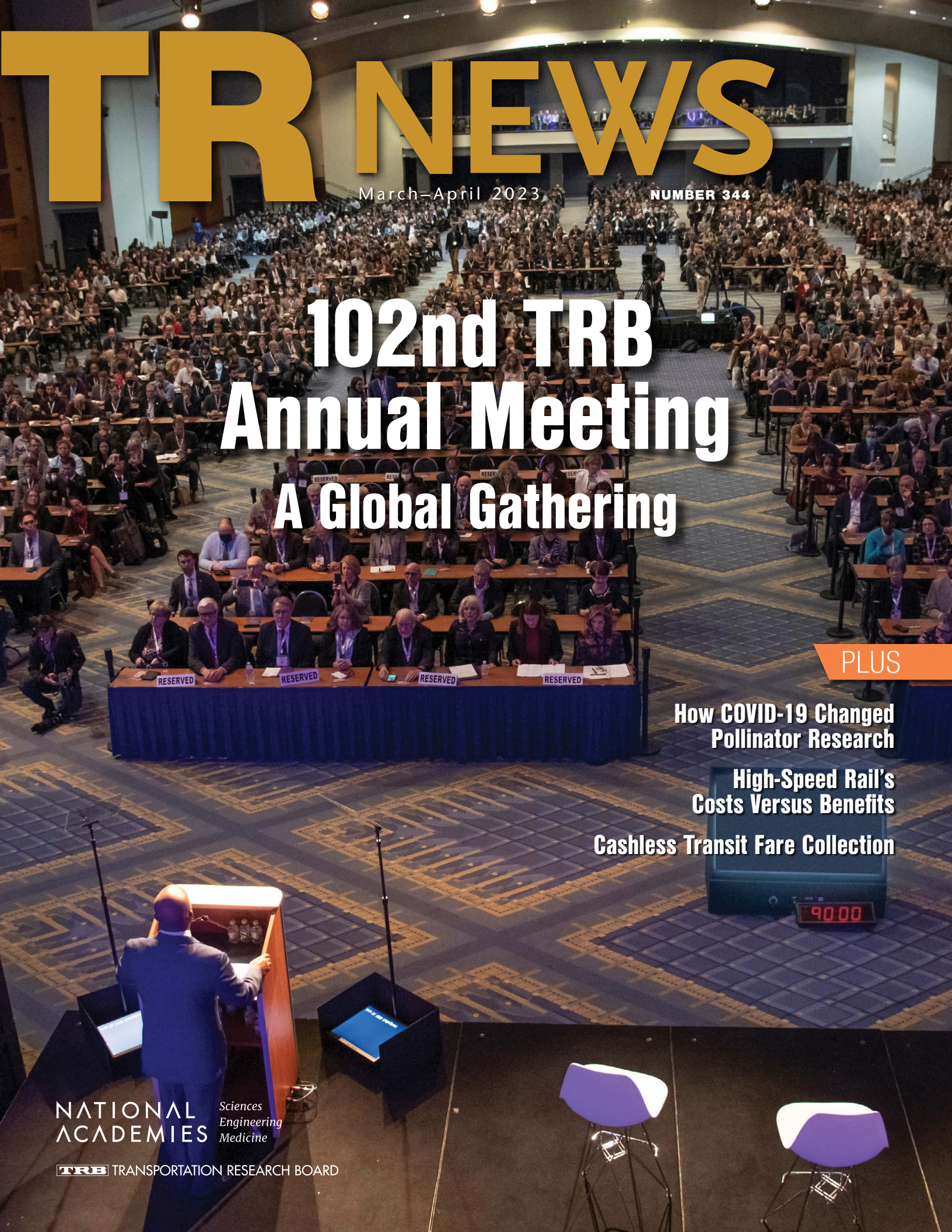
TR NEWS
March–April 2023 NUMBER 344



102nd TRB Annual Meeting

A Global Gathering

PLUS

How COVID-19 Changed Pollinator Research

High-Speed Rail's Costs Versus Benefits

Cashless Transit Fare Collection

NATIONAL ACADEMIES Sciences Engineering Medicine

TRB TRANSPORTATION RESEARCH BOARD

NATIONAL ACADEMIES *Sciences Engineering Medicine*

The **National Academy of Sciences** was established in 1863 by an Act of Congress, signed by President Lincoln, as a private, nongovernmental institution to advise the nation on issues related to science and technology. Members are elected by their peers for outstanding contributions to research. Dr. Marcia McNutt is president.

The **National Academy of Engineering** was established in 1964 under the charter of the National Academy of Sciences to bring the practices of engineering to advising the nation. Members are elected by their peers for extraordinary contributions to engineering. Dr. John L. Anderson is president.

The **National Academy of Medicine** (formerly the Institute of Medicine) was established in 1970 under the charter of the National Academy of Sciences to advise the nation on medical and health issues. Members are elected by their peers for distinguished contributions to medicine and health. Dr. Victor J. Dzau is president.

The three Academies work together as the National Academies of Sciences, Engineering, and Medicine to provide independent, objective analysis and advice to the nation and conduct other activities to solve complex problems and inform public policy decisions. The National Academies also encourage education and research, recognize outstanding contributions to knowledge, and increase public understanding in matters of science, engineering, and medicine.

Learn more about the National Academies of Sciences, Engineering, and Medicine at **www.nationalacademies.org**.

The **Transportation Research Board** is one of seven major programs of the National Academies of Sciences, Engineering, and Medicine. The mission of the Transportation Research Board is to provide leadership in transportation improvements and innovation through trusted, timely, impartial, and evidence-based information exchange, research, and advice regarding all modes of transportation. The Board's varied activities annually engage about 8,000 engineers, scientists, and other transportation researchers and practitioners from the public and private sectors and academia, all of whom contribute their expertise in the public interest. The program is supported by state departments of transportation, federal agencies including the component administrations of the U.S. Department of Transportation, and other organizations and individuals interested in the development of transportation.

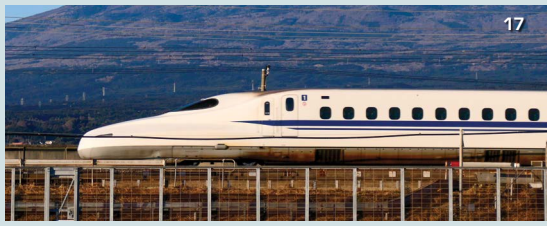
Learn more about the Transportation Research Board at **www.TRB.org.**

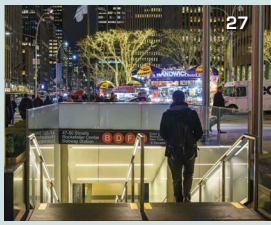
TRB

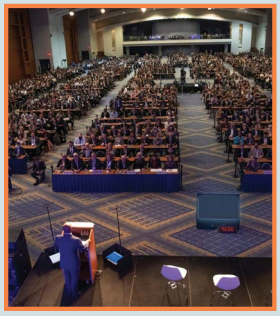
TRANSPORTATION RESEARCH BOARD 2023 EXECUTIVE COMMITTEE*

* Membership as of February 2023.

TR NEWS
Number 344 / March–April 2023







COVER TRB Executive Committee Chair Nathaniel Ford presides over the Chair's Plenary Session at the 2023 TRB Annual Meeting. More than 12,000 transportation professionals registered to attend the January gathering in Washington, DC. (Risdon Photography)

Coming Next Issue

The May–June 2023 issue of *TR News* examines the theme of Transportation Planning in Public Lands. Authors look at active transport in state parks, forecasting recreational travel demand, the innovations the National Park Service uses to collect data, and much more.

Matt and Cyndi Maxson, Flickr, CC BY-NC-SA 2.0

Bicyclists get fresh-air exercise while enjoying the scenery along a stretch of Missouri's Katy Trail State Park. Promoting mental and physical health, advocates of active transportation in state parks are building trail networks that also connect communities.

ALSO IN THIS ISSUE

TRB COVID-19 Resources

Agencies and organizations can use TRB publications and online resources for useful and timely information to help address issues related to the COVID-19 pandemic. To read about TRB's current research and activities, and for a list of relevant publications, visit www.nationalacademies.org/trb/blog/transportation-in-the-face-of-communicable-disease.

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.

***TR News* is produced by the Transportation Research Board**

Publications Staff
Natalie Barnes, Director of Publications
Heather DiAngelis, Associate Director of Publications
Cassandra Franklin-Barbajosa, Senior Editor
Erin Patricia Doherty, Editor
Jennifer G. Correro, Assistant Editor

***TR News* Editorial Board**
Christine L. Gerencher, Chair
Karen S. Febey
Nelson H. Gibson
Ann M. Hartell
Micah Himmel
Katherine Kortum
Joseph D. Navarrete

Transportation Research Board
Victoria Sheehan, Executive Director
Russell W. Houston, Associate Executive Director
Ann M. Brach, Director, Technical Activities
Patrice Davenport, Director, Strategic Program Development
Christopher J. Hedges, Director, Cooperative Research Programs
Paul Mackie, Director of Communications
Thomas R. Menzies, Jr., Director, Consensus and Advisory Studies
Gary J. Walker, Director, Finance and Business Operations

TR News (ISSN 0738-6826) is issued bimonthly by the Transportation Research Board, 500 Fifth Street, NW, Washington, DC 20001. Internet address: www.TRB.org.

Editorial Correspondence: By mail to the Publications Office, Transportation Research Board, 500 Fifth Street, NW, Washington, DC 20001, by telephone 202-334-2278, by fax 202-334-3495, or by e-mail cfranklin-barbajosa@nas.edu.

Subscriptions: North America: 1 year $75; single issue $19. Overseas: 1 year $100; single issue $19 plus shipping. Inquiries or communications concerning new subscriptions, subscription problems, or single-copy sales should be addressed to the Business Office at the following address, or by phone 202-334-3216, fax 202-334-2519. Periodicals postage paid at Washington, D.C.

Postmaster: Send changes of address to *TR News*, Transportation Research Board, 500 Fifth Street, NW, Washington, DC 20001.

Rejuvenation Out of Disruption

Envisioning a Transportation System for a Dynamic Future

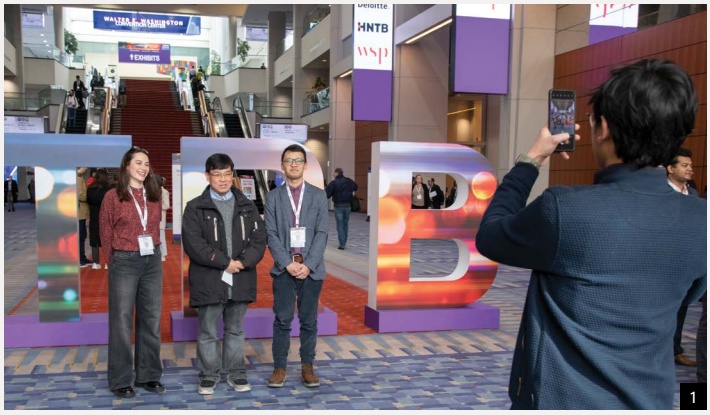
Restaurant hosts knew. Metrorail riders knew—from the oversized badges hanging from attendees' necks. Uber drivers certainly knew. "Are you here for the big transportation conference?" one asked. The word was out! More than 12,000 transportation professionals from around the world had converged on Washington, DC, for the 102nd TRB Annual Meeting, held January 8–12, 2023, at the Walter E. Washington Convention Center. Free of last year's COVID-19–imposed mask mandate, a near record number of participants gathered for committee meetings, poster and lectern sessions, award presentations, and a keynote address from National Transportation Safety Board Chair Jennifer Homendy.

Sessions and workshops addressed topics of interest to policy makers, administrators, practitioners, researchers, and students—many focused on decarbonization, automated and electric vehicles, and sustainability. Managed lanes expert Charles Fuhs delivered the 2023 Thomas B. Deen Distinguished Lecture, "Re-Envisioning Mobility on Urban Freeways: The Emerging and Evolving Roles of Managed Lanes."

Taking the stage with TRB Executive Committee Chair Nathaniel Ford and Vice Chair Shawn Wilson, U.S. Department of Transportation Secretary Pete Buttigieg and U.S. Secretary of Energy Jennifer Granholm discussed the federal government's goal of reaching net-zero carbon emissions in the nation's transportation sector by 2050.

Details and highlights appear on the following pages.

Annual Meeting photographs by Risdon Photography, except where indicated.



1


2

3

1 The perfect backdrop, the giant TRB sign draws international attendees (*left to right*) **Roxani Gkavra**, **Yusak Susilo**, **Muhamad (Taki) Rizki**, and **Faza Bastarianto**—behind the camera—to grab a photo for sharing on social media.

2 National Transportation Safety Board Chair **Jennifer Homendy** delivers the keynote address.

3 At the Chair's Plenary Session, U.S. Department of Energy Secretary **Jennifer Granholm** explains the need to add about 2000 gigawatts of energy to the nation's electric grid to support President Biden's goal of 100 percent clean energy by 2035 and the economywide goal of reaching net zero by 2050. On stage with her are (*left to right*) TRB Executive Committee Chair **Nathaniel Ford**, U.S. Department of Transportation Secretary **Pete Buttigieg**, and TRB Executive Committee Vice Chair **Shawn Wilson**. Ford and Wilson moderated the discussion.

Intersections

1 Convention Center staff in red jackets usher attendees into the Exhibit Hall, where transportation innovations from automated vehicles to mobile asphalt labs were on display.

4 **Marie Therese Dominguez** (*left*), Commissioner of the New York State Department of Transportation (DOT), pulls together a group of transportation leaders for an impromptu selfie at the Executive Committee Reception. They are (*left to right*) **Leslie Richards**, General Manager of the Southeastern Pennsylvania Transportation Authority; **Yassmin Gramian**, former Secretary of the Pennsylvania DOT; **Kristina Swallow**, former Director of the Nevada DOT; **Diane Guitierrez-Scaccetti**, Commissioner of the New Jersey DOT; **Victoria Sheehan**, TRB Executive Director; and **Julie Lorenz**, Secretary of the Kansas DOT.

5 Nineteen students from 14 schools attended the Annual Meeting as participants in the 2023 TRB Minority Student Fellows Program, with research backgrounds ranging from transportation and urban infrastructure engineering to civil engineering to mechatronics and robotics. Pictured are (*front row, left to right*) **Karen Febey**, TRB senior report review program officer and Minority Student Fellows Program manager; **Ossiris Rodriguez**; **Leonor Reyes**; **David Castano**; **Armando Martinez**; **Elijah Bond-Hawkins**; **Diana Cortes**; **Hector Cruz**; **Eric Olaguir**; **Nicole Anderson**;

2 **HollyAnna Littlebull** (*left*) and **Amanda Nadjkovic** take a break during a Sunday workshop.

3 **Tracy Duval** (*left*) discusses her role in transportation during the Minority Student Fellows Career Panel. Joining her are (*left to right*) **Darryl Moses**, **Margarita Ordaz**, and **Ian Rowe**.

6

Gabriella Cerna; and **Latoya Jones**, FHWA's Dwight David Eisenhower Transportation Fellowship Program manager. Shown back row (*left to right*) are **Quinton Butler**; **Anthony Forcades**; **Jeremiah Bailey**; **Sebastian Morales**; **Timothy Thiergart**; TRB Executive Director **Victoria Sheehan**; **Alonso Carrillo**; **Evan Taylor**; **Edward Clay**; **Rueben Esteves**; and **Nathaniel Coley**, FHWA's Dwight David Eisenhower Transportation Fellowship Program manager.

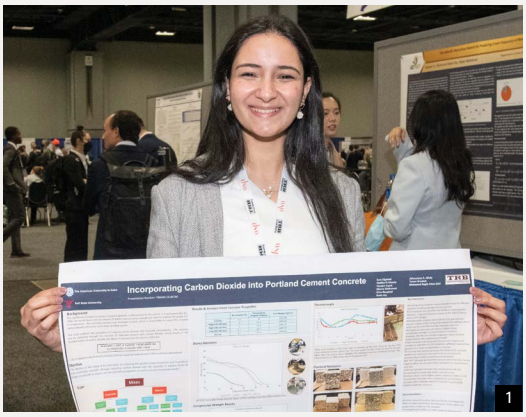
6 Overseeing the organization and activities of TRB's standing committees, the 2023 Technical Activities Council (TAC) are (*front row, left to right*) **Pamela Keidel-Adams**, TRB Technical Activities Division Director **Ann Brach**, **Michael Griffith**, TRB Executive Director **Victoria Sheehan**, **Allison Yoh**, and **William Eisle**. Standing (*left to right*) are **Brendon Hemily**, **Jane Lin**, **Robert Bertini**, **Pasa Lautala**, **Jeff Borowiec**, **Kathryn Zimmerman**, **Fred Wagner**, Technical Activities Division Deputy Director **Stephen Maher**, **Tara Cavalline**, and **Robert Hazlett**. Not pictured are TAC Chair **Avery Grimes**, **Eleftheria Kontou**, and **Tom Hickey**.

Sessions & Workshops

1 **Sara El-Gamal** prepares to share her research on "Incorporating Carbon Dioxide into Portland Cement Concrete".

2 New attendee **Pelumi Abiodun**, Morgan State University, takes notes during a lectern session.

3 **Helmut Leodarta** (*right*) finds something to laugh about during the "3-Minute Thesis Competition: Successful Research Communication to a Broad Audience". Seatmates (*left to right*) **Eleanor Fauchel** and **Hugues Blache** get the humor.



