NUMBER 308

MARCH–APRIL 2017

TR NEWS

Freight Planning

Innovations, Scenarios, and Environmental Justice

Plus:

Safety Culture Lessons from the Offshore Oil Industry

Mileage-Based User Fees: What Does the Public Think?

Driverless Cars: The Need for Interdisciplinary Research

TRB 96th Annual Meeting Photo Highlights

TRB TRANSPORTATION RESEARCH BOARD
The National Academies of
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The National Academies of
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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. C. D. Mote, Jr., 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 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.national-academies.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 innovation and progress through research and information exchange, conducted within a setting that is objective, interdisciplinary, and multimodal. The Board's varied committees, task forces, and panels annually engage about 7,000 engineers, scientists, and other transportation researchers and practitioners from the public and private sectors and academia, all of whom contribute their expertise in the public interest. The program is supported by state transportation departments, federal agencies including the component administrations of the U.S. Department of Transportation, and other organizations and individuals interested in the development of transportation. **www.TRB.org**

TRB

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COVER: Freight, commercial, transit, and private vehicles mingle with pedestrians along a major artery in the Harlem neighborhood of Manhattan, New York. (Photo: Emma Marie, Flickr)

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 Office**
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ALSO IN THIS ISSUE:

COMING NEXT ISSUE

Feature articles in the May–June magazine draw on recent activities to expand understanding of the role of transportation in the economy and to provide tools for practitioners to measure and communicate that role effectively. Authors explore cost–benefit analyses of investments in transportation infrastructure, the potential of freight production models to deliver insights into economic geography, the economic value of transportation assets and services, valuing a mature highway system, right-sizing projects, making transportation investments during economic downturns, and more.

Photo: New York State Thruway Authority

Construction of the new Tappan Zee Bridge across the Hudson River, on the New York State Thruway main line and Interstates 87 and 287, carries a price tag of $3.98 billion. The 3.1-mile-long structure will carry 140,000 vehicles per day and serve as a vital link for commuters, freight, and travelers in metropolitan New York.

Transportation Innovation

Leading the Way in an Era of Rapid Change

Former Congressman, Secretary of Commerce, and Secretary of Transportation Norman Y. Mineta received the Frank Turner Medal for Lifetime Achievement in Transportation for his work in transportation technology policy, economic development, and infrastructure projects.

Annual Meeting photographs by Risdon Photography.

The importance and promise of transportation innovation in this age of rapid change was the spotlight theme at the 96th Transportation Research Board Annual Meeting, January 8–12, 2017, in Washington, D.C. A record 13,377 transportation policy makers, administrators, researchers, and practitioners, from industry, government, and academic institutions gathered at the Walter E. Washington Convention Center and the Marriott Marquis hotel for more than 800 sessions and workshops and more than 200 exhibits, as well as award presentations, committee meetings, crosscutting sessions, and networking events. More than 125 sessions addressed the hot topics of transformational technology, transportation and public health, and resilience; 35 sessions explored the meeting's theme, "Transportation Innovation: Leading the Way in an Era of Rapid Change."

Bruce M. Smith, Apperson Crump PLC, and General Counsel, Memphis Area Transit Authority, delivered the 2017 Thomas B. Deen Distinguished Lecture on "Ethical Issues Facing Today's Transportation Agencies: Transparency and Security, Codes of Conduct, and Public–Private Partnerships." Jaiwon Shin, Associate Administrator of the Aeronautics Research Mission Directorate, National Aeronautics and Space Administration, delivered the Chairman's Luncheon address on a new era in aviation.

Details and highlights appear on the following pages.

Sessions and workshops engaged attendees with opportunities to gain knowledge and inspiration.

(*Below:*) A roundtable delivered leadership insights from state DOT women CEOs *(left to right)*: Paula Hammond, Victoria Sheehan, Stephanie Pollack, Jennifer Cohan, Leslie Richards, and Susan Martinovich.

