This, along with the potential for earthquakes on many of the islands and their overall isolated location relative to the rest of the world, made it clear to Galicinao and the NCHRP Project 14-29 team that the state of Hawaii would receive an immediate return on their investment in the assessment training.

Olsen and his team were hired by the Hawaii Local Technical Assistance Program (LTAP). Working with Hawaii LTAP and local transportation agencies, the team developed a customized training program that reflected the unique emergency response needs of the multiple-island state. The City and County of Honolulu took the lead and, after a couple of iterations, all parties decided that class size should be limited to approximately 30 trainees or a total of five workshops in order to train approximately 150 people, largely first responders.

WORKSHOP STRUCTURE

Hawaii LTAP hosted the workshops in December 2018 at two separate locations in Honolulu to facilitate attendance of city

Photo: Michael J. Olsen

Olsen (*left*) and Barbosa (*right*) assist attendees with small group discussions for assessing structural damage in the case-study portion of the workshop.

and county employees from across Hawaii. Workshop participants also included consultants and university researchers from as far away as Alabama. The smaller class sizes allowed for hands-on instruction and audience participation.

Each group received two days of training from a two-person team of instructors. On the first day, one team of instructors provided a general overview of the entire coding, assessing, and marking process. Topics included types of emergency events, potential structural damage, overall planning and preparation, assessment stages, response levels, and communication and coordination.

On the second day, high-level interactive training was provided by a different two-person team, who had more experience with the structural assessment process. Topics included fast reconnaissance, preliminary damage assessment, coding and marking guidelines, and mobile technologies. In the afternoon, two-person teams of attendees worked on two case studies. Teams first performed assessments based on photographs. After some discussion, each team then compared their coding results with those of the entire class.

In general, the attendees provided consistent coding outcomes; for example, "unsafe" or "inspected." Different experiences and backgrounds, however, led to some variances in component-level damage classification—for example, "none," "minor," "moderate," or "major" damage to a column based on the size of the size and type of crack observed—and prompted constructive discussions and sharing of experience.

FIRST, YOU PLAN

One of the overarching themes of the procedures recommended in NCHRP Project 14-29 is "First, You Plan." All of the parties agreed once the training had been completed that they now were much better positioned to carry out the planning efforts that are essential to responding to extreme emergency events, particularly when coordinating efforts across multiple islands.

At the conclusion of the workshop, a final discussion allowed each class to narrow down three immediate action items to make progress in planning and preparation. These actions ranged from identifying trainees' specific roles in the response to developing geospatial databases for structural inventories to investigating potential technologies for improving emergency response processes. The participants realized

Photo: Michael J. Olsen

Attendees were encouraged to ask questions regularly and to contribute to discussion at the workshop.

Photo: Joe Lewis, Flickr

An upcoming NCHRP project will focus on developing model procedures for post-event bridge damage assessment, as what was needed after the 1989 San Francisco earthquake.

that many of these efforts were not only important to emergency response but also had value in day-to-day activities.

National Adoption

The challenge now is to raise awareness among individual state transportation agencies regarding these recommendations and procedures. The American Association of State Highway and Transportation Officials (AASHTO) Committee on Maintenance is considering a proposal to publish *NCHRP Research Report 833* as an official AASHTO guidance document. This will provide additional incentive for other states to follow Hawaii's lead and obtain training.

Follow-Up Research

Recognizing the value of the work performed under NCHRP Project 14-29, the AASHTO Committee on Research and Innovation has included a related project in the NCHRP FY 2020 Program. NCHRP Project 14-45, "Model Procedures for Post-Event Bridge Damage Assessment and Engineering Evaluation," will seek the development of model procedure for post-event bridge damage assessment that can serve as a basis for transportation agencies' emergency response plans.

Acknowledgments

The project team thanks Amir Hanna, TRB, for serving as NCHRP Project 14-29 program manager. The team also thanks Hawaii LTAP, and all those who assisted and participated in the training in Hawaii, for their interest and support.

TRANSIT IDEA PROJECT 85

LookingBus

Looking Out for Every Rider

NIRIT GLAZER

The author is Cofounder and CEO, LookingBus, Ann Arbor, Michigan.

Above: The ability to determine the exact location of the bus stop from many nearby poles is critically important for riders with visual impairments, who often miss the bus because they are not waiting near the correct pole.

LookingBus is a smart city system that helps people with disabilities use public transportation, specifically addressing the challenges of using the public bus system, such as boarding and disembarking (that is, getting on or off the bus). People with visual impairments depend heavily on public transit as an essential service for engaging in daily life and social activities. However, they often face challenges finding the correct bus stop; determining which bus to board, especially at busy bus stops with multiple buses approaching; boarding the correct bus before the bus leaves the stop; and getting off the bus at the right bus stop.

Developed under TRB's Transit Innovations Deserving Exploratory Analysis Program, LookingBus uses smart bus stops and Internet of Things (IoT) technology to provide bus drivers with advanced notifications of riders with disabilities at upcoming stops to ensure that drivers can assist the riders as they board the correct bus (see Figure 1, page 34).[1] Likewise, drivers are notified when the rider needs to get off the bus (see Figure 2, page 35).

Pilot Test

In 2018, the team behind LookingBus conducted a pilot test in Detroit, Michigan, in collaboration with Detroit-based Suburban Mobility Authority for Regional Transportation (SMART). In preparation for this pilot test, the LookingBus team developed a variety of location-aware sensors and placed them at bus stops. The team also developed a mobile app for registered users that alerts drivers about the presence of riders with disabilities at their upcoming stops as well as when the riders need to get off the bus.

The pilot test used volunteer riders both with and without visual impairments.

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[1] To see the final report for Transit IDEA Project 85, *Location-Aware Networks Optimizing Use of Transit Systems by Blind Travelers*, visit http://onlinepubs.trb.org/onlinepubs/IDEA/FinalReports/Transit/Transit85.pdf.

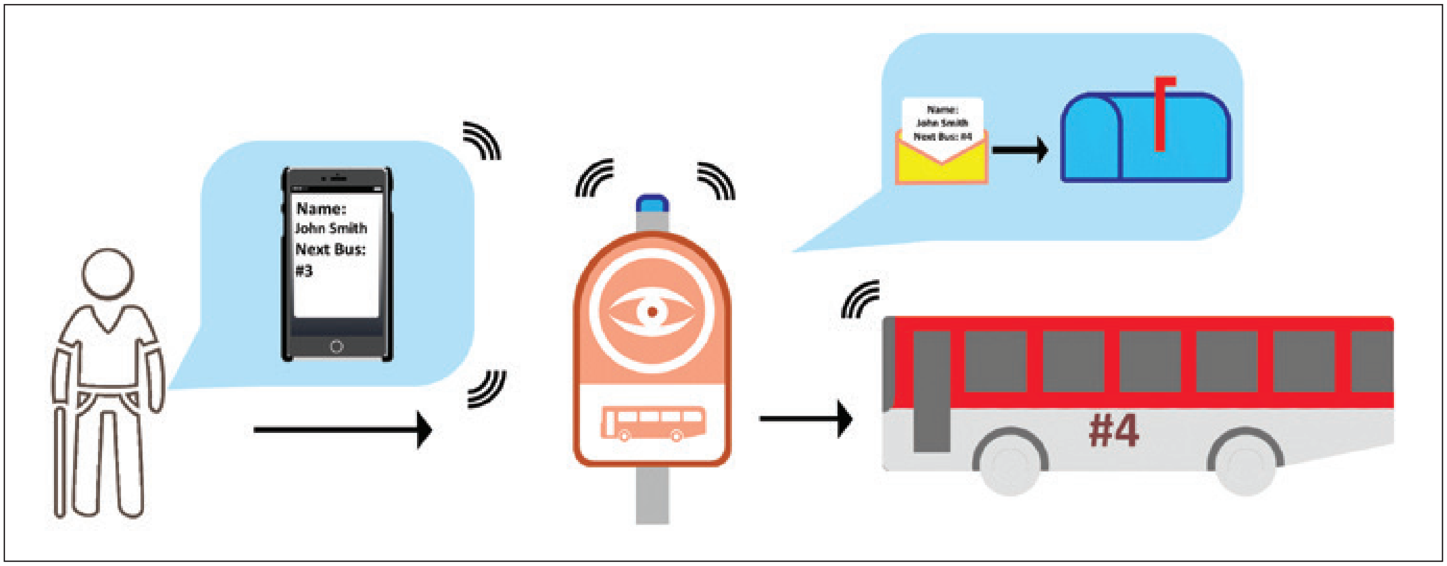


FIGURE 1 Getting on the bus.

Overall, findings from the test were positive, reinforcing the value of the service to stakeholders and its potential to integrate into and enhance current transit systems.

LookingBus is implementing a second pilot system in Lansing, Michigan, working with the Capital Area Transportation Authority for a full deployment of the LookingBus system throughout their fleet. The system is funded through the Michigan Mobility Challenge program.

Meeting a Challenge

The Americans with Disabilities Act of 1990 requires public transportation authorities to provide services for people with disabilities (*1*). More than 45 million people worldwide are blind and visually impaired; the unemployment rate for adults who are blind is approximately 70%, despite a higher college graduation rate than any other disability group (*2–3*). For the BVI population, one significant barrier to employment is the ability to commute. People with visual impairment cannot drive motor vehicles and therefore are reliant on public transportation both to obtain and to retain gainful employment.

Moreover, the reliance on high-cost paratransit, with its lengthy trips and the need for advance booking, is not well suited for getting to and from a place of employment.

A proof-of-concept cloud service–based mobile app was developed to allow users to register, manage their profiles, and select favorite travel destinations.

How the Process Works

In addition to the development of the sensors, a proof-of-concept cloud service–based mobile app was developed to allow users to register, manage their profiles, and select favorite travel destinations. At the beginning of each trip, a person who has registered with the LookingBus service reserves a trip using the mobile app.