1

2

Cassandra Franklin-Barbajosa

3

4

5

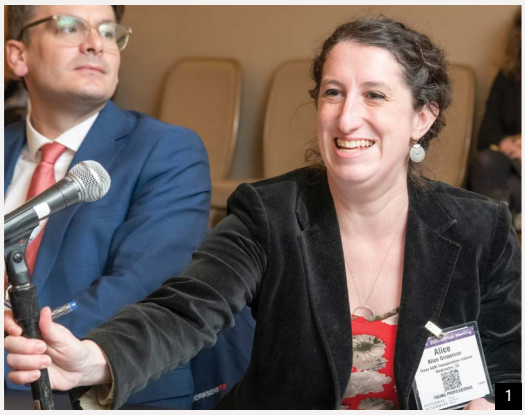
4 **Andrea Cristina Ruiz** takes part in the Post-It Note Scramble during the "Structuring a Long-Term Extreme Weather and Climate Resilience Research Agenda" workshop.

5 **Mike Rossi** leads a breakout session during the "Including Routine Asset Maintenance Costs in Transportation Asset Management Planning" workshop.

Committees

1 **Alice Grossman**, member of the Standing Committee on Transit Management and Performance, takes the mic.

2 **Shannon McLeod** works with other members of the Standing Committee on Ports and Channels.



Blue Ribbon for Best Practices

TAC member **Michael Griffith** presents Blue Ribbon Awards for best practices of outstanding technical activities committees in the following categories:

1 *Identifying and Advancing Ideas for Research*: Seismic Design and Performance of Bridges Committee, chaired by **Monique Head**; and

2 Airfield and Airspace Performance Committee, chaired by **Yu Zhang** (accepted by **Pamela Keidel-Adams**);

3 *Renewal: Attracting and Preparing the Next Generation of Professionals and Scholars in TRB*: Transportation-Related Noise and Vibration Committee, chaired by **Adam Alexander**;

4 *Implementation: Moving Research Ideas into Transportation Practice*: Freight Transportation Planning and Logistics Committee, chaired by **Sushant Sharma**;

5 *Leadership: Contributing to Improving the Management and Operation of TRB Committees*: Air Quality and Greenhouse Gas Mitigation Committee, chaired by **Douglas Eisinger**;

6 *Diversity: Increasing Committee Membership and Friends*: Freeway Operations Committee, chaired by **Beverly Thompson Kuhn** (accepted by **Robert Bertini**) (see Page 33); and

7 Rail Transit Infrastructure Design and Maintenance Committee, chaired by **Hugh J. Fuller**.

3 **Michael Bryant,** Texas DOT, comments at an open meeting of committees that address equity and environmental justice needs in transportation.

4 **Kristen Brown** (*left*) and **Matt Dean** participate in a networking activity during a Young Members Council on Sustainability and Resilience meeting.

5 **Frederic Fravel** shares insights with **Nina Stocker** (*right*) and other members of the Intercity Bus Transit Subcommittee.

Paper Awards

The Fred Burggraf Award is presented to researchers under age 35. Flanked by TRB Executive Committee Chair **Nathaniel Ford** (*left*) and TRB Executive Director **Victoria Sheehan** (*right*), who presented the Paper Awards, recipients are shown from left to right.

1 **Michael Elwardany** and **David J. Mensching** received the Burggraf Award for *Evaluating the Sensitivity of Intermediate Temperature Tests to Multiple Loose Mixture Aging Temperatures Using the FHWA Accelerated Loading Facility's RAP/RAS Experiment*. Not pictured: **Varun Veginati**.

2 **Irfan Batur**, **Chandra R. Bhat**, **Tassio B. Magassy**, **Aupal Mondal**, **Katherine E. Asmussen**, and **Ram M. Pendyala** received the Pyke Johnson Award for *The Influence of Mode Use on Level of Satisfaction with Daily Travel Routine: A Focus on Automobile Driving in the United States*. Not pictured: **Sara Khoeini**.

Paper Awards

(*continued*)

3 **Abubakr Ziedan, Candace Brakewood, Ashley Hightower,** and **Cassidy Crossland** received the William W. Millar Award for *Current Practices and Potential Rider Benefits of Fare-Capping Policies in the United States.*

4 **Gang-Len Chang**, **Yi-Ting Lin**, and **Yen-Lin Huang** received the D. Grant Mickle Award for *Extending the I-95 Rule-Based Incident Duration System with an Automated Knowledge Transferability Model.*

3

5 **Suphanat Juengprasertsak** and **Douglas J. Gabauer** shared the K.B. Woods Award for *Evaluation of Current MASH Occupant Compartment Intrusion Limits Using Real-World Crash Data*.

4

5

Major Awards

1 Principal of Chuck Fuhs, LLC, in Houston, Texas, **Charles A. Fuhs III** is the recipient of the 2023 Thomas B. Deen Distinguished Lectureship. His public- and private-sector experience spans some 50 years, during which he has been involved in the planning, implementation, and operation of freeways throughout North America. He has directed—or been engaged by federal, state, and local transportation agencies to work on—more than 200 projects and studies representing more than $20 billion in transportation investment in most U.S. metropolitan and Canadian cities. Fuhs is recognized for his contributions to the advancement of congestion-management applications on urban freeways, with particular focus on managed lanes.


1


2

2 **Gongkang Fu**, professor of civil and architectural engineering at the Illinois Institute of Technology, Chicago, is the 2022 recipient of the Roy W. Crum Distinguished Service Award. Named for TRB's former director, who served from 1928 until his death in 1951, the award recognizes outstanding leadership in transportation research or research administration. Fu is recognized for his significant innovative, visionary, and practical contributions to bridge engineering research, implemented in the practice of preserving and designing safer highway infrastructure in the United States and the world.


3

3 Recognized for his outstanding service to TRB, **Neil J. Pedersen** is the 2022 recipient of the W.N. Carey, Jr., Distinguished Service Award. Pedersen retired in

December as TRB's Executive Director, a position he held since February 2015. He is recognized for more than 40 years of leadership service to TRB—more than 30 years as a TRB volunteer and more than 10 years as a TRB staff member—and for his integrity and continual pursuit of technical excellence. In 2022, the Conference of Minority Transportation Officials presented Pedersen with the President and CEO's Award for Excellence for "outstanding contributions to diversity, equity and inclusion, accessibility, innovation, and community engagement at a time of disruption to the transportation industry." He has also been honored with the George S. Bartlett Award and AASHTO's Thomas McDonald Memorial Award. The Carey Award is named for TRB's executive director from 1967 to 1980.

4

5

6

4 Eugene (Gene) R. Russell, Sr., Professor Emeritus of civil engineering at Kansas State University, is the 2022 recipient of the Robert E. Skinner, Jr., Distinguished Transportation Research Management Award. Russell is recognized for the indelible mark he left on transportation for his 60 years of research management at Iowa State University, Purdue University, and Kansas State University. His lifelong research and research management accomplishments have made substantial contributions in areas such as roundabout traffic operations, roundabout safety, and rail and highway grade crossing warning systems and safety. TRB's Executive Committee established the award—named for TRB's executive director from 1994 to 2015—to recognize outstanding achievement in the management, administration, promotion, fostering, and implementation of transportation research.

5 Lillian Borrone, a member of the National Academy of Engineering, former assistant executive director of the Port Authority of New York and New Jersey, and past chair of the TRB Executive Committee, is the 2023 recipient of the Frank Turner Medal for Lifetime Achievement in Transportation. She is recognized as a trailblazer for women in transportation and for her substantial professional and volunteer contributions to transportation policy, administration, and research that aided in the advancement of safer and more reliable mobility for people and goods during her lifetime. She has been a pathbreaker, based on her distinctive and highly effective blend of keen intellect, hard work, attention to detail, and gracious leadership. The award recognizes lifetime achievement demonstrated by a distinguished career in transportation, professional prominence, and a distinctive, widely recognized contribution to transportation policy, administration, or research.

6 Thomas B. Deen (*right*), who served from 1980 to 1994 as TRB's eighth executive director, stands with **Charles A. Fuhs III**, recipient of the award named for him. The lectureship recognizes the career contributions and achievements of an individual in one of the areas covered by TRB's Technical Activities Division.

"I encourage you as the current generation of practitioners to take prudent risks, test new technologies to manage traffic flow, improve customer interface, document findings, promote research, share experiences, and create greater sustainability in practice when addressing the many challenges and opportunities that lie ahead."

—Charles A. Fuhs III
Thomas B. Deen Distinguished Lecture

New Executive Committee Leaders Take the Helm

Shawn Wilson (*left*), Secretary of the Louisiana Department of Transportation and Development and 2022 vice chair of TRB's Executive Committee, was elected as the committee's 2023 chair during the Annual Meeting. However, shortly after the event, Wilson announced his plans to retire from the department, as well as to step down from the TRB appointment. TRB is grateful for his many contributions and exemplary leadership as a member, vice chair, and chair of the Executive Committee.

Accepting the role as the 2023 chair is **Diane Gutierrez-Scaccetti** (*below*), commissioner of the New Jersey DOT. "It is an honor to be given the opportunity to assume a leadership role with such a well-respected organization that has international prominence," Gutierrez-Scaccetti stated. "I am grateful to the National Academies and to the Transportation Research Board for this recognition. The critical research conducted by TRB will help all [state] DOTs and partner agencies make more informed decisions in the planning and execution of transportation projects and initiatives."

As commissioner, Gutierrez-Scaccetti is responsible for maintaining and operating the state's highway and public road system; planning and developing transportation policy; and assisting with rail, freight, and intermodal transportation issues. She is a member of the Board of Directors for AASHTO and serves as chair of its Committee on Transportation Communication. She is also a member of the Board of Directors for the Northeast Association of State Transportation Officials.

Partnering with Gutierrez-Scaccetti as the 2023 TRB Executive Committee vice chair is **Carol Abel Lewis** (*left*), professor of transportation studies and Emeritus executive director of the Center for Transportation, Training, and Research at Texas Southern University in Houston. She serves as chair of TRB's Inclusion and Diversity Committee and is a member of the Transit Research Advisory Committee.

Nancy Daubenberger and **Hani Mahmassani** are new members of the Executive Committee. Reappointed members are **Carlos Braceras**, **Nathaniel Ford**, **Marie Therese Dominguez**, and **Susan Shaheen**.

Each year, the TRB Executive Committee selects a topic worthy of deeper analysis to address in a policy session. The 2023 policy session topic was successful transportation megaprojects, with the panel of experts (*left to right*) **Jim Gray**, Kentucky Transportation Cabinet; **Jack Marchbanks**, Ohio DOT; **Susan Shaw**, Virginia DOT; and **Eric Shen**, Shen and Associates.

Executive Committee

1 2022 TRB Executive Committee Chair Nathaniel Ford and National Transportation Safety Board Chair Jennifer Homendy make their way to the VIP Green Room ahead of the Chair's Plenary Session.

2 New TRB Executive Director **Victoria Sheehan** praises Frank Turner Medal winner **Lillian Borrone** as a trailblazer for female transportation leadership.

Also participating in the Executive Committee's agenda and deliberations are

3 **Nuria Fernandez**, Federal Transit Administration, and **Steven Cliff**, California Air Resources Board;

4 **Shailen Bhatt**, FHWA;

5 **Robert Hampshire**, U.S. DOT; and

6 **Jim Tymon**, AASHTO.

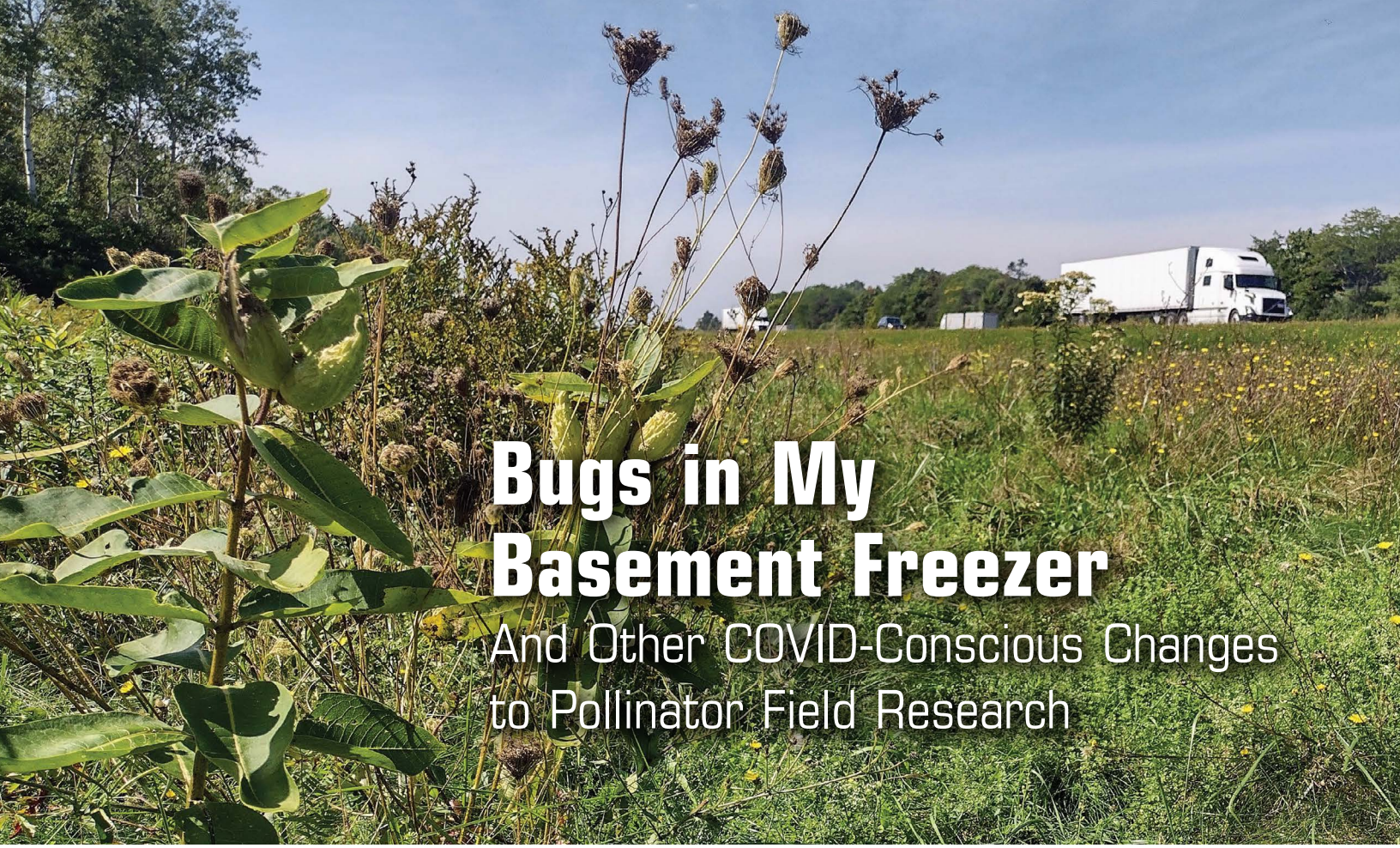
From Networking to Catnapping

As one excited attendee put it—just halfway through the Annual Meeting: "This is *overwhelming*!" And she's right! The challenges over the four-and-a-half day event are formidable: pouring over an abundance of lectern sessions, workshops, poster sessions, committee meetings, and spotlight events; racing back and forth through the expansive Convention Center and the adjacent Marriott Marquis Hotel to get to those coveted sessions on time—and without getting lost; calming nerves before a first-time presentation; connecting with the right organization for career-enhancing opportunities; and so much more. Yet, regulars enjoy boasting about how many Annual Meetings they've attended, and—when all is said and done—new attendees can't wait for next year.

1 With pen and program in hand, an attendee prepares to outline his plan of participation—selecting among the hundreds of workshops on the agenda.

2 Opportunities to network with other transportation professionals are a big draw for Annual Meeting attendees.

3 The heavy schedule can be as exhausting as it is energizing, as evidenced by one attendee who gave in to the need for a nap.



Bugs in My Basement Freezer

And Other COVID-Conscious Changes to Pollinator Field Research

Kaitlin Stack Whitney

KAITLIN STACK WHITNEY

The author is an assistant professor in the Department of Science, Technology, and Society of the College of Liberal Arts and extended program faculty in Environmental Science in the College of Science at the Rochester Institute of Technology in New York.

Native plants like common milkweed provide a natural habitat for wildlife and pollinators along this segment of the New York State Thruway that is on a reduced mowing schedule. This statewide research project is looking at how—and how much—mowing impacts pollinators.

Our research is one project within a larger movement to understand the contributions of transportation rights-of-way (ROWs) and other linear corridors to conservation. Our research objective is to examine if reduced roadside mowing along state highways is associated with changes in pollinating insect abundance and habitat quality for pollinators. We are answering this question through a large-scale experimental study in New York State across a range of landscapes and road characteristics—from north of the Adirondacks in forests and rolling hills in and near Plattsburgh, to Niagara Falls Boulevard, to Lake Ontario Parkway adjacent to apple orchards in Western New York, to NY-747 that takes travelers to New York Stewart International Airport near Newburgh, and roads that bring commuters to and from New York City. The project, Effects of a Modified Mowing Regime in NYSDOT ROWs on Pollinators and Vegetation, began in spring 2019 and is anticipated to be completed in 2023.

Background

Over the past several decades, as insect populations have declined and natural habitats across the nation have disappeared, highway roadsides have emerged as critical sites of interest for pollinating insect conservation efforts. Roadside areas also can be highly disturbed areas, due to on-road traffic and roadside management practices like mowing. As a common vegetation management practice, mowing maintains shortened vegetation for safety reasons, including:

- Safe spaces for cars that may leave the roadway or need to pull over to do so;
- Short vegetation that may give drivers extra time to react before animals like deer enter the roadway; and
- Trees that cast shadows on the road that can cause ice to form, especially in places like New York with long, cold winters.

These compelling reasons to keep vegetation short are built into the required clear

zone that runs parallel to highways. Yet, often there is more roadside area beyond. There, the frequency and timing of mowing can cut down flowers in bloom that provide resources for animals, including pollinating insects. Reducing mowing may result in better quality habitat.

Evidence from mowing studies to date is mixed, potentially due to variation in spatial and temporal scales. For example, the majority of studies examining potential impacts of mowing roadsides have been conducted in only one growing season or with small sections of highway. Limited study size and length may not reveal how changes in mowing patterns impact pollinators, leading to inconclusive or conflicting results.