(*Left:*) The Exhibit Hall showcased more than 200 products and services, including innovative technology such as the Robot Assisted Bridge Inspection Control, or RABIT.

INTERSECTIONS

1 First-time attendees consult the printed program and the mobile app to schedule their itineraries.

2 New and young professionals learn about TRB committee involvement, initiatives, and opportunities at the Welcome and Attendee Orientation.

3 The Technical Activities Council oversees the TRB Annual Meeting Program content and provides leadership and coordination for the 200-plus standing committees.

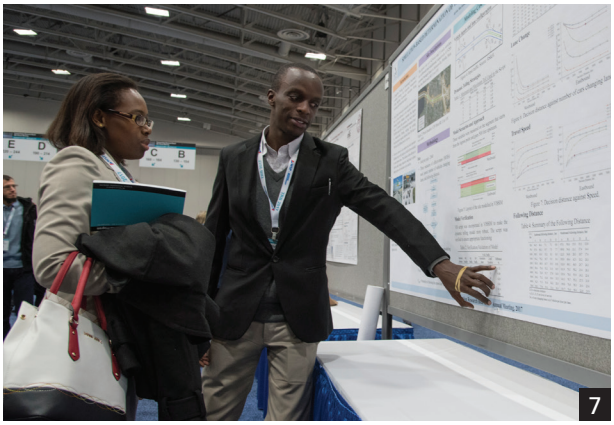
4 Young Members Council Chair Bevan Kirley *(second from left)* meets with previous chairs Joung Lee, Alison Conway, and Lucy Priddy at a young members networking reception.

5 The Minority Student Fellows Reception welcomed 21 graduate and undergraduate students, along with their faculty mentors and transportation leaders.

6 At the Riegl exhibit, a representative explains the innovations in unmanned LiDAR scanning systems.

7 The Exhibit Hall showcased many practical demonstrations and applications, including towing technology from U-Haul.

3 2017–2018 TRB Technical Activities Council *(front row, left to right:)* Eric Shen, David Ballard, Daniel Turner, Hyun-A Park, Joseph L. Schofer, Stephen Popkin, *(back row, left to right:)* Coco Briseno, Robert Shea, Ram Pendyala, Dennis Hinebaugh, Avery Grimes, Stephen Lane, David Harkey, Mary Ellen Eagan, Anne Goodchild, Peter Briglia, and Ann Brach.



SESSIONS & WORKSHOPS

1 Dan Smith, The Tioga Group, moderates a panel on Megaships: Megasolutions or Megaproblems?

2 Allison Davis, Washington Metropolitan Area Transit Authority, leads a workshop on dynamic planning.

3 Katie Gillies, Bat Conservation International, presents information on regulatory compliance and project delivery and approaches to conserving imperiled species.

4 Mark Dowd, University of California, Berkeley, participates in a panel on the U.S. DOT's Smart City Challenge and the work to advance multimodal mobility.

5 Laura Fay, a research scientist at Western Transportation Institute, Montana, presents doctoral student research in asphalt materials and mixtures.

6 Steve Wood, U.S. DOT, moderates a spotlight panel discussion on automated driving and unmanned aircraft systems.

7 Kelvin Machumu, University of North Florida, shares research on the minimum routing distance for managed lanes with Judith Mwakalonge, South Carolina State University.

8 Tom McMahon, Association for Unmanned Vehicle Systems International, offers insight on unmanned aircraft systems.

9 Christopher Kinzel, HDR Engineering, Inc., reviews the 6th Edition of the *Highway Capacity Manual*.

10 Mara Campbell, CH2M, takes the lead in a breakout session of a planning workshop.

SESSIONS & WORKSHOPS

(continued)

1 Outgoing Secretary of Transportation Anthony Foxx speaks to a large crowd on the spotlight theme of Looking Forward to Innovation in an Era of Rapid Change.

2 Somaye Dovirani, University of Massachusetts, engages attendees in a poster session on geometric design.

3 Duane Callender, U.S. DOT, shares insight on the Build America Bureau, a division responsible for transportation infrastructure projects.