Once the user arrives at the bus stop, a LookingBus sensor installed at the stop detects the rider and an alert message with the name and picture of the rider from their app profile is presented to the driver via the LookingBus Driver Alerting Unit (DAU) terminal.

When the user arrives at the destination stop, the LookingBus system again alerts both the users through the app on their device and the drivers through the DAU. The bus stop sensors, DAU, and user's mobile app work in synchrony to ensure that drivers and riders are fully informed throughout the journey (see sidebar, page 36).

Lessons Learned in the Pilot Test

Real-world testing was conducted with field partner SMART and volunteers who have visual impairments. Pilot testing of LookingBus highlighted a range of findings that will guide the continual development of the technology.

DRIVER FEEDBACK

Overall, drivers support a system that enhances the experience of transit users with disabilities, including riders with visual impairments. Drivers also offered valuable practical suggestions about visual, timing, and audible aspects of the system notifications to ensure that they are able to understand and address them.

Drivers noted that it was important that alerts be provided in a timely fashion and require minimal interaction with the

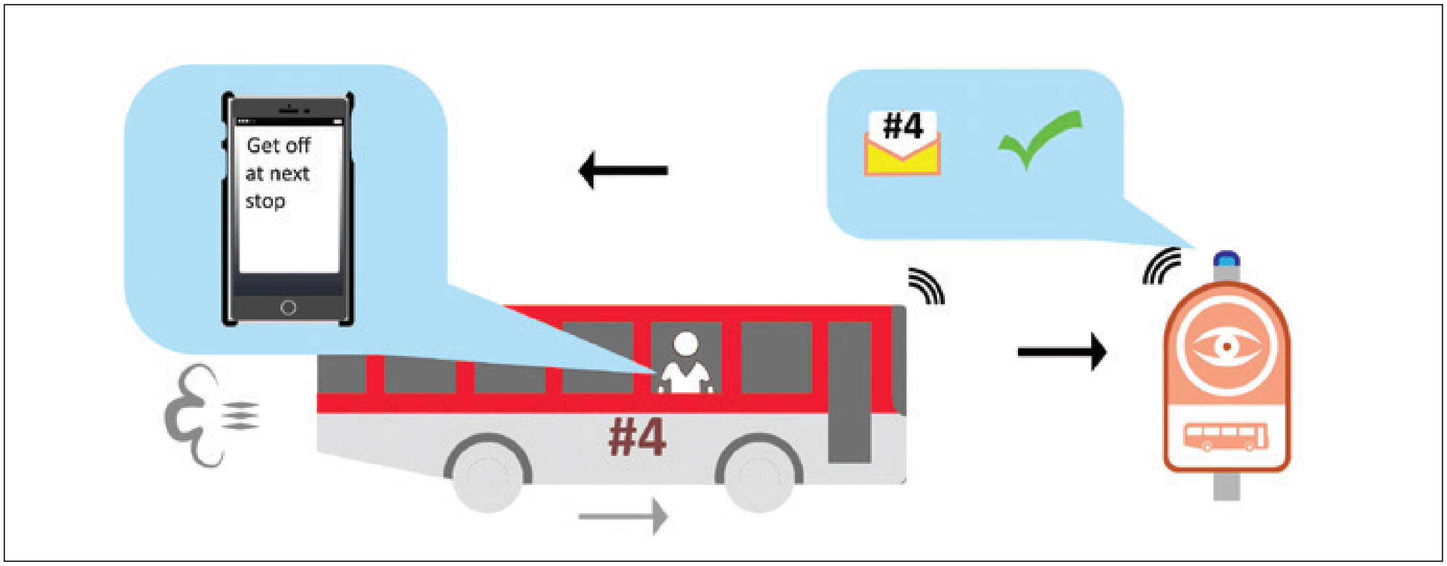


FIGURE 2 Getting off the bus.

system. Drivers also provided feedback on the positioning of the LookingBus terminal in the driver pit, as well as fonts, colors, and designs to differentiate among notifications.

RIDER FEEDBACK

Feedback from volunteers was extensive and proved vital in improving the interface to best satisfy the needs of individuals with disabilities, especially those with visual impairments. Pilot testing provided suggestions of training programs that would inform riders with disabilities of the Looking Bus system and how to use the service.

One of the standout points of interest from focus groups was that LookingBus technology enhanced accuracy in finding bus stops compared with GPS devices and other smartphone applications. Use of the technology also offered an added sense of security, in part because it assured users that the bus driver was expecting them at the stop and that the driver would be available to ensure safe boarding. Users also indicated other helpful aspects of the technology; for example, its ability to accept address or destination inputs, to plan an entire route for the user, and to allow both typing and voice input for information entry into the interface.

OPERATIONS FEEDBACK

SMART operators who observed the testing provided important feedback, especially on the integration of LookingBus with existing intelligent transportation systems. Operators appreciated the technological aspects such as system enhancement, placement of the driver terminal, and the minimal required interaction of the rider with the system. Operations personnel offered helpful suggestions on hardware design, including water resistance, robustness, and communication capabilities.

Driver alert unit positioned in bus.

Technological Advantages

LookingBus technology has several distinct technological advantages, ranging from physical design features to functionality, that facilitate an optimal and complete service for riders with disabilities. Bus stop sensors were designed as components of IoT (*4*). They have a minimum battery life of one year and must withstand all weather conditions and resist shocks in case the mounting pole were to fall over from an impact or wind (see sidebar, page 36).

The LookingBus mobile app goes beyond the micronavigation available through geolocation apps such as Google and Trekker, which can help users navigate only within 50 feet of their destination—leaving the burden on individuals with visual impairments to complete the trip while unable to see their destination. LookingBus guides the rider to the right bus stop and, by engaging the bus driver and dispatch center, ensures that the rider safely gets on and off the bus.

LookingBus also allows riders to reserve a trip within a flexible time range so they are not forced to depart at the exact same time on a recurring basis. They also are able to comfortably include a flexible bus reservation into their dynamic schedules, eliminating the need to modify their reservations daily. The app also notifies riders

LookingBus Components

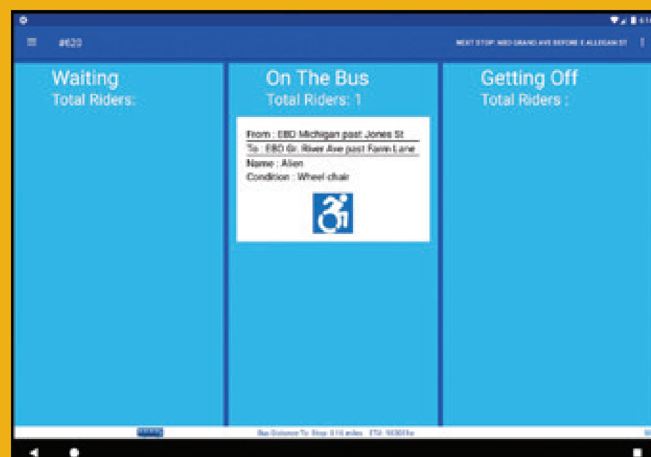
Smart Bus Stops

Sensor housing.

A variety of location-aware sensors was developed as a permanent attachment. These Internet-of-Things–enabled sensors were designed with battery or solar recharging elements to sustain long independent operation in the field under a range of conditions. The sensors were tested in Ann Arbor, Michigan, to evaluate their durability and survivability in variable weather conditions. Pole-mountable casings also were developed as waterproof housing for the sensors and as a way to mounting the sensors on bus stops to facilitate strong and reliable wireless communication.

Driver Alerting Device

A prototype driver alert unit (DAU) was developed for Android tablet with an 8-inch screen size. The tablet size was selected to fit in the busy space of the driver pit, which already includes several other screens. The DAUs communicate with the bus stop sensors in order to provide reliable advance notice to drivers about registered users awaiting pickup and drop-off. For mobile app users, the app announces when their bus is arriving and when the bus is within 40 feet of their scheduled bus stop destination.



Driver alert unit.

of nearby bus stop shelters in case of rain, cold, heat, or snow, and provides detailed alerts as to when users should exit the shelter and where the bus driver can see them upon the bus's approach.

The system's advance notifications also help drivers serve the riders better. For example, the notifications allow drivers to clear the priority seating even before the bus arrives at the stop, to stop at the most accessible pick-up point, and to help the rider get on the bus safely.

Early alerts to drivers are especially important in areas where bus stops are not perfectly accessible or when visibility is less than perfect. The alerts are especially valuable when riders are wheelchair bound. Because buses can only accommodate two wheelchairs, these alerts allow bus drivers to dispatch an additional vehicle to pick up the rider if the bus is already at maximum capacity. This allows drivers to proactively address rider needs.

The driver terminal also is completely independent from other bus systems. This means that, if other bus systems experience technical issues, LookingBus will not experience failure. From an IT perspective, this is valuable as it does not complicate the overall integration of the technology and will not affect existing bus systems.

The LookingBus tablet is mounted in its own position on the dashboard and does not interfere with the driver's use of other critical systems while they are driving. In feedback from the pilot test, drivers also mentioned that LookingBus prevented drivers from losing time in their strict schedules, because they did not have to stop to look for a user who no longer intends to board the bus.

With the LookingBus sensors at the bus stops, alerts are sent out to bus drivers only when riders are physically waiting at the stop. The sensors also cancel the notification in the event that the rider leaves the bus stop.

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Wisconsin's Oversize–Overweight Truck Route Evaluation and Efficiency

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A research project was conducted at the University of Wisconsin–Milwaukee, with funding from the National Center for Freight and Infrastructure Research and Education, or CFIRE, and the Wisconsin Department of Transportation (DOT), to develop an Oversize–Overweight (OSOW) vehicle traffic–history analysis portal. This application is focused on single-permit OSOW truck traffic to visualize routing trends, identify heavily traveled highway segments and intersections, evaluate truck routing and efficiency, and provide support to Wisconsin DOT for transportation infrastructure design and rehabilitation. Figure 1 (page 38) depicts an OSOW truck on State Trunk Highway 11 (STH-11) in Wisconsin.