How Large of an Area Is Involved?

Roadside habitats are one kind of right-of-way. There are railway, energy, and utility right-of-way habitats, as well. All of these linear habitats have become the focus of potential conservation interventions. This is partially driven by a decline in more traditional natural habitats for wildlife—like wild prairies—and a growing body of biological survey data showing that wildlife—such as grassland birds and pollinating insects—successfully forage and nest in roadside habitats.

Looked at individually, these roadside parcels seem small. A roadside right-of-way may be only a few meters wide in some places. When considered together, however, roadside rights-of-way constitute an enormous area. The United States is estimated to have more than 10 million acres in highway roadside habitat, the most of any country in the world. Wildlife habitat is just one potential benefit that rights-of-way can provide. Others include carbon sequestration, renewable energy generation, and the growth of living snow fences for winter road safety.

Determining If Less Is Actually Better

To understand if reducing mowing along state highways—like those in our study area in New York—can provide and improve habitat for pollinating insects, our study compares the abundance and diversity of pollinating insects and habitat quality in roadsides where the current mowing schedule is followed, compared to areas where the mowing schedule is reduced. For example, we use methods including

- Assessing roadsides using the Rights-of-Way as Habitat Working Group Scorecard,[1] which provides a common language to talk about habitat, establishes a consistent valuation method, and supports shared reporting;
- Performing sweep net sampling of insects in which a field worker does a walking transect that brushes a sturdy canvas net through vegetation and knocks insects off plants;
- Making timed floral observations to directly observe how many and which kinds of insects are visiting flowers in the roadside; and
- Performing plant transects to measure the presence and relevant abundance of different kinds of desirable (e.g., wildflowers) and undesirable (e.g., invasive and noxious) plants.

Nel Botha, Pixabay

Mention pollinators, and images of bees and butterflies instantly come to mind. Although insects do the majority of pollination—that process of moving grains of pollen from the male anther of a flower to the female stigma—bats, birds, and other creatures, as well as flies, wasps, and beetles, are all pollinators.

This project requires a whole team of people across the state to maintain and monitor study sites. As the project lead, I bring expertise in insect ecology, conduct landscape-scale experiments, and mentor student research assistants. Another faculty collaborator on the project has expertise in environmental management and student training. To date, we have worked with a dozen undergraduate student researchers on this project, from a variety of disciplines. Two of these graduate students based their master's theses in environmental science on the project. One focused on if and how variability in road traffic and roadside mowing levels intersect to impact *Bombus* spp. (bumble bees) (*1*). Another thesis is examining how environmental conditions in the surrounding landscape of highways may influence if and how reduced mowing impacts invasive and noxious plant species in highway rights-of-way.

The partnership and support of many people working for the New York State Department of Transportation (DOT)

[1] More information can be found at https://rightofway.erc.uic.edu/pollinator-habitat-scorecard/.

has been essential for the project. While the study was being designed, New York State DOT staff identified candidate highway segments in their regions for potential inclusion. Roadsides included in the study are managed by New York State DOT staff; mowing operators ensure that the areas receiving the reduced mowing treatment are maintained to the terms of the study guidelines.

Additionally, many of the highway roadsides being monitored require on-site support to safely visit and conduct our observations. This means that New York State DOT staff are supporting the safety of our visit and the safe travel of highway traffic through measures like work zone signage, shoulder closures, or traveling along with us in an attenuator truck. This support has enabled our research team to drive more than 70,000 miles throughout New York since 2019—safely—while successfully monitoring sites and collecting samples. Throughout the project, a technical advisory board comprised of New York State DOT staff from across the state has provided invaluable feedback on interim reports and questions. For example, deciding on the size of the study segments was a collaborative conversation to determine how large study segments could be. These are working landscapes—although we want to understand, ecologically, what is happening at the largest possible scales, we also do not want to make the work of New York State DOT managers and mowers unreasonably hard or impossible.

COVID-19 Impacts to the Research Plan

At the onset of the COVID-19 pandemic in 2020, we faced new challenges in coordinating this enormous team effort. For example, campus and state safety protocols and procedures were changing rapidly, requiring frequent meetings and coordination. Planning for fieldwork was challenging at the beginning, when masks and hand sanitizer were in high demand and often not available for field workers. So, we got creative: The university purchased cloth masks from a well-known local suit manufacturer

Kaitlin Stack Whitney

The author, pictured here, instituted changes like masking while in the field during the height of the COVID-19 pandemic. Some of the changes to how research was performed, like remote work, will remain.

that converted its production to meet COVID-19 needs, and I purchased hand sanitizer in bulk from a local distillery that similarly converted their facilities from making alcohol for drinking to alcohol for sanitizing.

Other problems were simply humorous. In spring 2020, my university—Rochester Institute of Technology—like many workplaces, was required to close. To ensure the safety of the frozen samples collected from highways during the previous summer, I moved them to my home. This meant that until campus reopened several months later, my basement freezer safely held hundreds of samples filled with thousands of dead insects collected from highways across the state. My kids thought this was pretty weird and definitely wondered about mom's job. Weird or not, we made it work. The campus closure continued through the summer 2020—including all through our field season. This meant that we could do the outside fieldwork all along New York State highways, but we were not allowed inside the buildings on campus all summer.

Although pivoting during the height of the pandemic was unanticipated, the need to adapt revealed the following silver linings:

- We were able to keep our team employed and safe throughout the pandemic. Fortunately, roadside monitoring work is outdoors and easily accommodates social distancing.
- Sampling methods for measuring plants and insects were largely unaffected by modifications needed for distancing and masking.
- We adapted training to be online over video and in written documents.
- The expansion of remote work was a welcome reminder that lots of people can contribute to transportation research, even if they do not want to or cannot come out onto the roadside.
- Using videoconferencing and networked file sharing, several students based in far-flung locations around the country were able to contribute to the analysis of audio and photo samples taken in past years.
- Remote work provided flexible and inclusive options for team members.

At this stage of the pandemic, campus has reopened and many pandemic measures have abated, but some collaborators still need to work remotely for their health and safety. As the research continues, we are glad to have them as part of the team.

REFERENCE

1. Schoenfeldt, A. *The Effect of Roadside Mowing and Road Traffic on Bumble Bee Abundance and Pollinating Insect Habitat Quality in New York Highway Rights-Of-Way.* MS thesis. Rochester Institute of Technology, New York, 2021. https://scholarworks.rit.edu/theses/10803.

Bee Positive
Airports Establish Pollinator Programs

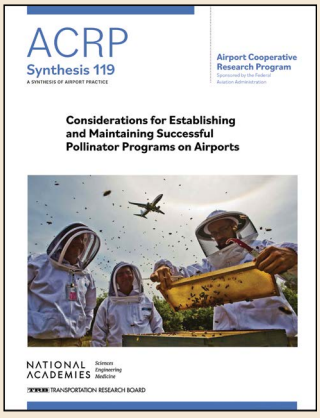
JOSEPH D. NAVARRETE

The author is a senior program officer at the Transportation Research Board of the National Academies of Sciences, Engineering, and Medicine in Washington, DC.

Over the past several years, some airports have implemented pollinator-friendly practices and programs that restore habitat for bees. *ACRP Synthesis 119: Considerations for Establishing and Maintaining Successful Pollinator Programs on Airports* summarizes experiences and practices from several of these programs.[1]

The research effort to produce the synthesis report included collecting information from existing sources and conducting surveys and interviews with airport operators, beekeepers, and other land managers, including state departments of transportation. *ACRP Synthesis 119* provides examples of pollinator-friendly programs designed to improve habitat and forage for native and managed pollinators, as well as examples of beekeeping programs that engage the public. The report also discusses how pollinator-friendly programs can be developed and managed, their cost, and the unique challenges airports face—such as operational issues, liabilities, and wildlife hazard management. Checklists and resources are included.

[1] Read *ACRP Synthesis 119* at https://nap.nationalacademies.org/read/26680.



According to *ACRP Synthesis 119*, airports have been establishing pollinator-friendly practices and programs since 1999. What are their lessons learned?

Artur Pawlak, Pixabay

Bees do not need much more than an open field, hive body boxes as brood chambers, and an attentive beekeeper. Airports, which by necessity often have an abundance of unused land, are a natural match. The Flight Path Program at Seattle–Tacoma International Airport and other programs involving pollinator awareness, innovative research, and environmental stewardship are showing how airports can provide a home for bees.

Which Program Is Most Popular?

Beekeeping programs are the most common type of pollinator-friendly program found at airports. These programs involve the active management of honeybee colonies by a local beekeeper on airport land. A less common practice is for airports to establish pollinator habitat management programs that seek to preserve and enhance the landscape around the airport to provide food and a habitat for pollinators.

Airports reported a wide range of benefits from having pollinator-friendly programs, including improved public relations, community engagement opportunities, expanded sustainability profiles, and airports being established as environmentally responsible land managers.

High-Speed Rail's Global Momentum

Do Infrastructure Costs Balance with the Benefits?

Maeda Akihiko, Wikimedia, CC BY-SA 4.0

ZHENHUA CHEN AND CHANGMIN JIANG

Chen is an associate professor in City and Regional Planning at the Knowlton School of Architecture at The Ohio State University in Columbus. Jiang is a professor at the School of International Trade and Economics at the University of International Business and Economics in Beijing, China.

At the foot of Japan's Mount Fuji, the Tōkaidō Shinkansen—the world's first high-speed rail line—connects the cities of Tokyo and Osaka. Other countries either have developed or are building high-speed rail infrastructure to connect major cities, as well. Although the fastest and most efficient ground-based commercial transportation, high-speed rail is more expensive than conventional rail to construct.

With an operating speed of 250 kilometers per hour or higher, high-speed rail has developed rapidly in many countries—including China, France, Germany, Italy, Japan, and Spain—over the past decade. Other countries—such as India, Malaysia, the United Kingdom, and the United States—are also developing high-speed rail, even though substantial debate remains about whether the gargantuan cost of high-speed rail infrastructure development will be offset by the systems' expected benefits.

One critical requirement for deciding how much to invest in this special infrastructure is to implement a thorough impact assessment of high-speed rail. The objective is to assess whether the proposed project has the potential to generate positive impacts so that the investment can be justified. Although the general practice is to conduct a project-level assessment by calculating the return on investment using the benefit–cost analysis method, a growing consensus is to recommend that the assessment be extended with an examination of high-speed rail's wider socioeconomic impacts. This is because a developed high-speed rail system may fundamentally alter various socioeconomic variables, including the economy, social equity, land use, modal competition, and the environment. In addition, the effects of high-speed rail may vary considerably from temporal and spatial perspectives, depending on the scale of the system and the area it serves.

Given that the interest in high-speed rail planning and investment in the United States is rising, this article aims to provide transportation scholars and practitioners with an overview of high-speed rail's effects on economic development and the environment. The review synthesizes a range of scholarly work focusing on the following five aspects:

- Economic impact,
- Social equity,
- Land use and housing impact,

Florian Pépellin, Wikimedia, CC-BY-SA-3.0

A direct Eurostar high-speed train transports skiers and others from London to the French Alps and back for 16 weeks of the winter.

- Aviation interactions, and
- Environmental impact.

This article is intended to provide a comprehensive and systematic understanding of high-speed rail's socioeconomic impact to facilitate more rational decision making in future infrastructure planning and investment.

Measuring Economic Impact

Economic impact is generally measured in changes in gross domestic product, gross output, employment, and economic productivity. The last metric is often defined as a ratio of the output volume and the input volume, and it measures the efficiency of using resources. Several studies reveal that high-speed rail investment positively promotes economic growth, given the improvement of intercity transportation accessibility (*1, 2*). However, other studies also show that the economic effect of high-speed rail depends on transportation demand. For instance, some studies indicate that a positive economic effect from high-speed rails is limited when the number of passengers is fewer than 8 to 10 million for a line with a distance of 500 kilometers (*3*). In addition, the economic effects of high-speed rails vary depending on other factors, such as the varying stages of economic development and the speed and frequency of service, regions, and industries the system serves.

One essential motivation of high-speed rail in countries like China is to promote coordinated regional economic development, which advances regional economic growth while it reduces social and economic inequity. The empirical evaluation reveals that the development of the Chinese high-speed rail system contributes to reduced regional economic disparity (*4*, *5*). For example, the growth of gross domestic product in less developed regions—such as the western regions in China—was found to catch up with the developed eastern regions in China after the development of high-speed rail. Similar findings were also observed in the cases of Japan (*6*), and South Korea (*7*). The evidence suggests that high-speed rail is the glue to link different regions.

Considering Social Equity Impact

High-speed rail affects social equity, as extensively examined in Europe and Asia. Social equity in transportation can be generally defined as a distribution of "benefits and burdens from transportation projects equally across all income levels and communities" (*8*). Social equity also has a direct influence on social stability. Transportation infrastructure like high-speed rail impacts both social equity and stability, especially from the national perspective. For instance, the source of high-speed rail investment in China is mainly from the central government. Hence, in China, the system is generally considered a quasi-public good, meaning that the system is intended to provide service to passengers, regardless of socioeconomic status and region. Under this approach, high-speed rail service is not limited to business travelers and developed regions; it also serves socially vulnerable groups and less developed regions. As a result, high-speed rail in

David McKelvey, Flickr, CC BY-NC-ND 2.0

Waiting at the Milano Centrale station in Milan, Italy, the Trenitalia Frecciarossa ETR 500 reaches speeds up to 360 kilometers per hour. The most popular route—from Milan to Rome (normally, a six-hour drive)—takes about three hours by high-speed rail.

Roderick Eime, Flickr, CC BY-ND 2.0

Outpacing surrounding traffic, an InterCity Express (ICE) 3 high-speed train slices between German cities at speeds exceeding 250 kilometers per hour.

China connects the developed east and south with the less developed west. These high-speed rail services (such as Lanzhou–Xinjiang and Shanghai–Kunming) matter significantly from the perspective of social stability, despite relatively lower travel demand and affordability. Eventually, the Chinese central government's expectation is that the improved regional connectivity brought by high-speed rail may facilitate inclusive and harmonious regional development in China.

In terms of the equity impact from the evaluations of individual passengers, findings from empirical studies are inconsistent. For instance, Chen and Wei showed that high-speed rail was not affordable for most of the population, based on a study of Hangzhou East Rail station in China (*9*). Research shows that, on one hand, high-speed rail had become a preferred mode for intercity travel in China, even for those in the less developed regions in China (*10*). On the other hand, passengers from less developed western provinces also expressed a sense of being excluded from using high-speed rail, given the concerns of high fares or the lack of understanding of which cities the system serves. Cass, Shove, and Urry suggest that although high-speed rail has a positive effect, such as increased accessibility to employment centers for commuters, it also generates negative social impacts (*11*). One example that has been observed in the United Kingdom is the creation of spatial inequity in cities or territorial areas without a high-speed rail service (*12*). Likewise, negative impacts of high-speed rails on spatial equity among territorial areas are found in Spain (*13*).

Research shows the impacts of high-speed rail on equity are inconsistent when looked at from a global scale. This is partly because of how studies are conducted (e.g., short- or long-term studies), the regional scales used, and the unique characteristics of the countries themselves. Nevertheless, scholars have generally reached a consensus to recommend that high-speed rail planning and investment not only consider the economic benefits but also the equity impacts.

Evaluating Land Use and Housing Impact

High-speed rail also has a significant impact on land use. From China's experience, high-speed rail development facilitates urban growth and expansion. The Chinese approach to high-speed rail station planning differs from the conventional planning method observed in Europe or Japan. In the latter cases, high-speed rail stations are usually located in downtown areas. In China, high-speed rail stations are in suburban and even rural areas. This strategy for route planning has several critical implications. For instance, local governments usually leverage high-speed rail development to expand the

dunhilaryu, Flickr, CC BY 2.0

China's early high-speed trains were imported or built under technology transfer agreements with foreign train manufacturers. The Beijing–Shanghai High-Speed Railway, which opened more than a decade ago, uses the new CRH380 trainsets, which can reach a top operational speed of 380 kilometers per hour.

urban landscape and stimulate new economic growth through developing real estate and upgrading civil infrastructure systems such as roadways and water systems. However, similar to the evaluation of equity impacts, this approach may not be applicable to all cities or countries and can be considered on a case-by-case basis. For instance, successful cases were found in cities in the eastern part of China, where population density is high, along with demand for new housing and related travel needs (*14*). However, unsuccessful cases can also be found, especially in less developed regions, such as the inner Mongolia cities and southwest China.

High-Speed Rail's Effects on Alternative Transportation Modes

The introduction of high-speed rail also significantly impacts alternative transportation modes, such as aviation. Some studies indicate that high-speed rail has a negative impact on air transportation because it reduces air travel demand and, in turn, airlines' passenger revenue miles (*15*). However, the substitutional effects of high-speed rail on air travel vary, due to factors such as route, travel distance, city type, and individual countries' available aviation infrastructure. For instance, Castillo-Manzano, Pozo-Barajas, and Trapero found that only part of high-speed rail passenger demand substituted for air travel in the case of Spain, due to the influence of competition price, travel time, service frequency, and travel distance (*16*).

The development of high-speed rail also benefits air transportation. The competition can promote the expansion of air transportation networks to cover more underserved markets, providing more passenger options. In addition, coordination between high-speed rail and aviation through strategies such as enhancing modal integration can be achieved by facilitating seamless intermodal transfers. Such coordination is also likely to improve the intercity travel experience and mutually promote the growth of air transportation services (*17*). The substitution between high-speed rail and air transportation can also mitigate the effects of disruptive events, such as transportation system failures or natural disasters (*18*). The development of high-speed rail has also been found to have a positive outcome on air transportation in terms of reducing congestion at bigger airports (*19*).