4 Mark Compton, Pennsylvania Turnpike Commission, discusses the Disadvantaged Business Enterprise Program.

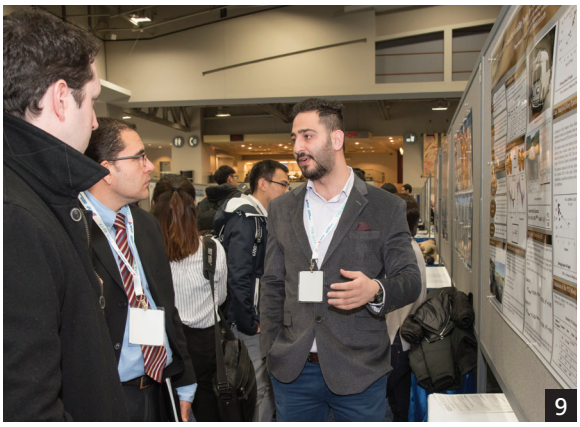
5 Sriram Kalyanaraman, University of Florida, explains how gaming and virtual reality technology offer opportunities for replicating real-world dynamics.

6 A panel session explores diversity and discrimination in transportation planning, design, and implementation.

7 Carlos Braceras, Utah DOT, speaks at the Federal Highway Administration's spotlight session on leadership in innovation.

8 John Van Steenburg, Federal Motor Carrier Safety Administration, traces trends in commercial motor vehicle crash data.

9 Waleed Aleadelat, University of Wyoming, explains his research on estimating the pavement serviceability index with smartphone applications to Jose Medina *(left)* and Roberto Barcena *(center).*



9 Communicating Concepts with Jane and John Q. Public Award winners framed by (*left*) Terri Parker, Texas A&M Transportation Institute, and (*second from right*) Claudia Bilotto, Parsons Brinckerhoff, and Ram Pendyala, Arizona State University: (*left to right:*) Grace Kyung, Trailnet; Eileen Barron, Utah DOT; Mathew Kwartin, Northwest Air Quality Communicators; and Wendy Gutschow, Southern California Environmental Health Sciences Center.

SESSIONS & WORKSHOPS

(continued)

1 Ranjani Prabhakar discusses her findings on predicting bikeshare trips between stations with Alex Erath.

2 Ruth Byrd-Smith, Allegheny County, and Donald Williams, Witherspoon & Williams, LLC, discuss growth opportunities for minority- and women-owned businesses.

3 At the State DOT CEO Roundtable, Shawn Wilson of Louisiana speaks on the challenges of competing with private-sector engineers.

4 Laura Mason, Washington Metropolitan Area Transportation Authority, participates in the question-and-answer portion of the State DOT CEO Roundtable.

5 Drew Kodjak, International Council on Clean Transportation, focuses on the future of smart and inclusive cities.

6 Oakley Brooks, National Air Carrier Association, joins a panel discussion with senior military officers and industry representatives on strategic mobility requirements.

7 William Williams, Texas A&M Transportation Institute, uses photographs of accidents to illustrate the impact of barrier design for heavy vehicles.

8 Roger Millar, Washington State DOT, joins in discussion on accommodating multimodal transportation options during the State DOT CEO Roundtable.

9 Winners of the Tenth Annual Competition and Call for Communicating Concepts with Jane and John Q. Public.

SESSIONS & WORKSHOPS

(continued)

1 Felipe Dias, University of Texas, Austin, outlines the data, modeling methodology, estimations, and elasticities of ridesourcing and carsharing.

2 Helen Reeves, British Geological Survey, shares her experiences in using geological models as a decision tool for planning and design.

3 Jonathan Upchurch, consultant, addresses the need to change the culture of transportation research.

4 Mary White, South Carolina State University, discusses her research findings on the habits of distracted college pedestrians with Lynn Jacobs, Fehr & Peers, Utah.