Problem

Wisconsin DOT issues both single- and multi-trip permits for OSOW vehicles. Single-trip permits are granted for a specific vehicle and route. Permit routes for vehicles with a gross vehicle weight (GVW) of less than 270 kips (135 tons) are automatically analyzed by Wisconsin DOT's enterprise geographic information system (GIS), which includes a database of segment restrictions such as bridge ratings, spring thaw limitations, and temporal restrictions for traffic regulations or special events. Superheavy vehicle permits for vehicles heavier than 270 kips (135 tons) are analyzed manually by Wisconsin DOT's bridge and pavement engineering divisions before approval.

As the number of OSOW vehicle permits issued in Wisconsin have increased in recent years, the management and analysis of OSOW permit data has become more labor-intensive and time-consuming. Large quantities of archived OSOW permit data—in the hundreds of thousands—are held by Wisconsin DOT. The manual extraction and analysis of these data for various purposes requires significant effort, is time consuming and may cause project delays if the needed data are not readily available.

As a result, there was a need to develop an interactive application capable of analyzing and presenting the historical data, with the ability to expand by adding future data at the end of every quarter, to be available for the coming years.

Solution

The objectives of this research project were to create software that would draw from the state's extensive OSOW permit database and would be used to define historical route and system corridor activity. The data query application would allow both for operational assessments for new permit application considerations and would provide invaluable planning benefits for future system improvement projects. This data-driven approach is essential to modify OSOW truck route maps to reflect historical use.

A significant portion of the project was devoted to mapping the routes of the OSOW permits dataset (data from 2007 to 2018). The route information was available only as a textual route description. The researchers used customized Visual Basic for Applications scripts for text parsing and route processing, with the results linked to a GIS database to map the permit routes onto a digital map of Wisconsin's highway network. The OSOW permits database encompasses all single-trip permits issued in Wisconsin between May 2007 and December 2018, including axle records for

FIGURE 1 OSOW truck on STH-11 in Wisconsin.

OW permits. The route-matching algorithms succeeded in mapping 98.4% of all single-trip permits.

The results allowed for visualization of permit traffic, geospatial queries of permit routes, origin–destination (O-D) analyses, and identification of heavily used permit vehicle corridors (see Figure 2, page 39). These results have many applications for highway and pavement design, bridge engineering, freight trend analysis, and highway system planning.

Figure 2*a* depicts an output of the analysis application, in which the OSOW vehicle routing is visualized and quantified. The results show significant variations in the number of permit vehicles across different highways as well as the highways that were most used by permit vehicles in Wisconsin and an O-D map (as shown in Figure 2*b*).

As an example, these analyses led to the identification of segments that received high levels of permit traffic (see Figure 2*c*), including some relatively minor highways, such as STH-140. In the case of the two-lane STH-140, overweight permit traffic rivals the levels on the nearby six-lane Interstate highway I-90/I-39, in part because of STH-140's suitability for use by trucks as a bypass.

Visual identification of permit route patterns and heavily traveled segments assisted in the selection of highway segments for further study, including the *Mechanistic–Empirical Pavement Design Guide* analysis (using AASHTOWare ME Pavement Design Software) and field testing of current pavement conditions.

Application and Benefits

Based on this research project, Wisconsin DOT Truck Route Evaluation and Efficiency (TREE) was designed specifically as a system planning and improvement tool; however, it also has been a great operational resource in vetting daily permit requests to define alternative route options. The TREE task force finalized maps of OSOW routing and is in the process of updating Wisconsin DOT design guidance, the *Facilities Development Manual*. This has resulted in

1. Identification of frequently used OSOW vehicle routes;
2. Identification of average OSOW vehicle dimensions;
3. Identification of frequent O-D pairs;
4. Resolution of interregional route conflicts for proposed final mapping by allowing region by region review of historical use;
5. A draft standard for classifying Long Trucks, 75- and 65-foot-restricted routes, and sensitivity testing;
6. Verification of suitability of routes and intersections to accommodate movement of OSOW vehicles; and
7. Requirements for construction project reviews to define compliance to OSOW design standards on designated OSOW routes.

The most direct benefit of this research is that using this data tool has allowed Wisconsin DOT to evaluate the entire statewide OSOW route system. Based on this assessment, Wisconsin DOT has been able to

1. Reduce the total mileage of OSOW Truck Route (OSOW-TR) from 5,784 miles to 3,963 miles, and
2. Reduce the number of OSOW-TR Wide-Truck Route intersections from 269 to 151.

These reductions in system OSOW accommodations will benefit the public and save resources by precluding added investments to sustain higher design standards on 1,821 fewer miles and 118 fewer intersections, while still meeting the operational needs of industry. Since its implementation, this data tool has been used regularly both by the agency's operations and planning areas to provide accurate insights into OSOW routing histories.

Reduced intersections and OSOW-designed routes reduce engineering and permit staff resources needed to evaluate and maintain system assets and create more efficient and streamlined routing evaluations for staff and industry by convening the routing evaluations and system engineering assessments on a much-reduced system inventory.

Wisconsin DOT OSOW unit personnel experienced a significant time savings in providing data, trends, and information to various district engineers across the state for different needs. The Wisconsin DOT permit office formally consisted of six full-time equivalents (FTEs). It now consists of four FTEs, fully burdened at $58,968 each, for a total of $117,936; annualized savings of two positions was accomplished through attrition.

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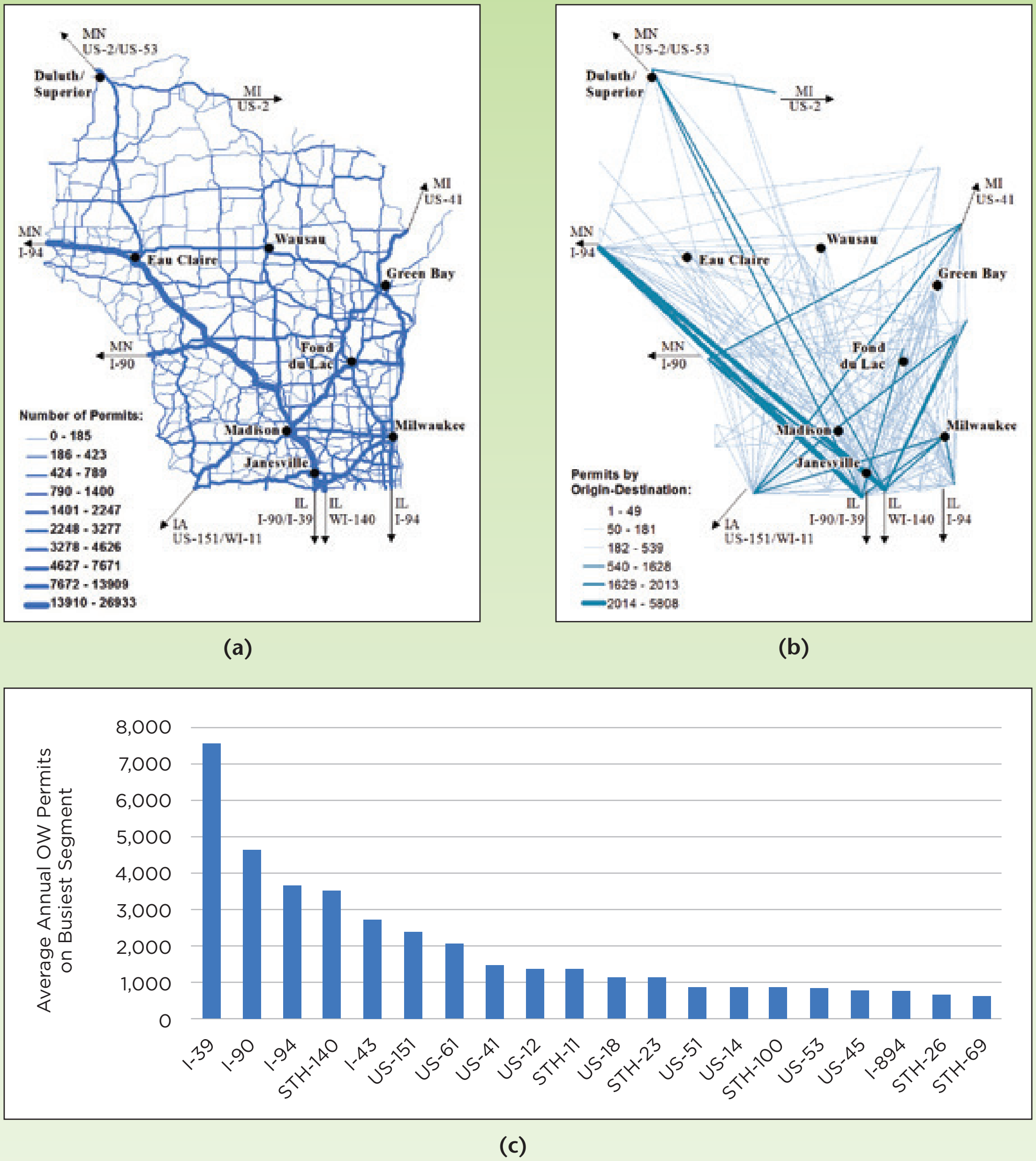

FIGURE 2 Typical results of the analysis tool developed for OSOW single-trip truck traffic: (*a*) maps of OSOW single-trip truck traffic; (*b*) OSOW O-D; and (*c*) most heavily traveled highways by single-trip OW permit trucks.

RESOURCES

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David Ballard

GRA, Incorporated

Over the course of his career with GRA, Incorporated, a firm specializing in air transportation economics, **David Ballard** has conducted economic impact studies of airports, regulatory impact analyses for the Federal Aviation Administration and Transportation Security Administration, and assessed the economic aspects of national airspace capacity growth for the National Aeronautics and Space Administration and other agencies.