Environmental Impact

The environmental effects of high-speed rail can be viewed from two aspects. The first aspect focuses on the influence of this rail system on the environment, such as greenhouse gas emission and air quality. The second aspect emphasizes the impact of environment on high-speed rail, such as climate change–induced extreme weather conditions.

The majority of studies focusing on the first aspect concludes that introduction or expansion of high-speed rail reduces total emissions by diverting travelers from other more polluting modes. For instance, based on an examination of 23 high-speed rail lines that opened in China between 2015 and 2016, Guo, Sun, Yao, and Zheng found that this kind of rail system reduced the concentration of carbon monoxide along highways (*20*). Similarly, Zhang, Wang, and Yao found that the development of high-speed rail also contributes to reducing haze of fine particulate matter (PM) pollution (measured at PM 2.5), although the effect is more significant in less developed western cities than in more developed eastern and central cities (*21*). Part of the reason for such a different effect could be attributed to the levels of substitutions with alternative transportation modes. Lin, Qin, Wu, and Xu showed that development of Chinese high-speed rail reduced annual average overall greenhouse gas emissions by 11 million tons of CO_2 equivalent through the replacement of road traffic (*22*). However, some researchers argue the possibility of a less optimistic result, especially when using life-cycle assessment to evaluate high-speed rail projects. When calculating for emissions from infrastructure construction, the manufacturing and maintenance of vehicles, as well as the production of energy that powers the transportation modes, the conclusion that high-speed rail reduced greenhouse gas emissions from the transportation system is much less certain.

Additionally, evidence has emerged in the past few years in studies focusing on China that concludes that high-speed rail has an effect in reducing greenhouse gas emissions; however, other studies show this effect may not be statistically significant or even reversed. When looking at regional studies, it has been found that the introduction of high-speed rail service has a significant impact on the greenhouse gas emissions of cities in the eastern coastal region and the western region, but not the central region of China. Moreover, in the western region, the carbon emission reduction effect of high-speed rail is found only in the major cities rather than the ordinary prefecture-level cities.

In addition, scholars have extensively examined the impact of extreme weather shifts on high-speed rail infrastructure and operations. For example, Binti Sa'adin, Kaewunruen, and Jaroszweski indicate that extreme weather conditions can lead to severe high-speed rail system failures, including degraded operations that lead to delays to train services (*23*). When comparing the on-time performance of aviation and high-speed rail systems in China under extreme weather conditions, high-speed rail tends to be more resilient to storm weather events—such as thunderstorms and heavy rain—than the aviation system (*17*). Additionally, studies show that airports can have a higher level of resilience (in terms of speed of recovery) after being impacted by extreme weather events if the cities have better rail connectivity (*24*). Overall, these findings suggest that future high-speed rail planning can more proactively consider the changing environment's effects on infrastructure system operation.

Conclusion

Investing in high-speed rail will likely generate far-reaching impacts on every aspect of socioeconomic life and the environment. As a result, the authors recommend that future planning for and investment in high-speed rail be implemented cautiously, while considering

not only the return on investment using the conventional benefit–cost analysis methods but also its wider socioeconomic consequences. The authors recommend that the investigation include but not be limited to economic, social equity, land use, and housing impacts. Instead, they recommend that high-speed rail's environmental impacts—such as its effects on CO_2 emission, air pollution, and resilience to disruptions caused by human-made events and climate change–induced extreme weather conditions—be carefully examined in both ex-ante and ex-post evaluations. In addition, the authors recommend that high-speed rail be evaluated in relation to intermodal options and considerations that could emphasize how to provide more seamless passenger and freight transportation services, especially under disruptive conditions.

REFERENCES

1. Chen, Z., J. Xue, A. Z. Rose, and K. E. Haynes. The Impact of High-Speed Rail Investment on Economic and Environmental Change in China: A Dynamic CGE Analysis. *Transportation Research Part A: Policy and Practice*, Vol. 92, 2016, pp. 232–245.
2. Diao, M. Does Growth Follow the Rail? The Potential Impact of High-Speed Rail on the Economic Geography of China. *Transportation Research Part A: Policy and Practice*, Vol. 113, 2018, pp. 279–290.
3. De Rus, G., and G. Nombela. Is Investment in High-Speed Rail Socially Profitable? *Journal of Transport Economics and Policy*, Vol. 41, No. 1, 2007, pp. 3–23.
4. Chen, Z., and K. E. Haynes. Impact of High-Speed Rail on Regional Economic Disparity in China. *Journal of Transport Geography*, Vol. 65, 2017, pp. 80–91.
5. Chen, Z. Measuring the Regional Economic Impacts of High-Speed Rail Using a Dynamic SCGE Model: The Case of China. *European Planning Studies*, Vol. 27, No. 3, 2019, pp. 483–512.
6. Miwa, N., A. Bhatt, and H. Kato. High-Speed Rail Development and Regional Inequalities: Evidence from Japan. *Transportation Research Record: Journal of the Transportation Research Board*, Vol. 2676, No. 7, 2022, pp. 363–378. https://doi.org/10.1177/03611981221078566.
7. Jiang, M., and E. Kim. Impact of High-Speed Railroad on Regional Income Inequalities in China and Korea. *International Journal of Urban Sciences*, Vol. 20, No. 3, 2016, pp. 393–406.
8. Sanchez, T. W., M. Brenman, J. S. Ma, and R. H. Stolz. *The Right to Transportation: Moving to Equity*, Routledge, New York, 2018.
9. Chen, C. L., and B. Wei. High-Speed Rail and Urban Transformation in China: The Case of Hangzhou East Rail Station. *Built Environment*, Vol. 39, No. 3, 2013, pp. 385–398.
10. Ren, X., Z. Chen, F. Wang, T. Dan, W. Wang. et al. Impact of High-Speed Rail on Social Equity in China: Evidence from a Mode Choice Survey. *Transportation Research Part A: Policy and Practice*, Vol. 138, 2020, pp. 422–441.
11. Cass, N., E. Shove, and J. Urry. Social Exclusion, Mobility and Access. *The Social Review*, Vol. 3, 2005, pp. 539–555.
12. Chen, C. L., and P. Hall. Using High Speed Two to Irrigate the Regions. *Built Environment*, Vol. 39, No. 3, pp. 355–368.
13. Monzón, A., E. Ortega, and E. López. Efficiency and Spatial Equity Impacts of High-Speed Rail Extensions in Urban Areas. *Cities*, Vol. 30, 2013, pp. 18–30.
14. Chang, Z., L. Zheng, T. Yang, and F. Long. High-Speed Rail, New Town Development, and the Spatial Mismatch of Land Leases in China. *Land Use Policy*, Vol. 115, 2022, p. 106014.
15. Jiménez, J. L., and O. Betancor. When Trains Go Faster than Planes: The Strategic Reaction of Airlines in Spain. *Transport Policy*, Vol. 23, 2011, pp. 34–41.
16. Zhang O., H. Yang, and O Wang. Impact of High-Speed Rail on China's Big Three Airlines. *Transportation Research Part A: Policy and Practice*, Vol. 98, 2017, pp. 77–85.
17. Castillo-Manzano, J. I., R. Pozo-Barajas, and J. R. Trapero. Measuring the Substitution Effects Between High-Speed Rail and Air Transport in Spain. *Journal of Transport Geography*, Vol. 43, 2015, pp. 59–65.
18. Chen, Z., and Y. Wang. Impacts of Severe Weather Events on Air and High-Speed Rail Delays. *Transportation Research Part D: Transport and Environment*, Vol. 69, 2019, pp. 168–183.
19. Takebayashi, M. How Could the Collaboration Between Airport and High-Speed Rail Affect the Market? *Transportation Research Part A: Policy and Practice*, Vol. 92, 2016, pp. 277–286.
20. Guo, X., W. Sun, S. Yao, and S. Zheng. Does High-Speed Railway Reduce Air Pollution Along Highways? Evidence from China. *Transportation Research Part D: Transport and Environment*, Vol. 89, 2020, p. 102607.
21. Zhang, F., F. Wang, and S. Yao. High-speed Rail Accessibility and Haze Pollution in China: A Spatial Econometrics Perspective. *Transportation Research Part D: Transport and Environment*, Vol. 94, 2021, p. 102802.
22. Lin, Y., Y. Qin, J. Wu, and M. Xu. Impact of High-Speed Rail on Road Traffic and Greenhouse Gas Emissions. *Nature Climate Change*, No. 11, 2021, pp. 952–957.
23. Binti Sa'adin, S. L., S. Kaewunruen, and D. Jaroszweski. Heavy Rainfall and Flood Vulnerability of Singapore–Malaysia High Speed Rail System. *Australian Journal of Civil Engineering*, Vol. 14, No. 2, 2016, pp. 123–131.
24. Zhou, L., and Z. Chen. Measuring the Performance of Airport Resilience to Severe Weather Events. *Transportation Research Part D: Transport and Environment*, Vol. 83, 2020, p. 102362.

Additional Resources

Jiang, C., and A. Zhang. Airline Network Choice and Market Coverage Under High-Speed Rail Competition. *Transportation Research Part A: Policy and Practice,* Vol. 92(C), 2016, pp. 248–260.

Xia, W., and A. Zhang. Air and High-Speed Rail Transport Integration on Profits and Welfare: Effects of Air–Rail connecting time. *Journal of Air Transport Management,* Vol. 65, 2017, pp. 181–190.

Chen, Z., A. Perl, and X. Wang. High-Speed Rail and the Environment. *Transportation Research Part D: Transport and Environment,* Vol. 101, 2021, p. 103102.

Jiang, C., Y. Wan, H. Yang, and A. Zhang. Impacts of High-Speed Rail Projects on CO2 Emissions Due to Modal Interactions: A Review. *Transportation Research Part D: Transport and Environment,* Vol. 100, 2021, p. 103081.

Li, H., J. Strauss, and L. Liu. A Panel Investigation of High-Speed Rail (HSR) and Urban Transport on China's Carbon Footprint. *Sustainability,* Vol. 11, No. 7, 2019.

Nash, C. When to Invest in High-Speed Rail. *Journal of Rail Transport Planning & Management,* Vol. 5, No. 1, 2015, pp. 12–22.

Sun, L., and W. Li. Has the Opening of High-Speed Rail Reduced Urban Carbon Emissions? Empirical Analysis Based on Panel Data of Cities in China. *Journal of Cleaner Production,* Vol. 321, 2021, p. 128958.

Going Cashless? Considering Changes to Transit Agency Fare Collection Systems

Washington Metropolitan Area Transit Authority

CANDACE BRAKEWOOD

The author is an associate professor at the University of Tennessee, Knoxville.

Paying a fare is as easy as tapping an app-enabled smartphone—or watch—to a sensor, just one of the payment options on Washington Metropolitan Area Transit Authority buses. It's contactless, quick, and customers can consolidate cards and skip fare machines.

Over the past decade, a few transit agencies in the United States have considered eliminating cash fare collection from onboard buses. Although many bus rapid transit, light rail, and heavy rail operators require prepayment of transit fares before boarding vehicles, nearly all large- and medium-size local bus operators continue to accept cash onboard vehicles.

Discontinuing the use of cash in transit vehicles has many potential benefits, including improvement to operations, safety, and security. Despite this, fare collection on buses presents unique challenges because of the sheer number of bus stops distributed throughout large metropolitan areas with few—if any—stations or terminals where fare-collection infrastructure can be more easily installed and maintained. Even when new fare payment systems that rely primarily on personal devices and payment instruments—such as smartphones and credit or debit cards—are implemented, transit agencies recognize that they have diverse constituencies of riders, including those who either prefer or need to pay with cash. This can pose challenges for riders who are "unbanked," which is typically defined as those persons lacking a checking or savings account at a bank or credit union.

Considering these challenges, *TCRP Synthesis 163: Considering the Unbanked in Cashless Fare Payment at Point of Service for Bus/Demand–Response Services* aims to inform transit agencies of the potential impacts of going cashless from the perspectives of bus, demand–response, and cable car operators (*1*). The study examined various elements of cashless fare collection systems, including operations, advantages and drawbacks, policy, and regulations, as well as considerations for certain populations of riders such as the unbanked.

The primary method was to provide detailed case examples of transit agencies, based on interviews with agency staff. Some of the selected transit agencies

National Association of City Transportation Officials, Flickr, CC BY-NC 2.0

Riders use their respective Clipper cards on all Bay Area transit systems, including Muni. Fares can be paid on surface transportation with any U.S. currency. However, exact change is required.

conducted small-scale pilot programs of cashless fare collection on one or a few routes; others suspended cash fare collection due to the COVID-19 pandemic. The remainder were considering or implementing cashless fare collection systemwide. The transit agency examples were classified into the three groups shown in Figure 1. Short summaries for six of the examples follow, with more details about these examples—as well as additional transit agency case examples—found in *TCRP Synthesis 163*.

Example 1

San Francisco Municipal Railway (Muni), California

Cable cars have unique fare-collection challenges. Muni implemented a pilot program that took a step toward cashless by aiming to significantly reduce onboard cash fare payments on three cable car routes. Tourists are the primary market for cable cars. Therefore, the transit agency focused marketing and outreach on this group. Motivating factors for reducing cash fare payments onboard were to decrease fare evasion, improve operator safety (conductors also help with braking the cable car), and boost security by reducing cash handling. In 2019, the pilot program was implemented with the following three primary changes:

1. Prepayment was required at sales kiosks in primary locations, such as near the touristy Fisherman's Wharf neighborhood;
2. Pricing was changed to incentivize prepayment; and
3. A comprehensive marketing, communications, and signage plan was implemented.

This pilot program was conducted before the COVID-19 pandemic, and cable car service was suspended from the spring of 2020 until fall 2021 due to COVID-19. Since reinstating service, Muni requires prepayment at terminal locations. However, to board cable cars in all other nonterminal locations or outside of terminal kiosk hours, customers may pay fares to the cable car operator in cash with exact change only.[1]

[1] To learn more about Muni's fare payment options, go to https://www.sfmta.com/fares/cable-car-single-ride.

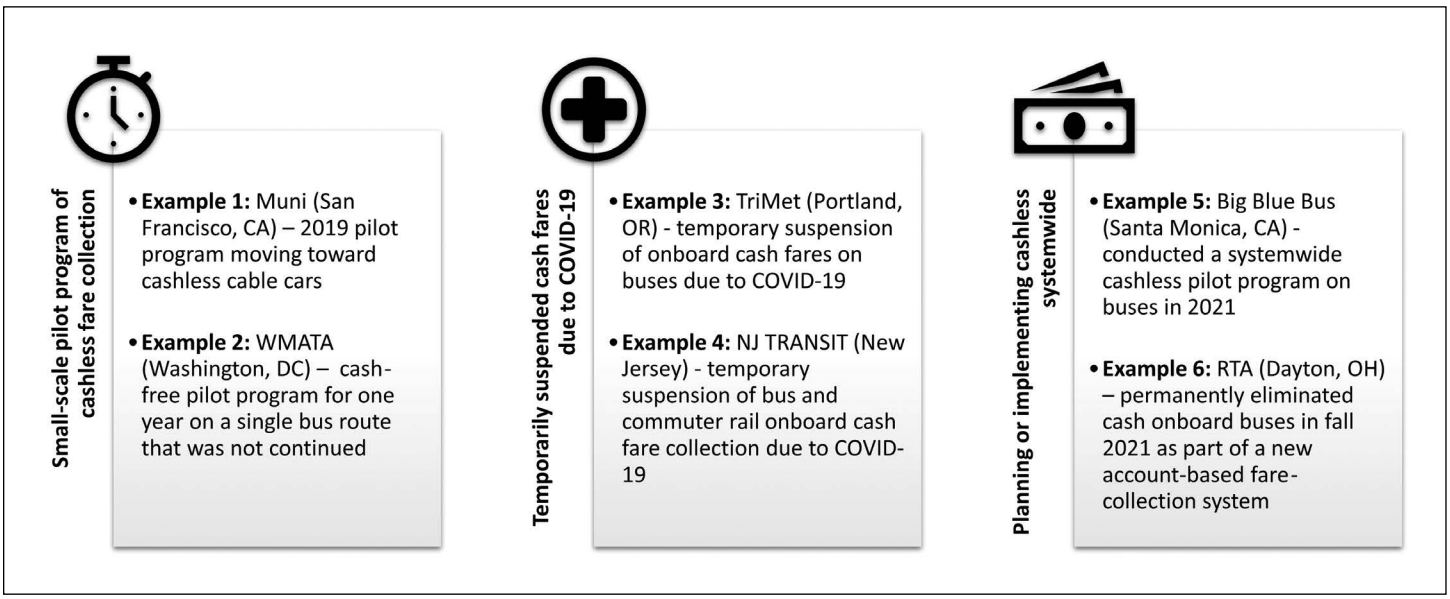


FIGURE 1 Transit agency examples.

Travis Estell, Flickr, CC BY-NC-SA 2.0

Often referred to as moving historic monuments, San Francisco's cable cars fare payment system now operates by offering options via ticketing apps and the Bay Area Clipper card. However, they still accept good old-fashioned cash—with exact change.

Example 2

Washington Metropolitan Area Transit Authority, Washington, DC

Washington Metropolitan Area Transit Authority (WMATA) conducted a one-year pilot program on a single bus route to evaluate cash-free boarding. The Route 79 MetroExtra was selected because it had good alternatives for those customers who wanted to continue to pay with cash (e.g., at ticket vending machines in nearby MetroRail stations), and there was a relatively small amount of cash payments onboard this route prior to the start of the pilot program. During the pilot, the agency collected customer and operator surveys. In general, both groups liked the cash-free boarding pilot program. WMATA also conducted a detailed technical evaluation of the program. However, operational changes such as running-time savings showed limited, if any, impact. After the pilot program ended, WMATA resumed onboard cash fare collection on the pilot route. One lesson learned is that the agency selected a route with low cash use prior to the pilot program. This meant that there was not much room to benefit by going fully cash free.