5 Bryce Little, Parsons Brinckerhoff, weighs in on federal funding compliance.

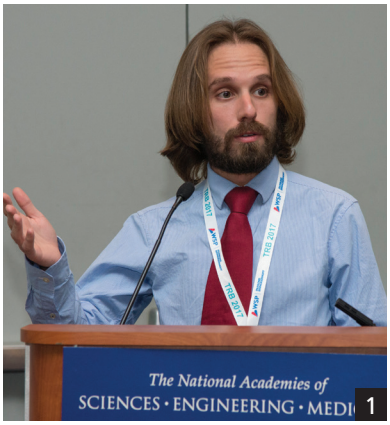
6 Ervin Dukatz, Mathy Construction Company, explains the need for obtaining higher-density asphalt to increase performance in pavement.

7 Jennifer Wells, Minnesota DOT, presents a case study of small unmanned aircraft systems applications from her state.

8 David Lattanzi, George Mason University, describes emerging bridge technologies, including the use of unmanned equipment.

9 Darryl Jenkins, American Aviation Institute, describes aviation-related innovations in the freight supply chain.

10 Sadie Smith, University of Arkansas, and Brian Diefenderfer, Virginia DOT, join in a panel on incorporating structural rehabilitation techniques into AASHTOWare Pavement-ME design.



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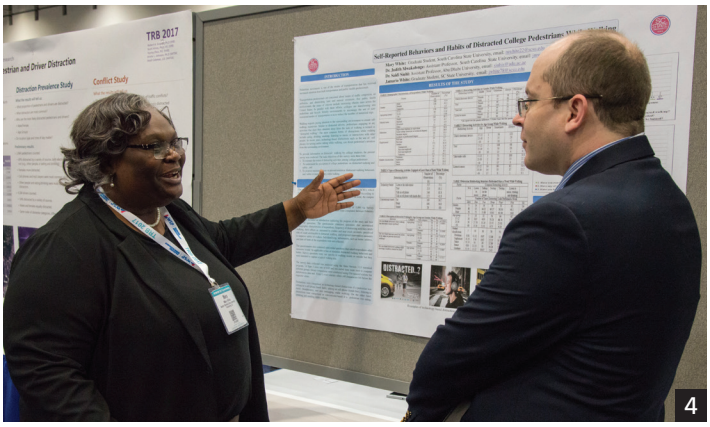
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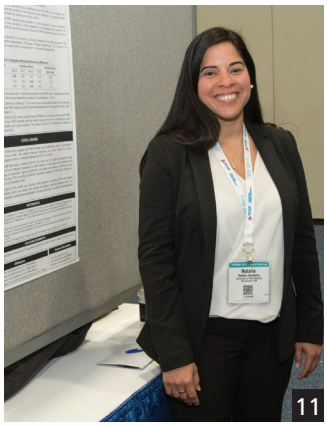
11 Natalia Sanabria, University of New Mexico, welcomes questions after concluding her poster presentation on artificial neural networks and ordered-probit models for forecasting pavement conditions.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COMMITTEES

1 Paul Leiby, Oak Ridge National Laboratory, engages with members of the Transportation Energy Committee.

2 Claudia Zapata, Arizona State University, chairs the Engineering Behavior of Unsaturated Geomaterials Committee.

3 William James leads committee discourse on eminent domain and land use.

4 Sreenivas Alampalli, New York State DOT, guides the work of the Testing and Evaluation of Transportation Structures Committee.

5 Members of the Urban Transportation Data and Information Systems Committee review their meeting agenda.

6 Norbert Delatte, Oklahoma State University, heads the meeting of the Properties of Concrete Committee.

7 Yu Zhang, University of South Florida, confers with fellow members of the Airfield and Airspace Capacity and Delay Committee.

8 Douglas Eisinger, Sonoma Technology, Inc., facilitates the Regional Air Quality Analysis Subcommittee.

9 The Urban Freight Transportation Committee is joined by conference attendees as they focus on emerging research. With a few exceptions, most committee meetings are open to the public.