"TRB-supported research—particularly through the Airport Cooperative Research Program (ACRP)—has consistently provided me with reference material and research results on which to build my own work," Ballard comments. "The availability of these research resources has helped me remain flexible as my career has presented me with new questions and challenges to address."

Ballard first became involved with TRB in the late 1990s, attending the TRB Annual Meeting and serving as a member of the Aviation Economics and Forecasting Committee. Although the first few years of Annual Meeting attendance could be overwhelming, Ballard soon involved himself in committee activities, especially Annual Meeting session planning and participation.

"Helping to create and organize even a small part of what would become the content of the Annual Meeting provided important perspective on TRB's purpose: supporting research and organizing research results in ways that could be clearly communicated to a wide-ranging community of interested scholars and practitioners," Ballard observes.

Ballard joined the Aviation Economics and Forecasting Committee in 2002 and served as its chair from 2009 to 2015. He served on the Task Force on Aviation Security and Emergency Management as well as the Subcommittee on Air Cargo. He became chair of the Aviation Group in 2017; as group chair, he represents TRB's aviation-related volunteer activities on the Technical Activities Council. Ballard also serves on the Transportation History Committee and the ACRP Project Panel on Understanding Impacts to Airports from Temporary Flight Restrictions.

"As I have moved among volunteer positions within TRB, I've had the great fortune to work with a wonderful range of people, both within and beyond aviation, who are engaged in such a fascinating range of tasks and responsibilities in their day jobs," Ballard notes, adding that the surprising parallels across modes offer learning opportunities: from safety issues to workforce concerns to maintenance and reliability challenges.

"TRB-supported research has consistently provided me with reference material and research results on which to build my own work."

After several years working in the restaurant industry post–high school, Ballard received undergraduate degrees in economics and math, and a master's degree in math, from the University of Texas at Arlington. He also received a master's degree in economics from the University of Illinois at Urbana–Champaign.

Ballard observes that interest in and engagement with TRB from students and young aviation professionals—particularly those from groups that are well-represented in the transportation workforce and community but underrepresented in TRB volunteer activities—must be encouraged by older TRB volunteers. The Aviation Group's Young Members Council has sponsored several important sessions, providing value to the aviation profession as a whole, he comments.

Ballard has also conducted research as a principal investigator on several ACRP projects. "Taking on ACRP and other large research projects has also taught me that much of what makes a research topic interesting is also what makes it a hard topic to clarify and crack open," he observes. "The value of research in all areas of transportation is that it helps to break open these hard questions and resolve them one way or another." Of course, each research question, successfully addressed, usually contains other interesting and complex challenges to address, he adds.

"I think the involvement both of researchers and transportation practitioners in TRB at all levels is especially important for assessing the practical relevance of research," Ballard muses. "Although it is natural that some research be a bit 'out there,' within TRB there can be a steady cycling of research activity and practical application and assessment that can in turn give rise to new research questions." This leads not only to cross-fertilization of research efforts but also encourages research results to mature into practical consequences that themselves have implications for new research topics.

Ballard also serves on his local municipal council and comments that transportation issues come up with surprising frequency: parking, public transportation access, conflicts between pedestrians and autos, and more. "My experience in TRB has helped me to understand and negotiate these issues for my community in very practical ways," he adds.

William L. (Bill) Eisele

Texas A&M Transportation Institute

For nearly 25 years, **William L. (Bill) Eisele** has been able to fulfill his passion of dedicated public service. In 1995, he joined Texas A&M Transportation Institute (TTI) in College Station as an assistant research scientist. He rose through the ranks of increasing research and administrative responsibility to his current position, senior research engineer and head of the Mobility Division at TTI. He is a recognized expert in the areas of mobility analysis, performance management, urban freight transportation, freight mobility, and access management.

"Our team thoroughly enjoys providing practical transportation solutions to our many public- and private-sector sponsors," Eisele notes. "We address a range of mobility issues across a variety of transportation modes, from measuring the problems to estimating the benefits and evaluating solutions."

Eisele observes that the current and future transportation ecosystem is a problem-solver's paradise and full of opportunity to address important transportation issues. As a co-author of TTI's *2019 Urban Mobility Report*, sponsored by the Texas Department of Transportation, Eisele helped define the extent of one of those issues: congestion in U.S. cities. "It is clear that most urban areas have big congestion problems. Engaging the proper stakeholders and identifying and funding the right combination of context-sensitive solutions for each unique city or region are critical to addressing this ubiquitous congestion problem," he comments.

Throughout his career, Eisele has been active with TRB. He first volunteered as a paper reviewer for several committees and in 2005 joined the Statewide Transportation Data and Information Systems Committee. He went on to serve on the Access Management Committee from 2006 to 2015, the Managed Lanes Committee from 2004 to 2010, and the Statewide Data and Information Systems Committee from 2005 to 2010. He has served on the Urban Freight Transportation Committee since 2009 and was named chair in 2017. The Urban Freight Transportation committee will receive the Blue Ribbon Committee Award for excellence in research at the 2020 TRB Annual Meeting.

"Timely research on key transportation challenges is the valuable first step to broader implementation of innovation."

"I find working with TRB as a volunteer to be very fulfilling," Eisele affirms. "The committee members I work with ensure that the 'R' in TRB stands for 'research' and for 'results.' Timely research on key transportation challenges is the valuable first step to broader implementation of innovation." As a committee member for 30 combined years, often serving on several committees at once, Eisele notes that he enjoys identifying the research challenges and developing problem statements, mentoring others, cultivating lasting friendships, and meeting the next generation of industry problem-solvers.

"The growth of urban areas and in e-commerce has caused a fierce competition for curb space in dense activity centers. As chair of the Urban Freight Transportation Committee, I lead an international team of leading minds on the topic of improving urban freight transport," he comments. "Solutions to these curb management and other first- or last-mile challenges require diverse perspectives and innovative ideas from around the world."

A Michigan native, Eisele received bachelor's and master's degrees from Michigan State University. He received a Ph.D. from Texas A&M University in Civil Engineering in 2001.

An underappreciated part of the job of a transportation professional is telling the transportation story in ways that are understandable to all stakeholders. Eisele notes the example of hearing family, friends, or colleagues complain about the trucks on the road. "They give me a befuddled look when I ask them if they ever order anything online, or eat, or have anything in their office or home. All of those things take deliveries—usually by trucks," he muses. "I have developed many research explanations by practicing on family and friends."

Over his career, Eisele has conducted a great deal of research via the National Cooperative Highway Research Program (NCHRP). Recently, he led a team that developed *NCHRP Research Report 897: Tools to Facilitate Implementation of Effective Metropolitan Freight Transportation Strategies*, which produced tools to facilitate implementation of effective metropolitan freight transportation strategies that address urban freight challenges.

"One of the most fulfilling rewards from a career in public service is mentoring others who are also dedicated to ensuring the health, safety, and welfare of our communities. I have the opportunity to mentor through TRB, at TTI, and as an executive professor at Texas A&M University, where I teach a transportation capstone course in urban planning," Eisele observes. "It is satisfying to watch these individuals become the next generation of transportation leaders."

In May, Eisele received the Patriotic Employer Award from the Office of the U.S. Secretary of Defense. He also was an Eno Transportation Foundation Fellow in 2000.

Using Plansheet Symbology for Contaminated Sites of Concern

CYRUS PARKER

The author is GeoEnvironmental Supervisor, North Carolina Department of Transportation, Raleigh.

The North Carolina Department of Transportation (DOT) has performed geoenvironmental due diligence on proposed transportation corridors since the early 1990s. The due diligence typically involves identifying sites of concern that could pose health and safety risks, construction delays, and environmental liability. This due diligence is the responsibility of the GeoEnvironmental Section of North Carolina DOT's Geotechnical Engineering Unit. Traditionally, due diligence information gathered from these investigations was transmitted in the form of memos and reports to stakeholders within the department to avoid or minimize impacts to the sites of concern.

Photo courtesy Cyrus Parker

When information about potential sites of concern is not communicated efficiently, construction projects may experience delays or even dangerous situations.

A frequent, unfortunate effect of using memos and reports as the main method of communication, however, was that information did not make its way into the hands of everyone who needed to know the location of these sites of concern. On some projects, sites of concern were acquired inadvertently, and construction began before the concerns on the sites were addressed—despite memos and reports documenting the concerns. Some projects resulted in construction delays from underground fuel tanks being ruptured during construction.

On one project, a natural gas utility contractor installed a gas main through a pair of buried fuel tanks before the fuel tanks could be removed. These concerns were known, but not to everyone that needed to know.

COLLABORATIVE EFFORT

North Carolina DOT's GeoEnvironmental Section sought to improve its method for communicating these sites of concern to project stakeholders, so a series of MicroStation GeoEnvironmental cells and line styles were developed to visualize these sites of concerns onto the project plansheets, as shown in the figures below.

Development of the cells and line styles was a collaborative effort between the GeoEnvironmental Section, Roadway Design Unit, and CADD Services of North Carolina, along with input from several other groups within the agency. The goal was for the cells and line styles to be unique, easily identifiable, and not in conflict with other elements on the plansheets. The skull-and-crossbones symbol was chosen because it is universally recognized as a symbol for caution and danger; this symbol was adapted into several variations to address different media and degrees of certainty.

The GeoEnvironmental Section reviews projects for sites of concern at various stages of project development. Each stage of review provides additional detail about the sites of concern as the project progresses through the various project renditions, from the initial study area to the more developed project limits and, ultimately, to the proposed final design.

Identification Phase

For example, once the study area is determined in the early stages of project development, the GeoEnvironmental Section performs a desk search of sites of concern to identify potential impacts to the project. These potential sites are identified on the plans with a question-mark skull-and-crossbones symbol (see Figure 1, below). The question mark signifies that the site is a potential site of concern.