Washington Metropolitan Area Transit Authority

Starting this year, WMATA's 20-year-old combination SmarTrip card–cash fareboxes will be upgraded on more than 1,500 buses. The new bus fare collection system will allow customers to use the same payment methods, but with faster processing of coins and bills.

Example 3

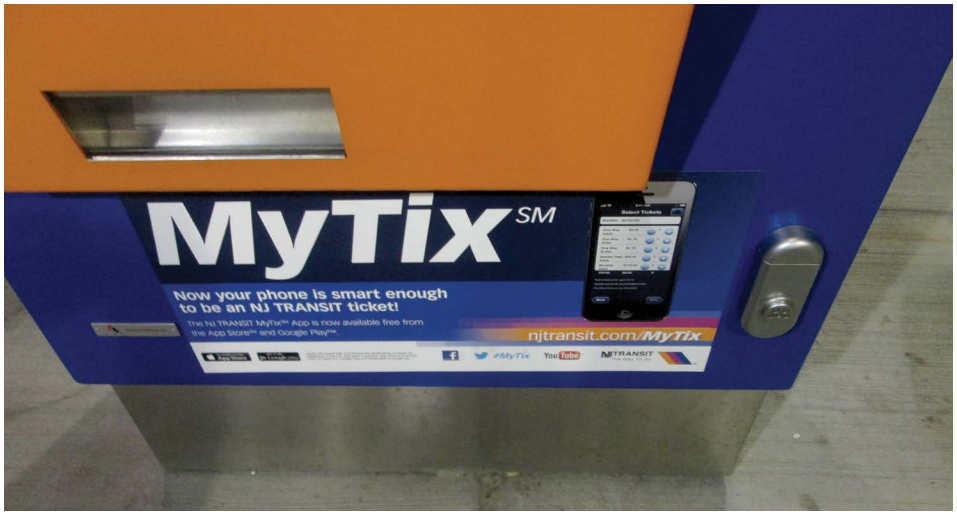
Tri-County Metropolitan Transportation District, Portland, Oregon

The Tri-County Metropolitan Transportation District (TriMet) suspended cash fare collection onboard buses during the COVID-19 pandemic due to public health concerns. The suspension lasted for approximately six months in 2020, which gave the agency time to install barriers at the front of vehicles to protect operators. During this time, TriMet customers were encouraged to pay fares by using the account-based Hop system. The results of suspending onboard cash fare collection are unclear, since there were numerous other service and policy changes during the same time frame. TriMet intends to continue collection of cash fares onboard buses in the future.

Example 4

New Jersey Transit Corporation

Like the previous example, the New Jersey Transit Corporation (NJ Transit) temporarily halted onboard cash fare collection on bus, as well as commuter rail, service for a short period in 2020 during the COVID-19 pandemic. The primary motivation was again public health concerns. Local intrastate and commuter interstate buses implemented rear-door boarding when possible and blocked off the space around the driver at the front of the vehicle. Bus customers were encouraged to prepurchase tickets, particularly through NJ Transit's mobile fare app. However, this was on the honor system. Cash fare payments resumed onboard buses, as well as onboard commuter rail services, in the summer of 2020. The results of temporarily moving to cashless fare collection during the COVID-19 pandemic also are unclear since there were numerous other changes during this time frame.



Adam Moss, Flickr, CC BY-SA 2.0

Bright blue and orange NJ Transit fare machines are easy to spot at Montclair State University at Little Falls. As of a year ago, the agency had installed 558 ticket vending and office machines with faster transactions, contactless payment, and mobile wallet applications. Displays provide travel information and advisories.

Example 5

The Big Blue Bus, Santa Monica, California

In the summer of 2021, the Big Blue Bus began a pilot program to evaluate cashless fare collection on their entire bus network. This was initially motivated by pandemic-related public health concerns. However, another key motivating factor included potential operational improvements. Customer surveys were conducted in advance of the pilot program, and data from the surveys were used in a Title VI Fare Equity Analysis.[2] Transit agency staff conducted extensive customer communication and education about contactless fare payment options and the cashless pilot program. The Big Blue Bus provided riders with one free 30-day pass to help increase adoption of contactless fare payment options, which helped to soften the initial implementation of the cashless pilot program. Once the pilot was underway, the transit agency was able to adjust schedules to shorten running times due to operational improvements.

Preliminary results from customer research conducted during the pilot program suggest that most riders do not intend to use cash again. However, some riders were concerned about possibly disenfranchising others who may be more vulnerable, such as the elderly or unbanked. According to recent press releases, the Big Blue Bus reinstated cash fare collection onboard buses in June 2022.[3]

Scott Page, Flickr, CC BY-NC-SA 2.0

The Big Blue Bus, the municipal bus line in Santa Monica, California, developed fare-change policies to promote safe, convenient, and equitable access. Administrators lowered fares, maintained onboard health and safety improvements, reduced boarding and travel times, and realigned fare products with customers' preferences.

Example 6

Greater Dayton Regional Transit Authority, Ohio

Greater Dayton Regional Transit Authority (RTA) has gradually launched an account-based fare payment system known as "Tapp Pay" on their bus and paratransit system. One phase of this program included eliminating cash fare payment onboard buses, which was implemented in November 2021. To plan for this, the RTA collected rider surveys and feedback, held public meetings, and conducted community outreach as part of the Title VI

[2] Title VI of the Civil Rights Act of 1964 requires that no person in the United States shall, on the ground of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving federal financial assistance.

[3] Read the *Big Blue Bus News* announcement at https://www.bigbluebus.com/Newsroom/News/City-Council-Approves-Big-Blue-Bus-Fare-Policy-Changes-to-Enhance-Customer-Experience.aspx?type=News.

process. The RTA partnered with private companies to provide a large retail sales network where customers can load cash into their Tapp Pay accounts. One component of the RTA's Title VI Fare Equity Analysis included identifying retail sales locations that are within one-quarter mile of a bus route or transit center to help ensure that riders who want to pay cash have a ticket sales channel in proximity. As part of the new fare payment system, the RTA introduced daily and monthly fare capping, which the agency believes is important—from an equity perspective—for those riders who cannot afford the upfront cost of a period pass. To encourage all customers to try out the new fare payment system, the RTA temporarily offered discounts on the fare-capping price. Additionally, the RTA implemented a "one more ride" policy with the Tapp Pay system. This allows customers to have a negative balance for one or two trips so that they can reload after the ride. Dayton's RTA continues to have cashless operations onboard buses more than a year later.

Conclusion

The public transit industry is slowly beginning to consider the concept of "cashless" or "cash-free" fare collection. The next few years should see a few leading transit agencies implement cashless fare collection policies onboard buses.

REFERENCE

1. Brakewood, C. *TCRP Synthesis 163: Considering the Unbanked in Cashless Fare Payment at Point of Service for Bus/Demand–Response Services*. TRB, National Research Council, Washington, DC, 2022. https://doi.org/10.17226/26589.

Based on the case examples, *TCRP Synthesis 163* identified the following 10 key findings and emerging trends in the public transit industry:

1. **Nascent idea:** The concept of "cashless" is a nascent idea for U.S. transit operators, and nearly all local bus operators at large- and medium-size metropolitan transit agencies in the United States continue to accept cash onboard buses.
2. **Terminology:** The industry lacks standard terminology to describe "cashless" or "cash-free" fare-collection systems. Some transit agencies prefer to say that they accept cash, just not onboard vehicles.
3. **Convenient alternatives:** One of the most critical elements in preparing for cashless fare-collection systems is to provide customers with convenient alternative options to pay cash, including a robust retail sales network and ticket vending machines.
4. **One more ride policy:** Some new fare policies—particularly "one more ride" policies that let customers have a negative balance for one trip so that they can reload—are likely to be implemented by agencies with account-based fare-collection systems that want to eliminate onboard cash fare collection.
5. **Vehicle operators:** A key motivating factor for removing cash onboard is operator health, safety, and security.
6. **Operational improvements:** Many agency staff believe that operational improvements are a potential advantage of removing cash from vehicles. However, more research is needed to quantify these effects.
7. **Facilitating all-door boarding:** Some agencies consider removing cash fare collection from vehicles to facilitate all-door boarding.
8. **Unbanked:** Transit agencies considering cashless fare collection systems want to understand unbanked riders and other populations who may have specialized needs. For example, these agencies consider how many riders are unbanked and how to meet their needs and the specialized needs of others.
9. **Title VI:** Title VI Fare Equity Analyses are likely to be needed as transit agencies plan for cashless fare-collection systems.
10. **Outreach:** Public outreach and communication are a key part of the planning process for cashless fare collection.

Better Evaluation, Better Decision Making

Prioritizing Public Transportation Investments

Diana Robinson, Flickr, CC BY-NC-ND 2.0

NAOMI STEIN

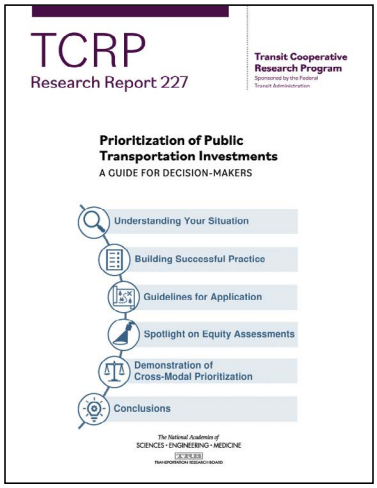
The author is a vice president at EBP US in Pittsburgh, Pennsylvania.

Transit riders—like this person entering the 50th Street Subway Station on Sixth Avenue in New York City—are probably unaware of how difficult it is for transit stakeholders to choose which projects receive scarce funding. Recent TCRP research can help transit organizations work through the snags.

The demand for public transportation investments far exceeds the funds available. While communities seek additional revenue sources to maintain current transit assets and serve rapidly changing travel markets, they need methods to help decide where to allocate limited resources. Using performance- and metric-based prioritization processes empowers decision makers to be more accountable, transparent, and rigorous in an environment of limited funding and tough choices. At the core of such approaches is the idea that better evaluation can support better decision making.

At the same time, there are challenges with shifting to more quantitative approaches. For example, transit projects seeking to compete for funding are often at a disadvantage because they have benefits that are either difficult to quantify or have traditionally been inadequately addressed by methods developed for highway capacity improvement projects. As decision makers work to support more sustainable portfolios of transportation infrastructure and services, they need methods to meaningfully compare outcomes across modes.

TCRP Research Report 227: Prioritization of Public Transportation Investments—A Guide for Decision-Makers provides practical advice for agencies looking to improve their prioritization practice for public



transportation projects (*1*). The guide focuses on methods used to prioritize transit capital projects and cross-modal decision making, specifically the comparison of public transit and nontransit projects. This article provides a snapshot of some of the key findings identified in the research.

Building from Existing Best Practices

National research, guidance, and state-of-the-practice reviews provide several lessons regarding the attributes of successful practices in investment decision making (Figure 1). Much of the existing guidance on multiobjective investment prioritization is also applicable to public transportation. For example, prioritization approaches should be

- Driven by objectives,
- Able to account for cost effectiveness,
- Designed to support specific decisions or comparisons,
- Used to leverage available data, and
- Part of a process of continued testing and improvement.

Similarly, the multiple objective decision analysis approach, defined in *NCHRP Research Report 921* and shown in Figure 2, offers a useful structure for transit and cross-modal prioritization (*2*). However, there are also considerations that are unique to transit and merit special consideration. Table 1 provides guiding questions that can be used to help strengthen transit prioritization at each stage of the multiple objective decision analysis process.

Criteria to Capture the Benefits of Transit

Effective transit prioritization requires a wide lens to capture the full range of transit investment objectives and outcomes. It is important to recognize transit's core purpose of providing access to opportunities, particularly for those with limited transportation options. Emphasizing the right measures that capture transit benefits for users and society can help overcome the disadvantages

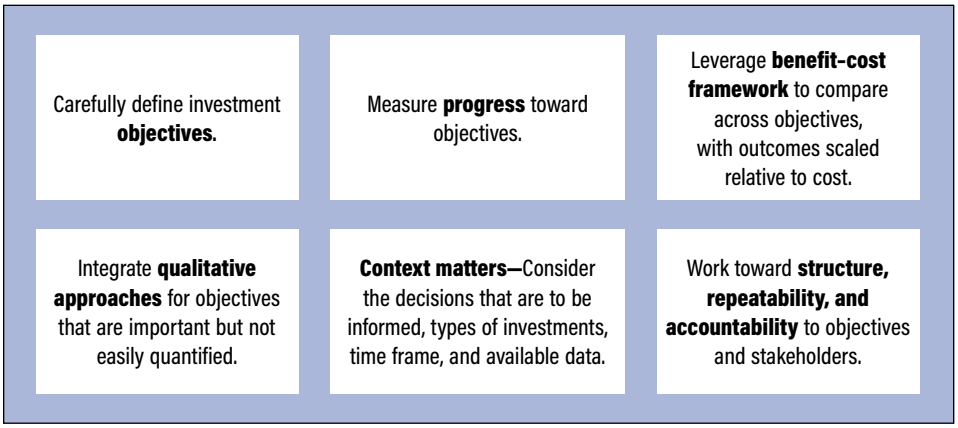


FIGURE 1 Attributes of successful investment prioritization practice. (Source: EBP.)

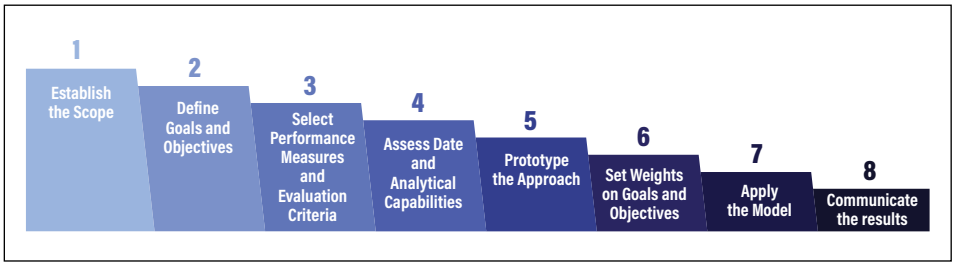


FIGURE 2 Multiple-objective decision analysis approach. (Source: Spy Pond Partners.)

TABLE 1 Questions to Guide Transit Prioritization.

Approach Step	Key Questions
Establish the Scope	Will transit investments be competing directly with nontransit investments? What types of transit and nontransit investments are within scope? Are there specific legislative, funding, or policy requirements that influence what objectives or criteria should be included? Does this prioritization process interact with those at other agencies?
Define Goals and Objectives	What do the considered transportation investments seek to achieve? Do goals differ across types of projects (transit vs nontransit or state of good repair vs capacity)? Do identified goals and objectives consider not only aggregate mobility and efficiency outcomes but also broader social, economic, and environmental outcomes that may be the primary focus of transit investments?
Select Performance Measures or Evaluation Criteria	• Are all the primary objectives of transit investments addressed by the selected criteria? • In cases where models or data are lacking, have qualitative measures been incorporated and clearly defined? • Can selected measures successfully differentiate between projects, and do they capture a range of outcomes? • Are any of the selected measures not applicable to transit? If so, are these balanced by those that are? • Across investment types, is there a need to develop measures that address the same conceptual outcomes but with different technical definitions (i.e., a planning time index on the roadway network compared with a on-time performance measure for transit)? • Is distributional equity reflected in the selected measures/criteria?

(*Continues on next page*)

(*Continued from previous page*)

Approach Step	Key Questions
Assess Data and Analytical Capacity	• Do available tools and data capture the benefits of transit? • Can additional data or qualitative information be incorporated to address any gaps? • Within any given performance category, who is best equipped to provide information?
Prototype the Approach	• Has the approach been tested on a sample set that includes a range of projects? • Are measures of different types and units appropriately normalized (e.g., on a scale of 0 to 100) prior to aggregation? • Are certain measures dominating or skewing the results?
Set Weights on Goals and Objectives	• Are certain weights dominating or skewing the results?
Apply the Model	• Is the methodology documented sufficiently to enable transparency and future iteration?
Communicate the Results	• Do the results empower decision makers to select and advance beneficial transit investments?

TABLE 2 Guidelines on Criteria Emphasis by Illustrative Archetype.

Criteria Type	Basic Access	Small Fixed Route	Growing Transit	Large Legacy System	Statewide
Accessibility	●	●	●	●	●
Congestion/Mobility	○	◑	●	●	◑
Cost effectiveness/preservation	◑	◑	◑	●	◑
Economic impacts	◑	◑	●	●	◑
Environmental quality	○	◑	●	●	◑
Land-use compatibility	◑	◑	●	◑	◑
Public health and quality of life	◑	◑	◑	●	◑
Regional integration and coordination	○	◑	●	●	○
Social equity/environmental justice	●	●	●	●	●
Viability/feasibility	●	●	●	●	●

Key: (●) criteria likely to be relevant and emphasized in public transportation project prioritization, (◑) criteria that may merit less emphasis, and (○) criteria of minor emphasis or likely not to be relevant.

transit projects sometimes face when they are prioritized alongside other modes. Through a literature review, online questionnaire, and agency interviews, *TCRP Research Report 227* identified the criteria that can be used to capture the benefits of transit (Table 2).

Spotlight on Equity

Transportation connects people to opportunities. Transit is vital to many people who face transportation disadvantages, whether due to income, race, ethnicity, ability, age, language, or the intersection of these characteristics. However, according to the U.S. Census Bureau, transit accounts for approximately 5 percent of commuters in most of the United States.[1] Because the number of transit users is fewer than the number of people traveling by personal vehicle, it is particularly important to consider distributional effects and their implications for social equity.

In the context of project prioritization, performance can be observed through the following two lenses:

1. The **aggregate outcome** lens focuses on measuring performance outcomes for all users of a transit system or for all travelers. While this supports cost-effective transit investments through methods like benefit–cost analysis, aggregate measures also have disadvantages. Specifically, a narrow focus on aggregate outcomes to guide investment decisions can leave out the equity goals and implications of many transit investments.
2. The **distributional equity** lens requires an assessment of the relative impacts of projects or investments for specific disadvantaged populations, compared to the overall population. This perspective seeks to understand whether planned investments improve unequal conditions that exist today because of historical decisions. It asks if proposed projects enhance fair and just access to resources and opportunities.