SPECIAL FEATURE

A Day in the Life of a TRB Committee

KATHERINE F. TURNBULL

The author is Executive Associate Director, Texas A&M Transportation Institute, College Station, and Vice Chair of the Transportation Research Board Executive Committee.

[A veteran standing committee of the Transportation Research Board's Technical Activities Division guides a newly formed standing committee on a one-day tour of the Annual Meeting:]

Hey kid, welcome to the TRB family of almost 220 standing committees and task forces! It's great that you, a new committee, can shadow me today. You will learn a lot about a day in the life of a TRB committee. Let's get started!

I've been around for almost 40 years, but there are many committees that are even older than I am. You have probably heard that the standing committees are called the lifeblood of TRB—we take our responsibilities absolutely seriously.

Monday is a good day to show you around the Annual Meeting, but many of us began our work over the weekend, with workshops, meetings, and the orientation session for new attendees—I saw you there at one of the briefing tables.

My planning activities actually began shortly after last year's Annual Meeting—which is always in January and always in Washington, D.C. I issued a call for papers and posters in an emerging area of research. I also worked with two other committees to develop and submit a proposal for a crosscutting session and a nomination for a Blue Ribbon award to the Technical Activities Council (TAC).

(*Photo, upper right:*) Wendy Jia, Chair of the Rail Transit Committee, celebrates her committee's blue ribbon award for communications.

(*Below:*) TRB Executive Director Neil Pedersen (*right*) briefs the New Chairs Orientation session.

My active committee members and friends reviewed 40 papers and 20 poster abstracts that arrived on August 1. For me, that number is fairly typical, but some of our fellow committees received more than 100 papers. Following the review process, I developed two podium sessions featuring papers, a crosscutting session, and a poster session. Working with three other committees, I also cosponsored a hot topic session.

I know it's only 7 a.m., but my research subcommittee has a breakfast meeting. Oh, that's right—you came in from the West Coast, so it's superearly for you. Better have a second cup of coffee!

[A few hours later....]

The morning went by quickly. The first podium session was great, and it was inspiring to see the younger members actively involved. The speakers in the crosscutting session did an excellent job of addressing a timely topic in ways that will benefit researchers and practitioners alike.

Our section meeting over lunch provides an opportunity to hear about topics and priorities discussed by the TAC and to share experiences with our peers. Our TRB senior program officer is knowledgeable and capable—she will answer all your questions and will help with all your activities, as she does with mine.

[A committee meeting follows....]

My four-hour committee meeting kept a big agenda moving along. The discussion of key activities and initiatives was informative, including the planning for a 12th international conference later this year. Hearing from a few speakers on recent federal, state, and local legislation and programs was also enlightening. Even with four hours, I never have enough time to address all the hot topics.

We still have some time to visit the poster session before we head to the annual Thomas B. Deen Distinguished Lecture. We work hard every year to reach out to diverse groups interested in the featured topic, with the goal of generating new problem-solving ideas, and the work pays off.

The Deen Lecture recognizes the career contributions and achievements of an individual in one of the areas covered by the Technical Activities Division. The major award is named for TRB's eighth Executive Director—he's sitting over there, with several other leaders and colleagues. The TAC also presents awards for best papers and for committee achievements at this session—it usually draws a full house.

Look up at the screen—how exciting to see my own name up in lights as the winner of the Blue Ribbon Committee Award for Community Building and Mentoring! The award recognizes my successful efforts with two other committees in reaching out to younger members and involving them in key leadership positions to plan our joint midyear meeting. It's now a model for our peers. Being selected a blue ribbon committee is a gratifying honor!

Robert Lim (*center*), San Francisco Municipal Transportation Agency, comments on an agenda item during the meeting of the Public Transportation Group Young Members Subcommittee.

[The two committees take a dinner break after the session.]