Field Investigation Phase

As the project development progresses and project limits of the preferred alternative are defined, the GeoEnvironmental Section performs a field investigation of the project limits. Some of the potential sites may be removed as sites of concern because, although they are within the initial study area, they may not lie within the smaller project limits. Other potential sites may change from potential to known sites of concern because of known contaminant releases discovered by the detailed site review. Sites with known contamination are identified on the plans by a face skull-and-crossbones symbol to distinguish it from potential sites of concern.

Final Investigation Phase

The final phase of investigation is performed when the right-of-way plans have been completed. Known and potential sites of concern then are sampled for soil and

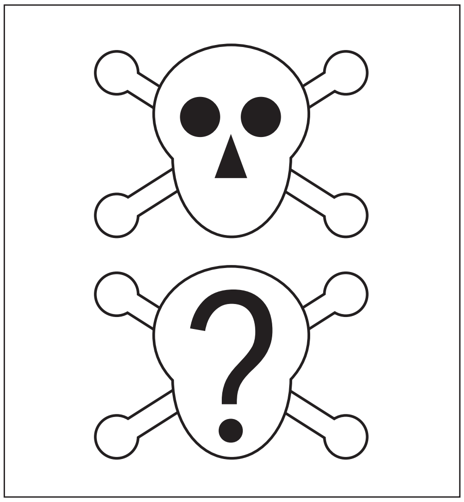

FIGURE 1 Plansheet symbols indicating sites of concern (*top*) and potential sites of concern (*bottom*).

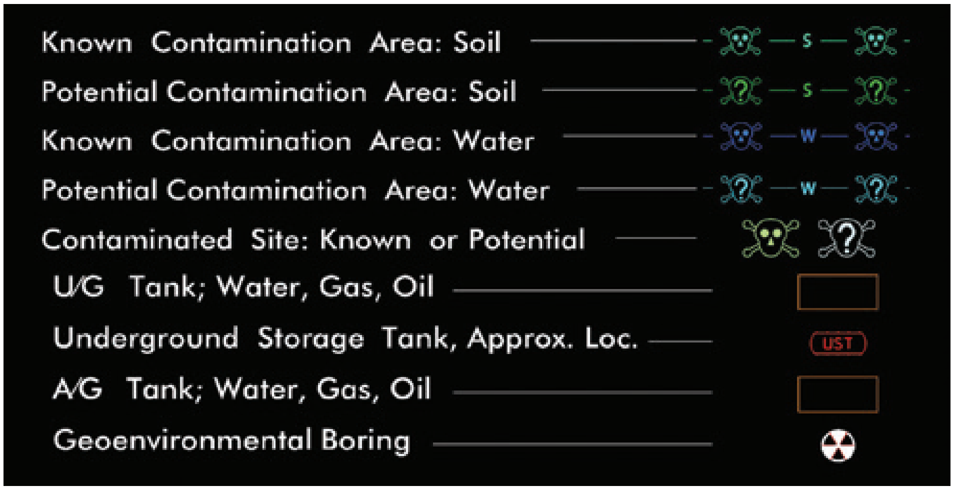

FIGURE 2 Plansheet symbology.

groundwater contamination to develop right-of-way acquisition recommendations, as well as design and construction recommendations to address contaminants that may be encountered during construction. Soil and groundwater data collected during the final phase of investigation are visualized on the plans by line styles showing contaminant plumes for soil and groundwater. These are depicted by skull-and-crossbones symbols along with “S” for soil and “W” for water (see Figure 2, above).

IMPLEMENTATION SUCCESS

Since this procedure has been in place, North Carolina DOT has received many comments from stakeholders who have reviewed the plans, such as the following:

- We were going to install a storm drain in this area and noticed the skull-and-crossbones on the plans. What do we need to know about this site?
- We plan to install a utility pole in the area marked with an Underground Storage Tank symbol. When can you remove this tank so we can install our pole?
- We want to do a wetland mitigation here but see a skull-and-crossbones symbol. Can we still do the mitigation here?
- We were about to make an offer to purchase this property but noticed the skull-and-crossbones. What acquisition recommendations do you have for this property?

These and many similar comments might have been missed without this symbology on the plans. Overall, adding geoenvironmental symbology to plansheets has been successful in providing a better awareness to North Carolina DOT stakeholders regarding geoenvironmental sites of concern.

Innovations in Tech-Enabled Road Pricing

ClearRoad Wins 2019 Six-Minute Pitch Contest

ALEXANDER BIGAZZI

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ClearRoad, a start-up company facilitating next-generation road pricing strategies, won the Six-Minute Pitch contest at the 2019 TRB Annual Meeting in Washington, D.C. ClearRoad’s financial and data management platform turns road usage data into financial transactions on behalf of roadway operators.

The annual Six-Minute Pitch session at the Annual Meeting offers four entrepreneurs the opportunity to pitch their new transportation technology product or service to a panel of transportation industry entrepreneurs and investors—in six minutes. Pitch presenters are judged on the commercial feasibility of their proposal and how the proposal contributes to meeting one of today’s critical transportation challenges. Two main questions that the judges often ask are 1) how well the company has proven its concept—including the importance of prototypes, demonstration projects, existing customers and partners, and experience in the industry—and 2) the potential growth for the company and sector.

Paul Salama, ClearRoad COO, pitched to a record-setting audience at the special TRB session. With a background in urban planning and technology consulting, Salama recognized the potential for tech-enabled road pricing to help cities manage traffic and, in particular, to realize the benefits of autonomous vehicles and avoid the risks of increased congestion.

Even though at that point Salama had delivered pitches to dozens of investors, he still prepared and practiced for the Six-Minute Pitch audience. To aspiring pitch participants, he recommends that no amount of practice is too much—especially in front of audiences.

Frederic Charlier, founder and CEO of ClearRoad, has a background in the tolling industry and worked on the pioneering road usage charge program in Oregon. Several states are planning or developing similar road pricing programs and pilots. ClearRoad is currently expanding its partnership network, engaging with road network managers at the corridor, city, and state levels and seeking innovations in approaches to road pricing as well as incorporating dynamic boundaries, traffic conditions, and vehicle-specific impacts.

At the Annual Meeting session, judge Gabe Klein noted that road pricing is a growing industry with space for many companies to participate in the new ecosystem.

Three other companies also participated in the 2019 Six-Minute Pitch: Commutifi, pitched by Esteban Sanchez; RFNav, pitched by Jim Schoenduve; and Ruut, pitched by Hamish Campbell. Commutifi provides commute scoring and indices to help businesses and cities understand and

Gabe Klein (*center*) offers feedback to Paul Salama (*right*). Also pictured (*left to right*) are judges Kathleen Baireuther, Sean O'Sullivan, and David Zipper.

improve travel options. RFNav is developing new technology for the autonomous vehicle market using advanced radar to achieve the precision of lidar but with better performance in adverse weather and lighting conditions. Ruut is a start-up medium-haul intercity bus service with a focus on quality of experience and traveler well-being.

The winner of the 2018 Six-Minute Pitch was Intelligent Pavement Solutions (ISP), a company that uses innovative data collection and processing methods to provide cities and counties with comprehensive pavement management systems. Since ISP's win, the company has spent a considerable amount of time in customer validation and began commercial operations in the second quarter of 2019. According to presenter Ram Reddy: "The Six-Minute Pitch came at a very crucial moment for IPS. It gave us direction as we refine and finalize our product and business model."

The 2019 Six-Minute Pitch judges included Kathleen Baireuther, Ford Smart Mobility; Gabe Klein, Fontinalis Partners and Cityfi; Sean O'Sullivan, SOSV; and David Zipper, German Marshall Fund.

The Six-Minute Pitch Transportation Start-Up Challenge is sponsored by TRB's Young Members Council and was moderated by Shana Johnson of Foursquare Integrated Transportation Planning, with assistance from Susan Paulus of Lakeside Engineers, Alex Bigazzi of the University of British Columbia, and Ginger Goodin of Texas A&M Transportation Institute.

For details on the Six-Minute Pitch, visit sixminutepitch.com.

2019 Six-Minute Pitch judges, presenters, and organizers (*left to right*): Sean O'Sullivan, Alex Bigazzi, David Zipper, Jim Schoenduve, Esteban Sanchez, Gabe Klein, Kathleen Baireuther, Paul Salama, Shana Johnson, Hamish Campbell, and Ginger Goodin.

Communicating the Challenge of Transportation Resiliency and Sustainability

12th Annual Competition Identifies Best Practices

TERRI H. PARKER

The author is Director, Marketing and Communications, Texas A&M Transportation Institute, College Station.

With strategies ranging from media outreach to an innovative clearinghouse tool to online tutorials, the winners of the 12th Annual Communicating Concepts to John and Jane Q. Public Competition illustrated best practices in communicating transportation resiliency and sustainability.

Members of the public understand that the transportation system is among the most critical systems affected during major disruptions—whether these are security incidents or weather events like hurricanes, wildfires, floods, or mudslides. At the same time, transportation professionals are developing strategies to increase the resiliency and sustainability of the transportation system.

Successful nominees highlighted fresh and unique ways of discussing the strategies, investments, and critical decision-making elements that are part of the transportation planning and response to changing climate conditions and major weather events.

The Colorado Department of Transportation (DOT) received top honors in the competition for its entry, "U.S. 34 Flood Recovery Project." When devastating floods hit Colorado in 2013, the

Competition winners and chairs (*left to right*): Claudia Bilotto, past chair, TRB Public Involvement Committee; Libby Rushley, chair, TRB Planning and Environment Group; Joseph Segale, Vermont Agency of Transportation; Annie Bennett, Georgetown Climate Center; Joshua Laipply, Colorado DOT; and Terri Parker, member, TRB Public Involvement Committee.

state's leaders sought to rebuild the affected roads and bridges better than they were before, while ensuring stakeholder participation and communication. The project team worked with community members to develop a mutually beneficial closure strategy spanning the tourist season and allowing emergency responders and residents to enter and exit the canyon in an emergency.