Equity analysis steps typically include the following:

1. **Define the population(s) of interest**, which are commonly described according to income, race/ethnicity, language ability, age, vehicle ownership, and ability;
2. **Select performance measures** for equity assessment (e.g., change in accessibility);
3. **Disaggregate results** based on geographic or demographic characteristics, or both; and
4. **Assess differences in outcomes**, giving more equitable outcomes higher ratings.

Decision makers are increasingly looking to include equity metrics or scores in prioritization processes to inform decision making and the comparison of projects across multiple objectives.

[1] See the full U.S. Census Bureau report at https://data.census.gov/table?q=S0802:+MEANS+OF+TRANSPORTATION+TO+WORK+BY+SELECTED+CHARACTERISTICS&g=0100000US&tid=ACSST5Y2019.S0802.

Multiple Routes to Success

Transit prioritization cannot be one size fits all. Rather, its methods should be tailored to individual community and transit market characteristics. While some objectives and metrics are universally relevant, others are best suited to specific contexts.

To provide guidance on choosing metrics that are context appropriate, the *TCRP Research Report 227* research team developed five illustrative transit prioritization archetypes (Figure 3). The archetypes were formulated based on common factors that influence the prioritization of public transportation projects, namely, the type of service currently provided, the desired level of future service, and the agencies involved in the decision-making process. While it is unlikely that any archetype will exactly match a given situation, these archetypes are intended to provide insights into issues of relevance based on existing commonalities.

Table 2 provides guidelines on the criteria that may be most relevant across the different archetypes. For example, while accessibility and equity are universally important, the role of transit in providing congestion relief may be most applicable to more urbanized areas (i.e., the growing transit and large legacy system archetypes).

In addition to choosing the right type of criteria, there are options and pathways to success when it comes to the format of the criteria, with implementation options that have varying levels of complexity (e.g., quantitative measures versus ordinal scores such as from 1 to 10). Choosing an approach is not an all-or-nothing decision. In practice, it is helpful to mix different forms of evaluation criteria, based on available information, tools, staff capacity for analysis, and whether an objective lends itself to quantification. Options in this area and their pros and cons are shown in Table 3.

Project evaluation and prioritization can be based on the following:

- **Condition information (current or forecast future)**: For example, current on-time performance or

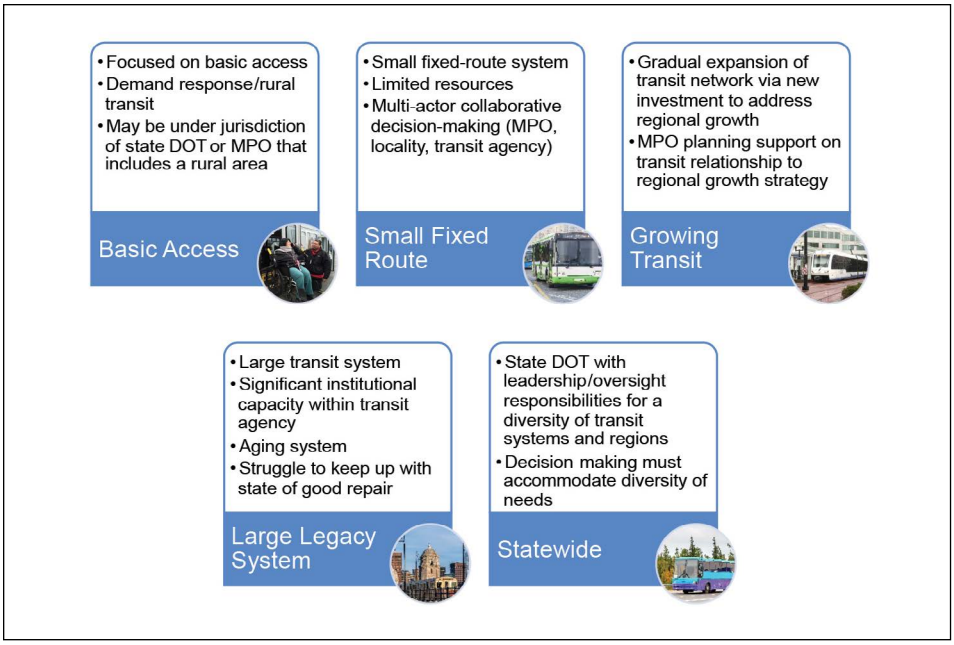


FIGURE 3 Illustrative transit investment prioritization archetypes. [DOT = department of transportation; MPO = metropolitan planning organization. (Source: *TCRP Research Report 227*.)]

TABLE 3 Options for implementation of evaluation criteria.

Option	Description	Pros & Cons
Qualitative input	Decision-factor considered through qualitative or descriptive analysis	Pros: • Does not require data collection or processing • Addresses hard-to-quantify objectives • Can be used to integrate expert knowledge Cons: • Subjective and hard to replicate consistently • Relationship to decision outcomes may not be clear
Ordinal scoring	Scoring of alignment with criteria along a point-based scale *Note: 3-point scales (Low/Medium/High) provide minimum resolution, while more points (e.g., 5- or 7-point scales) provide more meaningful resolution*	Pros: • Simpler than full quantitative evaluations • Can integrate formalized guidelines for how to apply ordinal scores, which introduces greater objectivity and reproducibility • Helpful in data-poor environments or for hard-to-quantify outcomes Cons: • Can still be subjective • Requires great care in definition and application of scoring rubrics
Quantitative measures	Measures that represent the magnitude of alignment with objectives (e.g., travel-time savings, monetized benefits)	Pros: • Increased objectivity, replicability • Can address full spectrum of potential relative differences across projects, allowing for more comparability Cons: • May be constrained by data or analytical capacity or accuracy • Not all objectives can be easily quantified • Can be resource- and time-intensive

present or future land-use mix may be measured.

- **Project attributes**: For example, a project might be given a certain number of points within an evaluation framework if it includes transit priority measures, such as dedicated lanes or queue jumps.
- **Project impact assessments**: Estimation—such as ridership increases, travel time savings, or improved accessibility, based on the characteristics of a project and how it interacts with the rest of the transportation system—provides more than normally available details on expected outcomes. Nevertheless, impact assessments are the most resource-intensive to develop and may not be feasible or desirable.

It is usually better to account for an important objective simply than not at all. In fact, in scenario testing of multiple approaches to prioritization, the *TCRP Research Report 227* research team found that project ranking is sensitive to the removal of an objective. That same pilot-testing exercise found that one can approximate the results of a data-intensive approach by using a streamlined set of measures.

Both findings show the importance of not being daunted by the task of setting up prioritization processes and rather, of seeking the best-available and manageable approach to addressing the range of transit investment objectives—including simplifying, where appropriate.

Acknowledgments

The author thanks the research team from EBP US, Spy Pond Partners, and TYLin for their talent and effort.

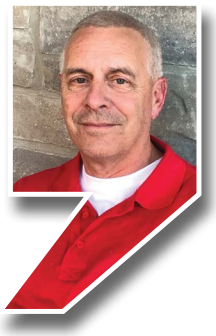
Learn more at https://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=4688.

REFERENCES

1. Stein, N., S. Middleton, P. Plumeau, W. Robert, and R. Perrin. *TCRP Research Report 227: Prioritization of Public Transportation Investments—A Guide for Decision-Makers.* Transportation Research Board, Washington, DC, 2021. https://doi.org/10.17226/26224.
2. Spy Pond Partners, High Street Consulting Group, and Burns and McDonnell. *NCHRP Research Report 921: Case Studies in Cross-Asset, Multi-Objective Resource Allocation.* Transportation Research Board, Washington, DC, 2019. https://doi.org/10.17226/25684.

VOLUNTEER VOICES

"TRB has more than enriched my professional life. I was writing a book manuscript between 2020 and 2022 that involved open-ended interviews as the prime research method used in 10 economic development case studies. COVID-19 hit when I was about 70 percent done with my research. I was caught like a deer in the headlights. The virus impacted all 10 case studies, and in-person interviews were no longer feasible. I turned to webinars, and some by TRB were very useful, especially regarding the effects of the virus on freight transportation patterns and trends in public transportation. Each of these webinars applied to two or more of the case studies. Instead of getting further behind in finishing my manuscript, I used TRB's webinars to help me continue writing it and to improve upon my speculations about how the virus would impact transportation trends.



—MICHAEL YODER
Research Fellow, Department of Geography and the Environment
The University of Texas at Austin

O.A. (Sam) Elrahman

Senior Research Scholar, Rensselaer Polytechnic Institute, Center for Infrastructure, Transportation, and the Environment

O.A. (Sam) Elrahman promotes research across national borders. A native of Cairo, Egypt, he grew up seeing the operational, economic, environmental, and health crises caused by uncontrolled urban growth, population explosion, and unfettered car ownership in his hometown. "Internationalization is a critical lens that we need to adopt," he advises. "We live on a small planet with finite resources. Problems experienced halfway around the world will have an impact here, on our doorsteps."

Elrahman holds a bachelor of science in city and regional planning from the College of Engineering in Cairo, Egypt; a master's degree in transportation planning and engineering from Polytechnic Institute of New York University (formerly Polytechnic University) in Brooklyn; a PhD in urban and environmental studies from Rensselaer Polytechnic Institute in Troy, New York; and a post graduate certificate in management development from Cornell University in Ithaca, New York. His career includes 32 years at the New York State Department of Transportation, observing, analyzing, and advising. His research and management experience during this time spanned environmental analysis, transit, project development, economic development, and policy. This diverse exposure led him to conclude that public policy must play a critical role in balancing the competing priorities of transportation, health, environment, and economic development. "I realized," he admits, "that an economically efficient, well-functioning, productive society cannot be built at the expense of human health and well-being. Building sustainable communities where the needs of every member of society are taken into consideration must be the goal of each transportation professional."

Elrahman transitioned from the public sector to academia in 2015, where his own research while a senior research scholar at Rensselaer's Center for Transportation Infrastructure and Environment centered on the links between transportation, health, and collaborative governance. A prolific author on numerous transportation topics, he is on the editorial boards of *Case Studies on Transportation Policy* and the *International Journal of Global Environment Issues*. He also serves as a peer reviewer for TRB's *Transportation Research Record* and is the coauthor of *Transportation and Public Health: An Integrated Approach to Policy, Planning, and Implementation*, published by Elsevier in 2019. "As a society," Elrahman explains, "we cannot have parallel and separate fields of transportation, health, and environment. We need to train practitioners to work at the nexus of those three fields and pursue the vision of a sustainable future."

"Science is on our side. There is plenty of evidence that supports sustainability."

He admits that this is not an easy pivot. "Science is on our side. There is plenty of evidence that supports sustainability." Elrahman points out that we have done this before, citing today's cleaner air and water as evidence of great strides made in the past 30 to 40 years, thanks to public policy.

An active member of the TRB community since 1983, Elrahman has been a long-term participant in the International Coordinating Council (previously, the Committee on International Cooperation), which he co-chaired from 2013 to 2019. He championed mainstreaming an international perspective in transportation research through maintenance of a web-based information clearinghouse, dissemination of research results, and advanced technology transfer. With this focus on international cooperation and networking, the committee received a TRB Blue Ribbon Award honorable mention in 2018 "for mainstreaming an international perspective in transportation research and promoting international cooperation in transportation."

Over the years, Elrahman has served on numerous TRB committees and project panels for the National Cooperative Highway Research Program. He is quick to point out that he has witnessed the innovation and creativity that are the hallmarks of the TRB community and benefited from opportunities to partner on scholarly efforts with members of the TRB community. "TRB has been an incubator of cutting-edge research partnerships and an international hub for researchers in the global transportation community," he observes, emphasizing that, "for more than 30 years, TRB has served as my community—providing me with a rich network that I have relied on to identify gaps in research priorities, forge partnerships for filling those gaps, and stay informed on all the latest developments in the field."

Noting that innovation and creativity are hallmarks of the transportation community, Elrahman states, "Without research, we would not be able to develop and apply evidence-based interventions to mitigate problems within the transportation system. Without research, we are flying blind and the human, fiscal, and operational costs can be enormous."

Two Committees Win the Diversity Blue Ribbon Award

At the 2023 TRB Annual Meeting, the Technical Activities Council (TAC) awarded two committees the Blue Ribbon Award for Diversity: the Standing Committee on Freeway Operations and the Standing Committee on Rail Transit Infrastructure Design and Maintenance. This article highlights the efforts of the Freeway Operations committee. The Rail Transit Infrastructure Design and Maintenance committee will be recognized in the next issue.

Standing Committee on Freeway Operations

The Standing Committee on Freeway Operations provides leadership in promoting, implementing, operating, and maintaining traffic management systems and strategies to enhance the efficiency, safety, and environmental sustainability on freeways and in freeway corridors. The committee won the Blue Ribbon Award for Diversity based on the steps it has taken to increase the diversity of its membership and friends by employer type, geography, age, and groups that are historically underrepresented in transportation research and practice.

The current chair, Beverly Kuhn, who is a senior research engineer at Texas A&M Transportation Institute in College Station, is the first female chair in the committee's more than 70-year history. "A diverse committee membership that reflects the demographics and cultures of the communities we serve and the varying disciplines of professional transportation practice can help the Freeway Operations Committee," she notes.

Kuhn sought to improve representation across all demographics considered in membership during the recent committee membership rotation process. To that end, she reviewed the list of active friends and polled committee members and subcommittee chairs to identify likely candidates who would bring diverse

Risdon Photography

TAC member Robert Bertini (*left*) accepts the Blue Ribbon Award for Standing Committee on Freeway Operations Chair Beverly Thompson Kuhn—presented by fellow member Michael Griffith—at the 2023 TRB Annual Meeting in Washington, DC.

perspectives to the committee's efforts and actively serve the committee. These efforts resulted in 16 of the 35 members being women and nine coming from underrepresented groups. Geographic representation includes North America, Europe, and Asia. There is also a balance across employer types, including those from public agencies (16), private sector (13), academia (9), and industry (1).

Listening to All Voices

Looking toward the future, the committee established a Young Professionals Forum to serve as a direct connection to its subcommittees. This forum coordinates volunteer opportunities for young members (i.e., ages 35 and younger) and friends to support subcommittee chairs in their roles and help ensure succession planning for these groups. The committee's Social Media Forum, led by a young member, coordinates website updates and orchestrates broad communication of committee activities and announcements to engage members and friends. That group launched the well-received committee newsletter for regular communication with members and friends. By embracing all aspects of diversity, the Standing Committee on Freeway Operations offers an increasingly open exchange of ideas that is inclusive and responsive to the needs of everyone.

"As transportation professionals, we are a network of stakeholders who support one another in providing a physical space for mobility," Kuhn explained when asked about the importance of diversity on this committee. "Freeways are part of that space, and it is our responsibility to ensure they are as safe, effective, and productive as possible so that the human community can thrive. The ability to accomplish that goal is strengthened when we listen to all voices."

ABOUT THE AWARD PROGRAM

The goal of the TAC Blue Ribbon Committees Program is to recognize exemplary best practice committee activities and the associated volunteer efforts. The Blue Ribbon Committees can serve as role models, with chairs and members sharing their experiences with others. The five Blue Ribbon Award categories are as follows:

- Research,
- Renewal,
- Implementation,
- Leadership, and
- Diversity.

The Diversity Award recognizes committees that have taken significant and noteworthy efforts to increase the diversity of committee membership and friends, especially from groups that are historically underrepresented in transportation research and practice.

INFLUENCER

Mia Zmud

Mia Zmud is a founding partner of Blue Door Strategy in Austin, Texas, where she helps organizations strategically align their emerging technology and business strategies to deliver on their commitments to innovation. She serves as co-chair of TRB's Committee Communications Coordinator Council.

What is your role as Committee Communications Coordinator Council co-chair?

Since it was established in 2009, the Committee Communications Coordinator Council has provided guidance to TRB committees and committee communications coordinators on building a portfolio of tools they can use to communicate and engage with members and friends regarding committee activities. Recognizing that this role can be daunting at first for committee communications coordinators who may not have a background in communications, we try to emphasize the coordinator part of the role. Committee communications coordinators don't have to do everything. Plus, committee communications activities can be a good way to involve committee friends and members in activities.

We encourage committee communications coordinators to build a team of volunteers to help maintain or build their portfolio. The coordinators are doing awesome work, and we try to include them in webinars and Annual Meeting workshops to share their experience firsthand.

For new committee communications coordinators, we also provide

- A welcome packet that explains their role to help them get started;
- A checklist and tools, including templates; and
- Webinar recordings of demonstrations on communication toolsets.

For example, template and webinar topics include sample communication plans, surveys for assessing committee communication needs, and how to build a committee website.

Every spring, we welcome new committee communications coordinators to their role and share a checklist and tips on getting started. During the year, we conduct a survey to assess their information needs and learn about the types of communications channels they are using, identify best practice, and perform website audits. We also work closely with our incredibly helpful TRB communications team and the National Academies' communications director to convey critical information and updates to committee communications coordinators.

How has TRB influenced your career?

Being involved in TRB has positively impacted my career. Networking with others in the industry and gaining access to research and practice from all over the world has many benefits. Being able to call or email someone to get a quick answer to a question, a copy of a report or article, or ask a specific question—and get a quick response—has helped me more than once!

TRB networking has led to professional collaborations and long-term personal friendships. Involvement on TRB committees and the Committee Communications Coordinator Council has given me both leadership experience and the opportunity to contribute to our industry. As I made career changes over the years, so did some of my industry interests and focus. Being involved in TRB, with each career change, I took advantage of TRB committees and other offerings to enhance my position.

Do you have any advice for others who may hesitate to take on a similar leadership role?