I hope you didn't mind our quick dinner. It did give me opportunity to introduce you to more of our committee peers. Soon you'll find your own favorite meeting places, and you'll quickly get to know the big family of TRB committees.

Our last stop on today's rounds is an evening session I cosponsored with three other committees to present multiple perspectives on an emerging issue.

[The evening session concludes.]

What a great day it has been—but I'm exhausted and ready to head back to my room. But you feel like you're just getting started? Have a great evening—and welcome to the TRB family!

Emily Parkany, Vermont Agency of Transportation, reports to the Transportation Education and Training Committee.

COMMITTEES

(continued)

1 Maureen Jensen receives a certificate honoring her leadership of the Subsurface Drainage Committee from Nancy Whiting, TRB, and Anand Puppala, Geotechnical Engineering section chair.

2 Peter Mandle of InterVISTAS Consulting delivers remarks to the Aviation Group after receiving the Francis X. McKelvey Award for contributions to airport planning and design.

COMMITTEE LEADERSHIP AWARDS

3 Eleni Christofa, University of Massachusetts, Amherst, receives the Outstanding Young Member Award for TRB committee service from Rod Schebesch of Stantec, Inc.

4 Jane Lappin and Steven Shladover *(center)* accept the Blue Ribbon Award for their committee's contributions to road vehicle automation research, presented by Operations Section Chair Robert Bertini *(right)*.

5 Emeritus member Bhagwant Persaud shares insights with the Safety, Data, Analysis, and Evaluation Committee, chaired by Kimberly Eccles *(center)*.


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Blue Ribbon Awards

The Technical Activities Council presented Blue Ribbon Awards recognizing committees for exemplary best practices:

- Community Building and Mentoring: Construction Management Committee, chaired by Paul Goodrum;
- Advancing Research: Highway Capacity and Quality of Service Committee, chaired by Tom Creasey;
- Contributing to TRB and the Transportation Community: Vehicle–Highway Automation Committee, chaired by Steve Shladover, and the Intelligent Transportation Systems Committee, chaired by Jane Lappin; with an honorable mention to the Performance Management Committee, chaired by Mara Campbell; and
- Communications: Rail Transit Systems Committee, chaired by Wendy Jia.

TRB Honors Committee Mainstays

The Transportation Research Board has established an emeritus membership category to recognize the significant, long-term contributions of individuals who have provided outstanding service through participation on the Board's standing committees. The individuals selected for recognition in this year's group of honorees are listed below:

- Barbara J. Arens, Transportation Planning Applications Committee;
- William D. Dye, Maintenance and Operations Management Committee;
- Mark E. Hallenbeck, Highway Traffic Monitoring Committee;
- John M. Kulicki, Steel Bridges Committee;
- Peter B. Mandle, Airport Terminals and Ground Access Committee;
- Timothy J. McGrath, Culverts and Hydraulic Structures Committee;
- Patricia V. McLaughlin, Public Transportation Group;
- Roger C. Olson, Pavement Maintenance Committee;
- Bhagwant Persaud, Safety Data, Analysis, and Evaluation Committee;
- Sandra Rosenbloom, Women's Issues in Transportation Committee;
- Jerry Wachtel, Vehicle User Characteristics Committee; and
- Kathryn A. Zimmerman, Transportation Asset Management Committee.


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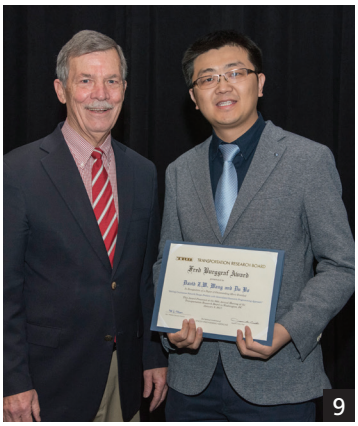
4 The D. Grant Mickle Award recognizes the outstanding paper on operations, safety, and maintenance of transportation facilities. *(Left to right:)* Florian Marczak, Victor L. Knoop, Ludovic Leclercq, and Serge P. Hoogendorn of the Delft University of Technology, Netherlands.