Colorado DOT used many innovative communication tools to communicate with the residents and various stakeholders, including public meetings, fact sheets, and an online tutorial. The team also coordinated with service providers like the U.S. Postal Service, school district transportation officials, package delivery services, waste haulers, propane delivery companies, residential contractors, and tourism industry leaders. More than 300 Internet and television media stories were published to keep the local communities informed.

Also receiving honors was the Vermont Agency of Transportation for the entry "VT Transportation Resilience Planning Tool." This web-based application identifies bridges, culverts, and road embankments that are vulnerable to damage from floods; offers risk estimates based on the vulnerability and criticality of roadway segments; and identifies potential mitigation measures based on the factors driving the vulnerability. The tool was developed in conjunction with a diverse group of stakeholders and was designed for volunteers, who are the backbone of Vermont town councils, planning commissions, conservation commissions, and emergency management agencies.

The Georgetown Climate Center at Georgetown University was recognized for "Linking Decision-Makers and the Public to Transportation Adaptation Resources," a comprehensive resource to publicize innovative plans, policies, projects, and other strategies for integrating resilience and adaptation measures into transportation sector programs and processes. This clearinghouse allows staff from local, regional, and state government agencies—as well as members of the public—to identify and easily absorb strategies utilized by transportation agencies from across the United States to consider climate change impacts in transportation decision-making.

Competition recognitions were also awarded in absentia to Rhode Island DOT for the project "Resilient Rhody Resources: Planning for Climate Change in Rhode Island" and to Sustainable Transportation Services of Indiana University, Bloomington, for the initiative "Sustainable Transportation Options for IU Students."

For more information about these entries, visit the TRB Committee on Public Involvement website at http://sites.google.com/site/trbcommitteeada60.

Transportation Is Changing, and So Is TRR

PATTI LOCKHART

The author is *Transportation Research Record* Journal Managing Editor, Transportation Research Board, National Academies of Sciences, Engineering, and Medicine, Washington, D.C.

The 2018 collaboration between Sage Publications and the *Transporation Research Record: Journal of the Transportation Research Board* (TRR) presented TRB the opportunity to take a fresh look at the journal and its role in the transportation community. The TRR team now has the opportunity to leverage Sage's online platform and marketing team to expand the reach and impact of the journal, one of the most-cited transportation journals in the field. With the guidance of the TRR Advisory Review Board, TRR has introduced several initiatives in 2019.

EDITORIAL BOARD AND YEAR-ROUND REVIEW

We are delighted to announce our inaugural Transportation Research Record Editorial Board.[1] The TRR Editorial Board is composed of more than 100 volunteers who work in a similar manner to the board of our sister journal at the National Academies of Sciences, Engineering, and Medicine, *Proceedings of the National*

[1] To view the current members of the Editorial Board, visit the TRR website (https://journals.sagepub.com/home/trr/) and click About/Editorial Board & Staff (https://trreditorialboard.weebly.com/).

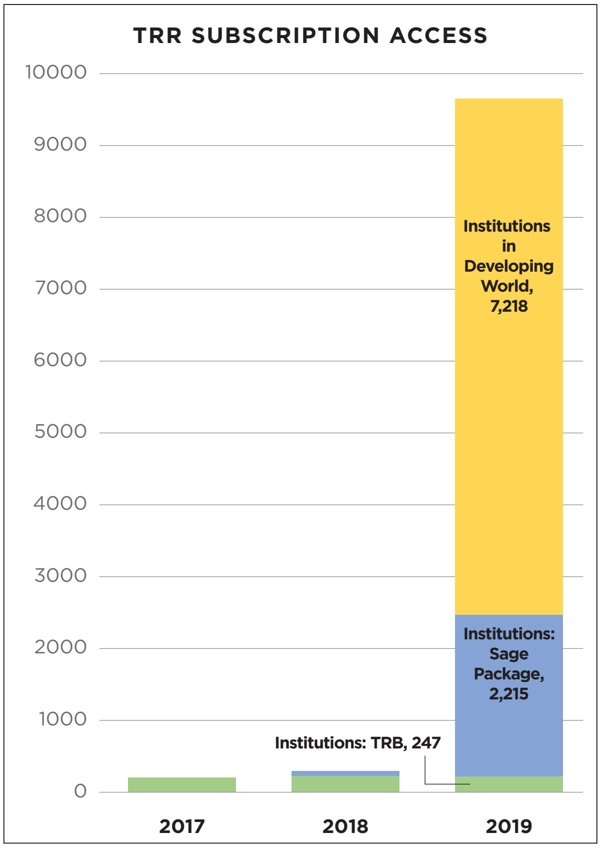


FIGURE 1 TRR subscription access, 2017–2019.

Academy of Sciences. The members of the Editorial Board represent the wide range of transportation research disciplines published in TRR and will be responsible for the strategic and tactical direction of the journal. The board will build upon the committee review process and, by moving to year-round review, will allow adequate time to elevate each paper to its highest potential.

DISCOVERABILITY

- *TRR* distribution has expanded from approximately 200 institutions in 2017 to more than 9,000 in 2019 (see Figure 1, at left).
- More than 7,000 institutions in the developing world now receive free access to TRR as part of the Research4Life consortium, which gives researchers in developing countries access to research.
- Migration to Sage's full-text HTML platform gives new content better visibility online.

TRANSPARENCY

- TRR is a member of the Committee for Publication Ethics and is compliant with their guidelines for integrity in review and publication.
- A data-accessibility policy is being implemented to support open-data mandates.
- Integration with Funder Registry (formerly FundRef) will help identify funding behind research and allow funders to connect grants with published works.

QUALITY OF SERVICE

- Faster speed to publication: in 2019, we published more than 90% of our content in the first half of the year, compared to 35% in 2018 and 15% in 2017.
- Integration with ORCiD and Publons validates review activity for our reviewers.
- Through our peer review platform, authors and reviewers receive free access to TRR.
- Collaboration with institutional press offices helps to promote new publications.
- The 2020 Annual Meeting will feature a "Promote Your Research" session.

LOOKING AHEAD

TRB will continue to collaborate with Sage to further enhance our service to the transportation community by developing a preprint portal, showcasing technical, practical papers. TRR papers also will be packaged into collections and can be browsed by topic. We also plan to provide publicity support for authors and to seek out ways to enhance our social media outreach.

For more information about TRR and our future improvements, see https://journals.sagepub.com/home/trr.

Interested in being a reviewer for TRR? Register now at https://www.editorialmanager.com/trr/default.aspx.

Study Ranks Urban Biking Access

Urban areas vary widely on how easily and feasibly cyclists can commute to work, and one study has calculated and ranked that accessibility in the 50 largest U.S. metropolitan areas. The Center for Transportation Studies at the University of Minnesota analyzed bike infrastructure according to low-stress routes—those with separated bike lanes and paths—and medium-stress routes—those that include on-street unprotected or shared lanes—to determine accessibility values in major metropolitan areas.

Using travel data from over all 11 million census blocks, researchers examined spatial patterns of accessibility on a national level. Rankings were calculated based on several factors: travel time, ease of route, and commute distance.

According to the report, cities often show different rankings between their low-stress and medium-stress job accessibility metrics. For example, Philadelphia, Pennsylvania, places 5th in low-stress access but only 13th in medium-stress access, and Minneapolis–St. Paul, Minnesota, places 12th in low-stress access and 7th in medium-stress access. This means that Philadelphians who are only willing to bike on low-stress facilities reach more jobs than Minneapolis residents using low-stress routes, but Minneapolis residents who are willing to travel on all types of bicycle facilities—low- and medium-stress—reach more jobs than Philadelphia residents.

The metropolitan areas that perform best when comparing medium-stress access to the maximum-possible bike access are Minneapolis–St. Paul; San Francisco, California; and Portland, Oregon. All three cities have bicycle networks that, on average, allow their residents to reach more than 74% of the job opportunities theoretically available to cyclists (if all routes felt as safe as an off-street path).

Photo: Oregon DOT

Portland, Oregon, is one of the most bike-friendly cities in the country.

For both low- and medium-stress routes, New York; San Francisco; Chicago, Illinois; and Denver, Colorado, are the top cities for bicycle commuting. Philadelphia; Washington, D.C.; and Portland also rank well in at least one category.

To read the full report, visit http://access.umn.edu/research/america/biking/2017/.

Infotainment Systems Dangerously Distracting

According to new findings by the AAA Foundation for Traffic Safety and the University of Utah, interactive vehicle technologies are dangerously distracting—particularly for older drivers.

Infotainment systems, which allow drivers to use voice commands and touch screens, require significant visual and cognitive demands, especially when the systems involve multiple menus. In a recent study, researchers asked two groups of participants—ages 21–36 and 55–75—to make calls, send texts, use navigation systems, and control the radio while driving with various stimuli. In one test, many participants could only detect the stimuli 25% of the time while completing technology tasks.

In all tests, the older participants performed more slowly, although previous studies have shown that very young and new drivers also are dangerously distracted for long periods, putting them at significant risk for crashes.

To learn more, visit https://aaafoundation.org/age-related-differences-in-the-cognitive-visual-and-temporal-demands-of-in-vehicle-information-systems.

INTERNATIONAL

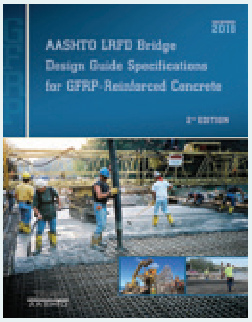
Mental Health Barriers for Travel Studied

Researchers from the University College of London examined the effect of mental health conditions like anxiety, depression, and obsessive-compulsive disorder on travel behavior. The study is based on a survey on mental health and travel, distributed via 18 organizations using social media, websites, and newsletters.

Approximately 385 respondents, all with various mental health conditions, provided information on their gender, age, where they lived, and how their conditions influenced their travel behavior. Challenges examined included travel planning; travel by walking, bus, train, metro, taxi, cycling, car, and planes; wayfinding; and interacting with other travelers. The study includes personal stories, statistics, analysis, and recommendations.