The advice I'd give to someone—regardless of their experience with TRB—is to simply volunteer. Committees are always looking for doers: people who can take full or shared responsibility for the smallest or largest of tasks, manage it well, and get it done. I would caution to not get too overextended with volunteering, particularly if you are in school or working full time. Taking on too much and too fast can be overwhelming.

For committee communications coordinators, my final words of advice are to delegate—especially if you find yourself overwhelmed. Don't do it all; ask for volunteers to help. There is almost always someone looking for an opportunity, and you can be the one to open the door to TRB engagement for that person.

For more information on the Committee Communications Coordinator Council, visit https://www.mytrb.org/OnlineDirectory/Committee/Details/4430.

Transportation Influencer highlights the journey of young professionals active in TRB. Have someone to nominate? Send an e-mail to TRNews@nas.edu.

CONSENSUS STUDY REPORT

Methods for Life-Cycle Analyses of Low-Carbon Transportation Fuels in the United States

BEN ULRICH

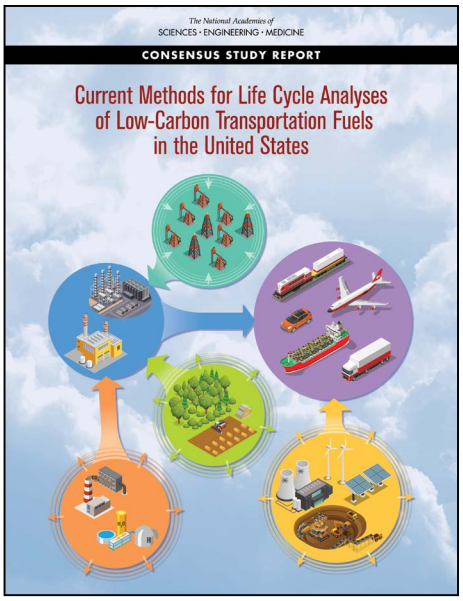
The author is a communications associate in the Office of the Chief Communications Officer at the National Academies of Sciences, Engineering, and Medicine in Washington, DC.

Transportation is the largest source of greenhouse gas emissions in the United States. Petroleum accounts for about 90 percent of transportation fuels, with biofuels, natural gas, and electricity accounting for the rest. There are federal and state programs to reduce greenhouse gas emissions from transportation fuels, but they require the use of assessment techniques to calculate their greenhouse gas emissions. Life-cycle assessment (LCA) is an approach to estimate the total emissions from products, including fuels. *Current Methods for Life Cycle Analyses of Low-Carbon Transportation Fuels in the United States* examined methodological approaches of LCA, considerations for estimating greenhouse gas emissions, issues for a low-carbon fuel standard, and methodological issues for transportation fuel types.

UNDERSTANDING AND USING LCA

LCA can address a range of questions regarding greenhouse gas emissions of low-carbon transportation fuels. The two broad approaches to LCA, shown in Figure 1 as yellow circles representing global environmental burdens, are

- Attributional LCA, which evaluates the emissions that can be estimated and assigned to a given fuel; and
- Consequential LCA, which evaluates how emissions would change if a given policy or set of actions were implemented.



This *Consensus Study Report* was authored by the Committee on the Current Methods for Life-Cycle Analyses of Low-Carbon Transportation Fuels in the United States and carried out within the National Academies' Division on Earth and Life Sciences' (DELS) Board on Environmental Studies and Toxicology.

In general, attributional LCA is appropriate when assigning emissions to products or processes and consequential LCA is appropriate when practitioners wish to understand the effects of a proposed decision or action on net greenhouse gas emissions.

Public policy design informed by LCA is most effective when it ensures that the consequential life-cycle impact of the proposed policy is likely to reduce net greenhouse gas emissions and increase net benefits to society. Considering changes in production and the use of multiple fuel types, as well as justifying when it excludes the emissions consequences of certain fuels, also can strengthen policies.

CONSIDERING VEHICLE–FUEL COMBINATIONS AND EFFICIENCIES

Efficiency and production emissions of transportation fuels can vary widely within and across vehicle fuel type technologies, making fair comparisons with single-point estimates challenging. To meaningfully compare transportation fuel LCAs, consider the vehicles that use those fuels, including the range of vehicle efficiencies within each fuel type to ensure that the comparisons are made on comparable transportation services. An LCA designed for regulatory impact assessment might consider a range of estimates for possible changes in the vehicle production emissions required to

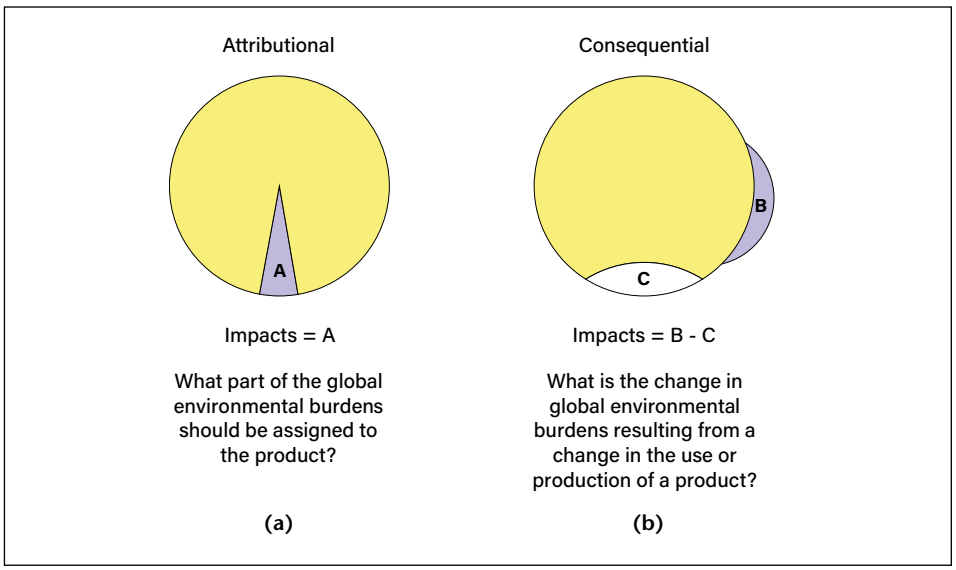


FIGURE 1 How attributional (*a*) and consequential (*b*) LCA address different questions. (Source: B.P. Wiedema.)

convert transportation fuels into transportation services and the resulting changes in vehicle fleet composition.

WEIGHING FUEL-SPECIFIC CONSIDERATIONS

The life-cycle greenhouse gas emissions of petroleum fuels (i.e., gasoline, diesel, and jet fuel) vary because of their source and refinery. Explicitly including these variations can improve the quality of a low-carbon fuel policy.

Aviation and Marine Fuels

Many aviation fuels are derived from petroleum, but qualities unique to jet fuel and to alternative aviation fuels may require special consideration beyond the LCA approaches used for alternative fuels in other sectors. These include non-CO_2 effects from aviation fuels, like aviation-induced cloudiness, or the use of different alternative fuel and airframe combinations that may affect airplane efficiency and overall emissions.

Marine fuels have similar supply chains and LCA methodological considerations relative to other transportation fuels but have unique life-cycle aspects that effect attempts to quantify their emissions, such as methane slip from liquefied natural gas combustion in marine engines. Baseline life-cycle greenhouse gas emissions for marine fuels should potentially be updated in the future as the industry adjusts to new regulations that could change the fuel type of deployed vessels.

Biofuels

Biofuels can be produced with a range of feedstocks, with corn and soybeans being the most common in the United States. LCA methods commonly used to estimate greenhouse gas emissions associated with crop production in conventional agricultural systems are largely similar, regardless of the crop.

Woody Biomass

One of the most abundant biofuel feedstocks in the United States is woody biomass. The greenhouse gas emissions associated with woody biomass production come from multiple sources, including the use of energy and materials for forest management, harvesting, storage, and transportation. Greenhouse gas emissions associated with the conversion of biomass into fuel come from multiple sources, including on-site combustion of fuels, direct emissions from conversion processes, and upstream emissions.

Vicky Vinch ON OFF, Flickr, CC BY-NC-ND 2.0

Corn in a tank car powering across the United States may serve many purposes, including being used as biofuel. Along with soybeans, corn is among the most common biofuel feedstock.

Electricity as a Vehicle Fuel

Plug-in electric vehicles—including battery electric vehicles and plug-in hybrids—use energy stored in an onboard battery for propulsion and charge the battery using electricity from the power grid. Attributional LCA approaches assign a portion of total power grid greenhouse gas emissions to plug-in electric vehicle charging, while consequential LCA approaches estimate power grid emissions with and without plug-in electric vehicle charging, presenting the difference as the consequential effect of plug-in electric vehicle charging. The latter approach is best used to estimate power grid emissions implications and characterize the uncertainty of estimates due to assumptions, especially for future scenarios.

Download the report at https://nap.nationalacademies.org/catalog/26402/. Learn more about DELS at https://www.nationalacademies.org/dels/division-on-earth-and-life-studies. For information about the board, see https://www.nationalacademies.org/best/board-on-environmental-studies-and-toxicology.

Detecting Emerging Hazards in Commercial Aviation

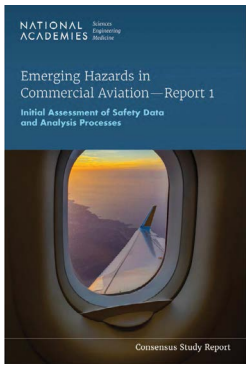
LIDA BENINSON AND STEPHEN GODWIN

Beninson is a senior program officer and Godwin is a scholar at the National Academies of Sciences, Engineering, and Medicine, in Washington, DC.

Commercial air transport in the United States has experienced sharp declines in the risk of fatalities, including several years in the past decade without any at all. Expectations about the risks of flying, however, were challenged following two overseas accidents in 2018 and 2019 involving aircraft manufactured in the United States (*1*). As a result, Congress requested that the National Academies of Sciences, Engineering, and Medicine initiate a series of reports over a 10-year period to assess the ability to use data and analysis to identify emerging safety hazards. In August 2022, the committee for this effort released its first report, which offers a high-level

Mike McBey, WikiMedia Commons, CC BY 2.0

Industry statistics show U.S. commercial aviation safety improved more than 40-fold over the past several decades. To retain the safety record achieved, the challenge for aviation explored in this report is identifying emerging hazards before they can lead to accidents.



assessment of the data and methods currently used by the commercial aviation industry and FAA (*2*).

The committee found that the current data and analysis methods used in the aviation industry are invaluable for identifying and monitoring potential safety hazards in the immediate time frame. For example, critical data sources include

- Voluntary, nonpunitive systems for pilots, controllers, and other employees to report safety concerns;
- Voluminous digital data streams on aircraft and component performance; and
- Voluntary independent audits of flight crew performance agreed to by management and labor.

COMMERCIAL AVIATION SAFETY TEAM

There are several concurrent data-sharing and analysis efforts across the aviation ecosystem, some mandated and others voluntary. The primary program for detecting aviation safety hazards is the Commercial Aviation Safety Team (CAST), which is a voluntary collaboration of aviation industries and government agencies that identifies, ranks, and analyzes hazards. CAST also develops and implements cost-beneficial safety enhancements to manage these hazards. In support of CAST, the Aviation Safety Information Analysis and Sharing (ASIAS) initiative provides collaborative sharing and aggregation of nonpublic, proprietary data and other public data in an effort to determine trends and monitor the effectiveness of implemented safety enhancements. The committee commends CAST and ASIAS for sharing data, identifying and prioritizing recognized hazards, voluntarily implementing safety enhancements, and assessing the efficacy of these enhancements.

A CULTURE COMMITTED TO SAFETY

Aviation companies, FAA, CAST, and ASIAS currently rely heavily on data representing both technical safety and flight crew performance on the front lines of carriers and air traffic control. As important as they are, front lines represent one layer of defense that needs to be supported by organizations with cultures that are deeply committed to safety and that develop and implement systematic plans and programs that constitute additional layers of defense. Although more difficult to measure, assessments of culture and the effectiveness of organizational safety performance also could serve as leading indicators. Alarmed by media reports that FAA deferred too heavily to industry in certification of advanced complex aircraft technologies, Congress required FAA to administer a safety culture survey within its certification office, which the committee will assess in later reports once it its implemented and the results are available.

There are systematic processes in place to identify, characterize, and handle commercial aviation hazards that have already emerged at the front line, but these activities may not be adequate for identifying newly emerging hazards. In future reports the committee will review application of advanced methods of data mining to discover anomalous patterns, and assessment of them by subject matter experts.

These advanced methods may not be the only ways to identify emerging hazards as the commercial aviation system continues to evolve. Consider the potential impact on aviation safety of the following:

- New entrants in the airspace using novel aircraft;
- Severe weather changes associated with climate change;
- Changing business practices to adapt to flight crew shortages and other issues;
- Increased reliance on rapidly evolving technologies, including complex software that are difficult to certify; and
- Increasing complexity throughout the aviation system.

SCANNING THE HORIZON

The next phase of the study will apply a strategic foresight method known as "horizon scanning" to identify the future safety hazards that may arise due to these trends through facilitated

workshop activities with broad input from diverse stakeholders. While this activity may identify previously unidentified or overlooked hazards, its primary aim will be to demonstrate a method that can be broadly applied to predict and then monitor for emerging hazards that threaten the remarkable level of aviation safety the industry and FAA have achieved.

REFERENCES

1. Committee on Transportation and Infrastructure. *Final Committee Report: The Design, Development & Certification of the Boeing 737 MAX*. U.S. House of Representatives, Washington, DC, September 2020. https://www.scribd.com/document/476253115/2020-09-15-FINAL-737-MAX-Report-for-Public-Release#.
2. National Academies of Sciences, Engineering, and Medicine. *Emerging Hazards in Commercial Aviation—Report 1: Initial Assessment of Safety Data and Analysis Processes*. The National Academies Press, Washington, DC, 2022. https://doi.org/10.17226/26673.

Navigating an Electric Vehicle Future

RAPHAEL APEANING, KYRA HOWE, AND ELIZABETH ZEITLER

Apeaning is a former research fellow at the Institute for Carbon Removal Law and Policy in Washington, DC. Howe is a research assistant at and Zeitler is associate director of the Board of Energy and Environmental Systems at the National Academies of Sciences, Engineering, and Medicine in Washington, DC.

In October 2021, the National Academies' Division on Engineering and Physical Sciences and the Board on Energy and Environmental Systems[1] convened a four-day workshop on Navigating an Electric Vehicle Future. The following highlights are from the discussions and presentations.

ELECTRIC VEHICLES AND DECARBONIZATION

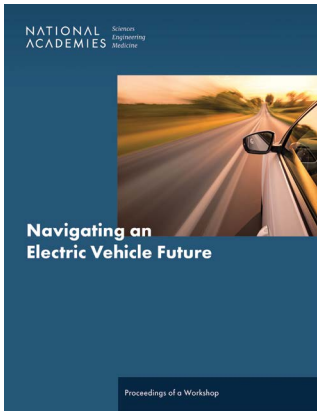
The widespread adoption of electric vehicles will play a critical role in decarbonizing the transportation sector as the nation moves toward net-zero emissions. Recent announcements from automakers and the federal government, as well as legislative provisions like the Infrastructure Investment and Jobs Act of 2021 and the Inflation Reduction Act of 2022, aim to stimulate electric vehicle deployment and technology improvements while making electric vehicles an affordable and practical option.

However, many challenges remain with meeting buyers' and drivers' needs and to ensure that manufacturing supply chains and the electric system can support this large-scale transformation. The virtual workshop convened to identify some of the challenges to widespread electric vehicle deployment and discuss policy, technical, and market strategies intended to help federal agencies and other stakeholders to plan. The first day of the workshop provided an overview of electric vehicle technologies, capabilities, and policy and regulatory considerations. It also examined the role of electric vehicles within a decarbonized transportation system. The subsequent days included detailed technical discussions on the following:

- Vehicle production and life cycle,
- Electric system challenges and solutions, and
- Consumer needs.

Alex Zahn, Unsplash

Transportation industry experts at this workshop looked at the potential opportunities and realities of a shift to electric vehicles, like this one charging up curbside. The way in which electric vehicle technology is deployed is integral to protecting our economy, ensuring equity, and reducing greenhouse gas emissions.



These workshop proceedings identify some of the challenges to widespread electric vehicle deployment and discuss policy, technical, and market strategies to help federal agencies and other stakeholders plan.

[1] For information on the National Academies' Division on Engineering and Physical Sciences see https://www.nationalacademies.org/deps/division-on-engineering-and-physical-sciences. Visit https://www.nationalacademies.org/bees/board-on-energy-and-environmental-systems to learn more about the Board on Energy and Environmental Systems.

VEHICLE PRODUCTION AND LIFE CYCLE

Brad Markell, AFL-CIO Industrial Union Council, pointed out that the switch to electric vehicles might have deep and troubling implications for communities and the labor economy at large. The barriers to entering the electric vehicle market are lower than the traditional automotive industry due to the electric vehicle market's lower ratio of capital-to-labor requirement. Thus, the additional opportunities for automation and simpler assembly lines could potentially disrupt the automobile labor economy.

Fan Dai, California–China Climate Institute at the University of California at Berkeley, discussed how battery reuse and recycling policies will play a crucial role as China reaches higher volumes of zero-emission vehicle sales. Some of the policy initiatives in China aim to identify the requirements of companies that use battery packs from retired electric vehicles and encourage cooperation between battery manufacturers and reuse companies.

ELECTRIC SYSTEM CHALLENGES AND SOLUTIONS

Rohan Patel, Tesla, emphasized the notion that electric vehicle charging can increase overall grid–system utilization and drive down rates through kilowatt-hour billing. Rate design will be critical for the long-term success of utilities providing services for residential and nonresidential electric vehicle charging users.