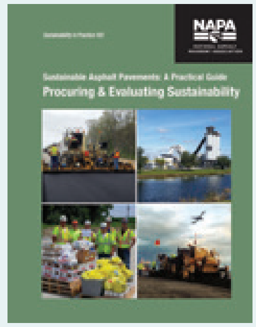
More than one-third of all respondents indicated that they frequently do not leave home because of anxiety. Many respondents noted that factors like clearer information, better-trained staff, travel training, and travel assistance cards might encourage them to use transit.

To read the full report, visit www.ucl.ac.uk/civil-environmental-geomatic-engineering/sites/civil-environmental-geomatic-engineering/files/mental_health_and_travel_-_final_report.pdf.



AASHTO LRFD Bridge Design Guide Specifications for GFRP-Reinforced Concrete, 2nd Edition
American Association of State Highway and Transportation Officials, Washington, D.C., 2018; 121 pp. Free downloadable PDF at https://store.transportation.org/Item/PublicationDetail?ID=4148.

These guide specifications offer a description of the material properties of glass fiber–reinforced polymer (GFRP) composite materials and provisions for the design and construction of concrete bridge decks and railings reinforced with GFRP reinforcing bars. Advancements in material specifications and new knowledge and field experiences are included.

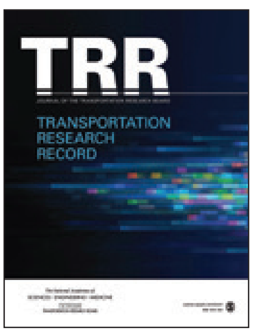


Sustainable Asphalt Pavements: A Practical Guide—Procuring and Evaluating Sustainability
National Asphalt Pavement Association, 2019; 14 pp. Free downloadable PDF at www.asphaltpavement.org/PracticalGuide.

This volume, the third installment in the *Sustainable Asphalt Pavements* series, outlines how public projects are starting to incorporate and reward sustainable construction projects. Discussed are specific approaches for procuring sustainability and guidance for evaluating sustainability and best practices.

The titles in this section are not TRB publications. To order, contact the publisher listed.

TRB PUBLICATIONS



Transportation Planning Applications
Transportation Research Record 2672, Issue 46

The economic implications of deteriorating highway conditions, the effect of automated driving on commuter travel time saving, and the impact of street intersection characteristics on perceived bicycle safety are some of the topics examined in this issue.

2018; 82 pp. For more information, visit http://journals.sagepub.com/home/trr.

Travel Behavior and Values
Transportation Research Record 2672, Issue 47

Included in this issue is the 2018 Thomas B. Deen Distinguished Lecture, which addresses the expanding uses of travel time, along with articles on mobility, mode choice behavior, and travel mode systems.

2018; 241 pp. For more information, visit http://journals.sagepub.com/home/trr.

Transportation Network Modeling
Transportation Research Record 2672, Issue 48

This issue presents research on network modeling, including school bus trip scheduling, risky route choices based on predictive traffic information, and taxi fleet operations, among other topics.

2018; 147 pp. For more information, visit http://journals.sagepub.com/home/trr.

Articles for Issues 1–9 of the *Transportation Research Record: Journal of the Transportation Research Board* (TRR) Volume 2673 (2019) are now online. Beginning this year, *TRR* will publish one interdisciplinary issue monthly. Individual articles will be released as available and compiled into the issue at the end of the month. Readers will be able to access either the complete issue or individual articles. For more information, visit http://journals.sagepub.com/home/trr.

Travel Demand Forecasting
Transportation Research Record 2672, Issue 49

Examined in this issue are forecasting methods, models, and analysis for such topics as long, noncommute travel behaviors; travel-time reliability; and plug-in electric vehicles.

2018; 170 pp. For more information, visit http://journals.sagepub.com/home/trr.

Effects of Information and Communications Technology on Travel Choices
Transportation Research Record 2672, Issue 50

Store versus online shopping, automated vehicles on urban roads, social media engagement of transit agencies, and commuting multitasking are some the topics explored in this issue.

2018; 78 pp. For more information, visit http://journals.sagepub.com/home/trr.

Transportation Planning, Program and Investment Decision Making
Transportation Research Record 2672, Issue 51

Included in this issue are articles on transportation planning for connected automated vehicles, identification of recurring bottlenecks, real-time information technology readiness, and construction cost impact of Hurricanes Katrina and Rita.

2018; 108 pp. For more information, visit http://journals.sagepub.com/home/trr.

Geological, Geoenvironmental, and Geotechnical Engineering
Transportation Research Record 2672, Issue 52

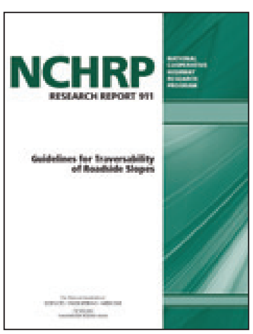
Engineering applications for areas like fine-grained soil distribution, porous asphalt mixtures, recurrent pavement heave, and stabilized earth reinforcements are examined in this issue.

2018; 357 pp. For more information, visit http://journals.sagepub.com/home/trr.

Transportation Research Record 2673
Issue 1

This issue includes the 2019 Thomas B. Deen Distinguished Lecture on innovative asphalt pavement technology as well as articles across a broad range of transportation topics like environment, freight, data, and infrastructure.

2019; 531 pp. For more information, visit http://journals.sagepub.com/home/trr.



Guidelines for Traversability of Roadside Slopes
NCHRP Research Report 911

Thousands of simulations for combinations of slope configurations and geometric conditions that represent real-world rollover crash scenarios were conducted to produce this guidance on roadside slope traversability, which includes shoulder width, foreslope, and foreslope width.

2019; 160 pp.; TRB affiliates, $63.75; nonaffiliates, $85. Subscriber categories: highways, design, safety and human factors.

Guidelines for Detection and Remediation of Soluble Salt Contamination Prior to Coating Steel Highway Structures
NCHRP Research Report 912

A brief background on soluble salts as well as responses to a series of inspector, contractor, and designer questions are explored in this practical guidance on detecting and remediating soluble salt contamination before coating steel highway structures.

2019; 100 pp.; TRB affiliates, $54; nonaffiliates, $72. Subscriber categories: construction, maintenance and preservation, materials.

Compendium of Successful Practices, Strategies, and Resources in the U.S. DOT Disadvantaged Business Enterprise Program
NCHR Research Report 913

This report examines disadvantaged business enterprises that have successfully competed for state department of transportation (DOT) contracts and explores the types of business assistance that contributes to their success.

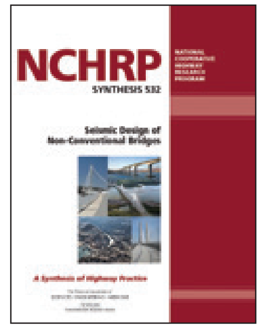
2019; 212 pp.; TRB affiliates, $69.75; nonaffiliates, $93. Subscriber categories: administration and management, law.

Measuring, Characterizing, and Reporting Pavement Roughness of Low-Speed and Urban Roads
NCHR Research Report 914

This report reviews the practices for measuring and characterizing pavement roughness and the unique features of low-speed and urban roads and evaluates the use of inertial profilers for these measurements.

2019; 164 pp.; TRB affiliates, $63.75; nonaffiliates, $85. Subscriber categories: materials, pavement.

To search for TRR articles, visit http://journals.sagepub.com/home/trr. To subscribe to TRR, visit https://us.sagepub.com/en-us/nam/transportation-research-record/journal203503#subscribe.



Seismic Design of Non-Conventional Bridges
NCHRP Synthesis 532

This synthesis documents seismic design approaches and criteria used for nonconventional bridges, such as long-span cable-supported bridges, bridges with truss tower substructures, and arch bridges.

2019; 142 pp.; TRB affiliates, $60; nonaffiliates, $80. Subscriber category: bridges and other structures.

Very Short Duration Work Zone Safety for Maintenance and Other Activities
NCHRP Synthesis 533

This synthesis identifies the current state of practice among state DOTs regarding selection and setup of very short duration work zone. Case examples from four state agencies are presented.

2019; 74 pp.; TRB affiliates, $49.50; nonaffiliates, $66. Subscriber categories: highways, maintenance and preservation, safety and human factors.

Developing Innovative Strategies for Aviation Education and Participation
ACRP Research Report 202

This report includes resources to help promote interest in aviation among young people, ranging in age from 10 to 25 years old.

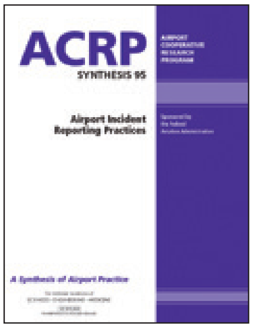
2019; 108 pp.; TRB affiliates, $57; nonaffiliates, $76. Subscriber categories: aviation, education and training.

Guidelines for Collecting, Applying, and Maintaining Pavement Condition Data at Airports
ACRP Research Report 203

Provided in this report is guidance on the collection, application, and maintenance of pavement condition data, including data on visually observed as well as mechanically measured conditions.

2019; 120 pp.; TRB affiliates, $57; nonaffiliates, $76. Subscriber categories: aviation, maintenance and preservation.

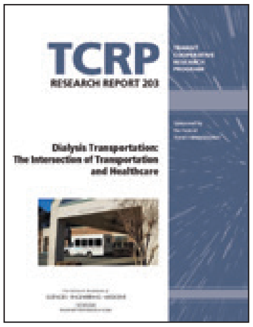
To order the TRB titles described in Bookshelf, visit the TRB online bookstore, www.TRB.org/bookstore, or contact the Business Office at 202-334-3213.



Airport Incident Reporting Practices
ACRP Synthesis 95

This synthesis focuses on current practices for defining, collecting, aggregating, protecting, and reporting airport organizational incident information in order to assist airport operators understanding the nature of airport incident reporting and its importance for organizational learning and effectiveness, risk management, operational safety, and worker safety.

2019; 112 pp.; TRB affiliates, $57; nonaffiliates, $76. Subscriber categories: aviation, administration and management, policy.



Dialysis Transportation: The Intersection of Transportation and Healthcare
TCRP Research Report 203

This report addresses the complicated relationship of transportation and healthcare, highlighting problems, identifying strategies, and suggesting options that may be more appropriate for dialysis transportation.

2019; 148 pp.; TRB affiliates, $63.75; nonaffiliates, $85. Subscriber categories: public transportation, passenger transportation.

CENTENNIAL QUOTES

Ever since I attended my first meeting as a graduate student, I have been inspired and motivated by the many opportunities, leadership, and vast network that this organization provides. Almost two decades ago, I connected with a small group of colleagues that assembled from across the globe at TRB's annual meeting to introduce and advance the topic of shared mobility. TRB has provided a critical home and network for this emerging and innovative idea. Ultimately, our TRB shared mobility subcommittee has grown to encompass a much larger community of scholars and practitioners who share a passion for better understanding the social and environmental impacts, policy implications, and future evolution of this topic.

—SUSAN A. SHAHEEN
Professor and Co-Director, Transportation Sustainability Research Center, University of California (UC), Berkeley, and Director, Innovative Mobility Initiative, UC Institute of Transportation Studies

As a pedestrian advocate and founder of WalkBoston, I found TRB to be a place to meet, engage with, and work with the best minds in transportation, and to learn from Annual Meeting sessions. I served as chair of the Pedestrians Committee for 6 years—and was able to plan and increase those sessions (thank you, Rick Pain!)—followed by 4 years as the chair of the Pedestrians and Cycles Section. In Boston, I served on the MassPike board and took in TRB sessions about guardrails, paving types—I even presented MassPike's innovative landscape management program, also known as "let the grass grow." It was all such fun.

—ANN HERSHFANG
WalkBoston

December

11–12 **Conference on Health and Active Transportation**
Washington, D.C.

11–13 **International Accelerated Bridge Construction Conference***
Miami, Florida

18–21 **5th Conference of Transportation Research Group of India***
Bhopal, Madhya Pradesh, India

2020

January

12–16 **TRB 2020 Annual Meeting**
Washington, D.C.
For more information, visit www.trb.org/AnnualMeeting.

February

25–28 **American Society of Civil Engineers Geo-Congress 2020***
Minneapolis, Minnesota

March

8–20 **Geosynthetics 2020: Case Studies***
Charleston, South Carolina

April

2–3 **Commodity Flow Workshop**
Washington, D.C.

RECENT AND UPCOMING WEBINARS

November

20 Using GIS for Land Use Compatibility Planning Near Airports

21 Metered Roundabouts: Peak-Hour Flows and Part-Time Signalization

December

3 Advanced Structural Materials for Concrete Bridges

5 Innovative Alternative Intersection and Corridor Studies Using the HCM6

10 Give the "All Clear:" Hazard Zoning at General Aviation Airports

11 Tunnel Operations Practices Featuring the MassDOT Tunnel

January 2020

27 Turning Your Aviation Research Question into a Problem Statement

29 Turbocharged: Turbo Roundabout Advancements

To subscribe to the TRB E-Newsletter and keep up to date on upcoming activities, go to www.trb.org/Publications/PubsTRBENewsletter.aspx and click on "Subscribe."

CONSENSUS AND ADVISORY STUDIES

November

19–20 Committee Meeting on Lead Emissions from Piston-Powered General Aviation Aircraft
Washington, D.C.

21–22 Federal Railroad Administration Research & Development Committee Meeting
Washington, D.C.

December

5–6 Review and Update of Bureau of Safety and Environmental Enforcement Offshore Oil and Gas Operations Inspection Program Committee Meeting
Washington, D.C.

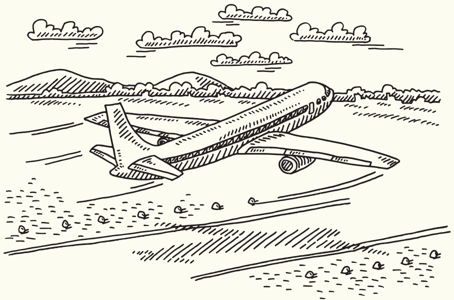
10–11 Research and Technology Coordinating Committee Meeting
Irvine, California

For more information on these events, e-mail Michael Covington, TRB, at mcovington@nas.edu.

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.

*TRB is cosponsor of the meeting.

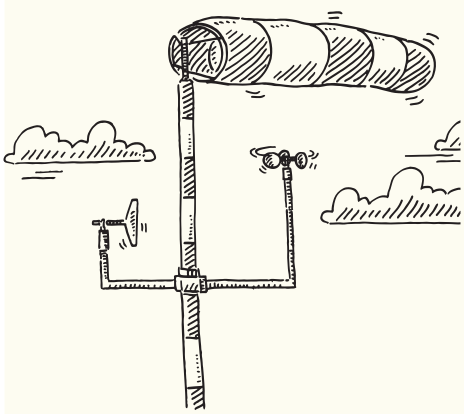
COOPERATIVE RESEARCH PROGRAMS



Problem statements are being accepted for the FY 2021 **Airport Cooperative Research Program** (ACRP). The deadline is Sunday, March 1, 2020.

For more information, see www.trb.org/ACRP/ACRP.aspx.

A helpful 5-minute video, "What Makes a Good Problem Statement?," can be found at https://vimeo.com/327744004.

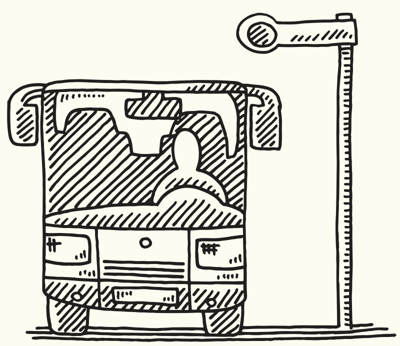


Submissions are being accepted to the **ACRP University Design Competition for Addressing Airport Needs**. A Notice of Intent (due Jan. 28, 2020 for spring semester) is encouraged but not required. Electronic and hard copy proposal submissions must be sent to the Virginia Space Grant Consortium by April 29, 2020.

For submission guidelines and more information, visit vsgc.odu.edu/ACRPDesign-Competition.

The **Transit Cooperative Research Program** panel nominations are accepted between Nov. 11, 2019, and Jan. 25, 2020.

For more information, visit www.trb.org/TCRP/TCRP.aspx.



NASEM EVENTS

November

20–22 **Astro2020: Panel on State of the Profession and Societal Impacts Meeting**
Arnold and Mabel Beckman Center, Irvine, California
For more information, contact Dionna Wise at dwise@nas.edu.

December

3 **Seminar on Climate-Resilient Smart Cities: Human–Technology Integration**
Keck Center of the National Academies
500 Fifth Street, NW
Washington, D.C. 20001
For more information, contact Tina M. Latimer at TLatimer@nas.edu or 202-334-3218.

11 **Depicting Innovation in Information Technology**
Keck Center of the National Academies
500 Fifth Street, NW
Washington, D.C. 20001
For more information, contact Shenae Bradley at sbradley@nas.edu or 202-334-2293.

16 **Advancing Urban Sustainability in China and the United States: A Workshop**
National Academy of Sciences
2101 Constitution Avenue, NW
Washington, D.C.
For more information, e-mail sustainability@nas.edu.

INFORMATION FOR CONTRIBUTORS TO **TR NEWS**

TR News welcomes the submission of articles for possible publication in the categories listed below. All articles submitted are subject to review by the Editorial Board and other reviewers to determine suitability for *TR News*; authors will be advised of acceptance of articles with or without revision. All articles accepted for publication are subject to editing for conciseness and appropriate language and style. Authors review and approve the edited version of the article before publication.

ARTICLES

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, technology, etc.). Manuscripts should be no longer than 3,000 words. Authors also should provide tables and graphics with corresponding captions (see Submission Requirements). Prospective authors are encouraged to submit a summary or outline of a proposed article for preliminary review.

MINIFEATURES are concise feature articles, typically 1,500 words in length. These can accompany feature articles as a supporting or related topic or can address a standalone topic.

SIDEBARS generally are embedded in a feature or minifeature article, going into additional detail on a topic addressed in the main article or highlighting important additional information related to that article. Sidebars are usually up to 750 words in length.

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 graphics, and are subject to review and editing.

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. Research Pays Off 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 the logo of the agency or organization submitting the article, as well a one or two photos or graphics. Research Pays Off topics must be approved by the RPO Task Force; to submit a topic for consideration, contact Stephen Maher at 202-334-2955 or smaher@nas.edu.

OTHER CONTENT

TRB HIGHLIGHTS are short (500- to 750-word) articles about TRB-specific news, initiatives, deliverables, or projects. Cooperative Research Programs project announcements and write-ups are welcomed, as are news from other divisions of the National Academies of Sciences, Engineering, and Medicine.

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, Web link, and DOI or ISBN. Publishers are invited to submit copies of new publications for announcement (see contact information below).

SUBMISSION REQUIREMENTS:

- **Articles** submitted for possible publication in *TR News* and any correspondence on editorial matters should be sent to the *TR News* Editor, Transportation Research Board, 500 Fifth Street, NW, Washington, DC 20001, 202-334-2986, or lcamarda@nas.edu.
- Submit **graphic** elements—photos, illustrations, tables, and figures—to complement the text. 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. Large photos (8 in. by 11 in. at 300 dpi) are welcomed for possible use as magazine cover images. A caption must be supplied for each graphic element.

Note: Authors are responsible for the authenticity of their articles and for obtaining written permissions from publishers or persons who own the copyright to any previously published or copyrighted material used in the articles **as well as any copyrighted images** submitted as graphics.

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