Maria Bocanegra, Illinois Commerce Commission, discussed the regulatory opportunities and challenges for massive electric vehicle adoption and grid impacts from a policy perspective. She emphasized that incentives represent an opportunity for regulators to review and manage grid investments for vehicle integration. For example, tailored qualifying infrastructure or distribution improvement charges can incentivize utilities by providing a guaranteed return on investment through surcharge rates.

CONSUMER NEEDS

Ahmed Abdulla, Carleton University, discussed a survey of electric vehicle owners in California that

- Studied changes in the adoption profile and attitudes toward electric vehicle incentives and
- Examined charging behavior and user interaction with workplace charging.

The survey found that commuters who recently adopted electric vehicles more often charged earlier than the maximal peak for solar power production. Also, there is emerging opposition in terms of risk that can stymie adoption or cause a plateau, such as cybersecurity and data privacy concerns.

Shelley Francis, EVNoire, discussed the importance of centering equity in the electric-mobility policy discourse because there are historical connections between segregation and unequal mobility. Destructive transportation policies and practices tend to skew toward Black-American and Latin-heritage communities; these policies and practices have disproportionately exposed minority communities to detrimental public health effects. The transition to electric mobility presents a unique opportunity to prevent the reoccurrence of similar transportation inequities.

The proceedings of the workshop on Navigating an Electric Vehicle Future are available at https://nap.nationalacademies.org/26668.

Searches in a Snap

A Ready-Reference Topic Guide

ALEXANDRA BRISENO

Briseno, former TRB senior librarian, is the archives and records manager/historian for the National Academies of Sciences, Engineering, and Medicine in Washington, DC.

Whether preparing for a meeting or seeing what research TRB is working on, the Snap Searches series allows a researcher or other professional quick access to TRB research by transportation mode and topic. The information is presented succinctly and efficiently.

Mapbox, Unsplash

Presenting at a conference or prepping for a meeting—like this one—can benefit from TRB's Snap Searches, which cover 67 transportation-related topics with hyperlinks to information sources.

WHAT IS A TRB SNAP SEARCH?

A Snap Search is an individual PDF with topic-specific content curated by the TRB Library and featuring hyperlinks to TRB reports, current and upcoming projects, related National Academies Press[1] publications, relevant committees, panels, and TRB-sponsored conferences. Examples of popular topics include

- Social equity and underserved populations,
- Public transportation,
- Workforce, and
- Shared mobility.

Also included within each document is a hyperlink to TRID (the Transport Research International Documentation Database),[2] where the most recent publications on that topic can be retrieved using a preconfigured complex search strategy. As a ready-reference guide, these documents can be printed or shared electronically.

WHAT APPLICATIONS DO THE SNAP SEARCHES HAVE?

The Snap Searches are helpful for dissemination during field visits or state partnership visits. They also help assist practitioners looking for a starting point in learning about a transportation-related topic. "I encourage the use of the Snap Searches," advises TRB Senior Program Officer Camille Crichton-Sumners, "because they provide a handy list of relevant ongoing and completed TRB research, conferences, and associated committees."

Snap Searches originated as a series of internal documents called *An Overview Guide*. They were created by the Technical Activities Division in 2015 to share with states during department of transportation visits. Their popularity led to the first publicly available Snap Searches being created in 2018. This first group included 25 topics. Today, there are 67 topics available that are updated at least twice a year or by request. A date stamp on the first page of each document shows when the Snap Search was last updated.

When TRB's Cooperative Research Programs officers liaise with the AASHTO and TRB committees, they often provide updates to the committee members. "I like to highlight the Snap Searches as an excellent reference for the committees' research development efforts," explains TRB Senior Program Officer David M. Jared. "The searches show, concisely, what research on a topic is completed, pending, and active, as well as who is involved. It's a great way to get up to speed on a research topic and avoid duplication of effort."

Since research topics and practitioner concerns often cut across modes and programs, many find it helpful to see what projects are currently underway at TRB. "I use Snap Searches when I want to quickly see the recent research in a particular topic area from all of the Cooperative Research Programs," notes TRB Senior Program Officer Ann Hartell. "Having the information in a format that's printed or easy to share electronically makes it so handy and efficient whenever I want to share information with the practitioner communities."

Snap Searches are available online at https://www.trb.org/InformationServices/Snap.aspx. All members, sponsors, and TRB staff can request either an updated Snap Search or a new topic. For more information, email the TRB Library at TRBlibrary@nas.edu.

[1] For more information, go to https://nap.nationalacademies.org/.
[2] Find the Transport Research International Documentation Database at https://trid.trb.org/.

COOPERATIVE RESEARCH PROGRAMS NEWS

GUIDEBOOK FOR LOCAL TRUCK PARKING REGULATIONS

Fehr & Peers received a $450,000, 30-month contract [National Cooperative Highway Research Program (NCHRP) Project 08-141] to examine how and why local municipality, county, and metropolitan planning organizations' truck staging and long-term and short-term parking policy decisions are made; identify gaps and opportunities in truck parking and staging regulations; and develop a guidebook that includes a range of model truck parking and staging ordinances, rules, and regulations suitable for consideration and adoption by local municipalities.

For further information, contact Camille Crichton-Sumners, TRB, 202-334-1695 or CCrichton-Sumners@nas.edu.

NON-PROPRIETARY PREFABRICATED SOLUTIONS FOR CONCRETE BARRIER SYSTEMS

Florida International University received a $900,000, 36-month contract (NCHRP Project 22-56) to identify, develop, and crash-test durable prefabricated versions of existing compliant barriers according to *Manual for Assessing Safety Hardware (MASH)* crash testing requirements.

For further information, contact Ahmad Abu-Hawash, TRB, at 202-334-2257 or AAbu-Hawash@nas.edu.

GUIDANCE FOR CONSTRUCTION OF SAND SEALS AND ULTRA-THIN BONDED WEARING COURSES

The University of Arkansas was awarded a $175,000, 18-month contract (NCHRP Project 14-48) to develop recommended guidance for the construction of sand seals and ultra-thin bonded wearing courses as used in preservation treatments.

For further information, contact Bijan Khaleghi, TRB, at 202-334-1946 or BKhaleghi@nas.edu.

GUIDELINE FOR DEPICTING EXISTING AND PROPOSED UTILITY FACILITIES IN DESIGN PLANS

Iowa State University was awarded a $550,000, 36-month contract (NCHRP Project 15-81) to create a guideline for state DOTs after identifying current, successful practices and developing sound approaches for retrieving, depicting, and

managing data for utilities, as well as determining and depicting utility conflicts.

For further information, contact David Jared, TRB, at 202-334-2358 or DJared@nas.edu.

EXAMINATION OF TRANSIT AGENCY COORDINATION WITH ELECTRIC UTILITIES

APTA received a $55,000, 18-month contract [Transit Cooperative Research Program (TCRP) Project J-07/Topic SA-60] to create a synthesis report documenting transit agencies' current practices for coordinating or partnering with electric utilities to negotiate rate structure and increase energy loads in relation to transit fleet electrification and other zero-emissions fleet transitions. The synthesis will focus on bus fleet electrification, whether for specific bus routes or the larger transit network.

For further information, contact Mariela Garcia-Colberg, TRB, at 202-334-2361 or MGarciaColberg@nas.edu.

Marc A. Hermann/MTA, Flickr, CC BY 2.0

As transit agencies convert existing bus fleets to zero-emissions alternatives, such as this electric bus in New York City, increased demands will be placed on the power grid. A new synthesis report will examine current transit agency practices and identify opportunities for coordinating with electric utilities.

MEMBERS *ON THE MOVE*

Gary Jenkins has been promoted to TRB program operations manager for the Technical Activities Division. Previously, he was operations coordinator.

Ilona Kastenhofer, formerly with Battelle Memorial Institute and the Virginia Department of Transportation, joined TRB in February as an NCHRP senior program officer with the Technical Activities Division.

Arefeh Nasri joined TRB as an NCHRP senior program officer in January. Previously, she was a faculty research scientist with the National Center for Smart Growth Research and Education at the University of Maryland in College Park.

VOLUNTEER VOICES

"TRB has always been helpful and influential in my professional career. As a student, I presented at the TRB Annual Meetings. These meetings have a job board, and that led me to meet an employer who was looking for a candidate. I was looking for a job after graduation, so they invited me to interview. And that's how a student from Fargo, North Dakota, ended up getting a position in Tulsa, Oklahoma. In my current position, TRB has helped me find different products and services, such as the latest bicycle–pedestrian technology and big data products. I am thankful to be an active TRB Annual Meeting attendee.

—NIMISH DHARMADHIKARI
Associate Researcher and Modeler
San Diego Association of Governments, California

Did You Know?

State DOT Fun Facts

JAIME RALL

The author is the principal at J. R. Rall Consulting in Golden, Colorado, and Notre Dame, Indiana. She has been the lead investigator for all three editions of *Transportation Governance and Finance*.

In 2022, AASHTO published the third edition of *Transportation Governance and Finance: A 50-State Review of State Legislatures and Departments of Transportation*. Resulting from NCHRP Project 20-24, it examines how all 50 states and the District of Columbia pay for and manage their transportation systems. Based on in-depth survey responses from nearly 200 state stakeholders, the updated compendium details governance issues, revenue sources, finance tools, and how state transportation programs have been affected by the COVID-19 pandemic. A bonus: This time around, respondents also shared one-of-a-kind state facts.

To learn more, visit the AASHTO Store at https://store.transportation.org/Item/PublicationDetail?ID=5029.

MONTANA

The distance from Yaak to Alzada, Montana—from this state's northwest corner to its southeast corner—is greater than the distance from Chicago to Washington, DC.

WASHINGTON

The state of Washington operates the nation's largest ferry system.

WYOMING

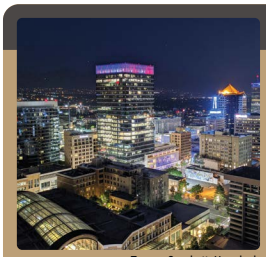
Wyoming leads the country in per capita vehicle miles traveled, averaging 18,065 miles per Wyomingite in 2018 alone.

NEVADA

BLM Nevada, Flickr, CC BY 2.0

The federal government owns more than 80 percent of the land in Nevada—the highest percentage in the nation.

UTAH



Tanner Crockett, Unsplash

During the last decade, Utah was the fastest growing state. Its population is expected to double in the next 50 years.

COLORADO

Colorado leads the nation in rural transit trips—more than double any other state.

ALASKA

Doug Helton, NOAA, NOS, ORR, Flickr, CC BY 2.0

Alaska's 237 state-owned airports make up the largest airport system in North America.

HAWAI'I

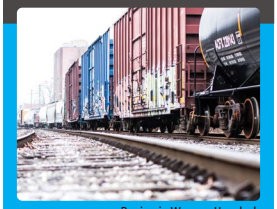
Simon_sees, Flickr, CC BY 2.0

Comprised of many islands, Hawai'i is the only state without a state highway patrol.

KANSAS

Kansas law caps the state highway system at 10,000 road miles, divided among the state's 105 counties. All other highways are under city or county control.

ILLINOIS



Benjamin Wagner, Unsplash

Nearly one-third of all U.S. freight traffic originates, terminates, or passes through Illinois, the only state where all seven Class I railroads operate.

INDIANA

Dubbed the "Crossroads of America," Indiana ranks first in pass-through Interstate highways, on which more than $650 billion in goods traverse the state annually.

MASSACHUSETTS

Yassine Khalfalli, Unsplash

Boston built America's first subway, which opened to the public in this Massachusetts capital in 1897.

NEW JERSEY

New Jersey is the most densely populated state, with more than 1,200 people per square mile.

DELAWARE

Geoff Livingston, Flickr, CC BY NC ND 2.0

The lowest-lying state, Delaware recently created a DOT division to examine climate change and sea-level rise impact.

WASHINGTON, DC

The nation's capital sees huge commuter flows daily. Before COVID-19, roughly two-thirds of workers in the District of Columbia did not live there.

WEST VIRGINIA

In West Virginia, there's no county roadway ownership and 95 percent of public highway miles are state-maintained—a higher percentage than in any other state.

KENTUCKY

Kentucky has more miles of navigable waterways than any of the other lower 48 states and is the only state with a continuous border of rivers running along three of its sides.

MISSOURI

Missouri was the first state to take bids and begin construction on the Interstate Highway System.

LOUISIANA

cmh2315fl, Flickr, CC BY NC 2.0

The state with the most moveable bridges—Louisiana—has 150 statewide, 100 of which the state DOT owns and maintains.

TEXAS

Austrini, WikiMedia, CC BY 2.0

Everything's bigger in Texas, which has more lane miles of roadway than any other state.

Note: DOT = department of transportation.

MEETINGS, WEBINARS, AND WORKSHOPS

April

24 **Joint Meeting of TRB Forum and ITS America Connected and Automated Vehicle Committee**
Grapevine, Texas
For more information, contact Katherine Kortum, TRB, 202-334-3123, KKortum@nas.edu.

25 **TRB Webinar: Resilient Freight Planning—Lessons from Ukraine and Puerto Rico**

May

2 **TRB Webinar: Truck Parking Strategies, Technologies, and Partnerships**

3 **TRB Webinar: Deploying Artificial Intelligence Applications for Asset Management**

9 **Aeronautics Research and Technology Roundtable**
Washington, DC
For more information, contact Gaybrielle Holbert, DEPS, 202-334-3477, gholbert@nas.edu.

9–10 **TRB's International Conference on Road Weather and Winter Maintenance***
Washington, DC
For more information, contact Stephen Maher, TRB, 202-334-2955, SMaher@nas.edu.

15–18 **11th National Aviation System Planning Symposium**
Irvine, California
For more information, contact Christine Gerencher, TRB, 202-334-2970, CGerencher@nas.edu.

20–22 **7th Biennial Conference on Marine Transportation System Innovative Science and Technologies Toward Greater Sustainability**
Washington, DC
For more information, contact Scott Brotemarkle, TRB, 202-334-2167, SBrotemarkle@nas.edu.

24–26 **International Transport Forum 2023 Summit: Transport Enabling Sustainable Economies***
Leipzig, Germany
For more information, contact Bill Anderson, TRB, 202-334-2514, WBAnderson@nas.edu.

June

4–6 **Innovations in Travel Analysis and Planning***
Indianapolis, Indiana
For more information, contact Claire Randall, TRB, 202-334-1391, CRandall@nas.edu.

4–6 **International Bridge, Tunnel, and Turnpike Association Road Usage and Charging and Finance Summit***
Salt Lake City, Utah
For more information, contact Claire Randall, TRB, 202-334-1391, CRandall@nas.edu.

4–8 **International Conference on Ecology and Transportation***
Burlington, Vermont
For more information, contact Claire Randall, TRB, 202-334-1391, CRandall@nas.edu.

20–22 **Conference on the Marine Transportation System Innovative Science and Technologies Toward Greater Sustainability**
Washington, DC
For more information, contact Scott Brotemarkle, TRB, 202-334-2167, SBrotemarkle@nas.edu.

*TRB is co-sponsor of the meeting.

Please contact TRB for up-to-date information on meeting cancellations or postponements. For Technical Activities meetings, visit www.TRB.org/calendar/calendar or e-mail TRBMeetings@nas.edu. For more information on a TRB webinar, contact TRBwebinar@nas.edu. For information on all other events or deadlines, inquire with the listed contact.

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."

In Memoriam

William Perez, chief scientist at toXcel, has died. He was a human factors scientist with more than 30 years of expertise in the transportation industry. He had served on the NCHRP project panel on Driver Information Overload and was a friend of several TRB committees, including the Standing Committee on Impairment in Transportation and the Standing Committee on Research Innovation Implementation Management.

Richard W. Willson, professor and chair of the Urban and Regional Planning Department, College of Environmental Design, at California Polytechnic University, Pomona, died in December 2022. Involved in TRB's Minority Student Fellows Program as a faculty mentor since 2011, he also was the author of *Reflective Planning Practice: Theory, Cases, and Methods*, among other titles.

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. All authors are asked to review our policy to prevent discrimination, harassment, and bullying behavior, available at https://www.nationalacademies.org/about/institutional-policies-and-procedures/policy-of-harrassment.

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 as 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 Nancy Whiting at 202-334-2956 or nwhiting@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, Cassandra Franklin-Barbajosa, cfranklin-barbajosa@nas.edu, 202-334-2278.
- Submit **graphic** elements—photos, illustrations, tables, and figures—to complement the text. Photos must be submitted as JPEG or TIFF files and must be at least 3 in. by 5 in. and 2 megabytes with a resolution of 300 dpi. Large photos (8 in. by 11 in. with a minimum of 4 megabytes at 300 dpi) are welcome for possible use as magazine cover images. A detailed 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.

TRANSPORTATION RESEARCH BOARD
500 Fifth Street, NW
Washington, DC 20001

PERIODICAL MAIL
U.S. POSTAGE
PAID
WASHINGTON, DC
PERMIT NO. 244960

ADDRESS SERVICE REQUESTED

Let's Hear from You!

In each issue, we pose a sometimes light and fun transportation-related question that allows you to share your thoughts with other readers. To answer, **click here** or e-mail us at **TRNews@nas.edu** and follow these simple steps:

1. In the subject line, include **"Volunteer Voices: [the question you're answering]";**
2. Answer the question thoughtfully, but keep it brief—up to about 150 words;
3. Add whether you are a TRB member or volunteer, and list the committees you are involved with; and
4. Add TRNews@nas.edu to your contacts so we avoid your spam folder when we tell you you're going to be published.

That's it! Like all *TR News* content, your response may be edited for grammar, length, and TRB style. When the issue with your quote is published, you'll get a PDF of the page featuring your response and photo.

Now that you have the details, here's the question:

What single topic would you like to learn more about at a future TRB Annual Meeting, and why is it important to you?

Scan the QR code to answer our online survey question.

NATIONAL ACADEMIES *Sciences Engineering Medicine*

The National Academies provide independent, trustworthy advice that advances solutions to society's most complex challenges.
www.nationalacademies.org

TRN344