5 *(Left to right:)* William W. Millar, past president of the American Public Transportation, joined Millar Award recipients Carlyn Muir and Graham Currie of Monash University, Victoria, Australia; coauthor Mustafizur Rahaman was not present.



PAPER AWARDS

1 The Thomas B. Deen Distinguished Lecture Award was given to Bruce Smith for his career contributions and achievements. (*Left to right:*) Mrs. Smith, Bruce Smith, Thomas B. Deen, and TRB 2016 Executive Committee Chair James Crites.

2 Bruce Smith, Apperson Crump, PLC, describes Ethical Issues Facing Today's Agencies: Transparency and Security, Codes of Conduct, and Public–Private Partnerships.

3 The Pyke Johnson Award for best paper in planning and environment was presented to Harry J. P. Timmermans, Eindhoven University of Technology, Netherlands (coauthors Ifigenia Psarra and Theo A. Artenze were unable to attend).

4 Mickle Award recipients (see caption at left).

5 The William W. Millar Award honors the best paper in the field of public transportation.

6 Eric Morris *(left)* and Brian Taylor received the Charley V. Wooten Award for best paper on policy and organization; coauthor Jeffrey Brown was not present.

7 Dan Turner, Technical Activities Council chair, presents the K. B. Woods Award for best paper in design and construction to Scott A. Anderson, FHWA Resource Center.

Two Fred Burggraf Awards were presented for outstanding papers by authors under age 35:

8 For aviation, to Megan Smirti Ryerson, University of Pennsylvania; and

9 For planning and environment, to David Z. W. Wang and Bo Du (who was unable to attend), both of Technological University, Singapore.

MAJOR AWARDS

1 Norman Y. Mineta receives the Frank Turner Medal for Lifetime Achievement in Transportation; Malcolm Dougherty makes the presentation.

2 The W. N. Carey , Jr., Distinguished Service Award honored longtime leader and Executive Committee member H. G. (Gerry) Schwartz, Jr.

3 The research achievements of Sandra Q. Larson of Iowa DOT earned the Roy W. Crum Distinguished Service Award, presented by Neil Pedersen.

4 Accolades continued for Past TRB Executive Director Robert E. Skinner, Jr. (*left*), with the George S. Bartlett Award for contributions to highway progress, presented by C. Michael Walton, University of Texas, Austin.

5 Jaiwon Shin of NASA delivered the Chairman's Luncheon address on "A New Era in Aviation."

6 TRB 2016 Executive Committee Chair James M. Crites starts the awards ceremony.

EXECUTIVE SESSIONS

7 Panelists (*left to right:*) Bryan Grote of Mercator Advisors, Jack L. Schenendorf of Covington and Burling, LLP, and Jeff Davis of the Eno Center for Transportation discuss infrastructure funding under the new administration.

8 Lauren Alexander Augustin of the National Academies of Sciences, Engineering, and Medicine describes studies on risk, resilience, and extreme events.

9 Alan C. McKinnon, Kuehne Logistics University, contributes to a panel on transportation and climate change.

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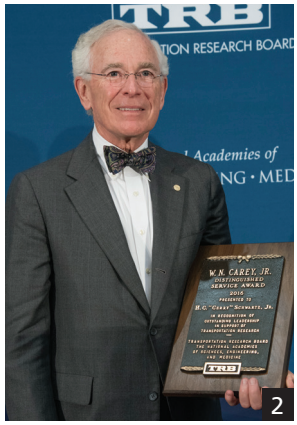

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10 (*Below, center:*) Caroline Alméras and Mark Robinson, General Secretary and President, respectively, of the European Conference of Transport Research Institutes, explore the prospects of programs with TRB.

11 (*Below, right:*) Patrick Malléjacq, Secretary General of the World Road Association, and TRB Executive Director Neil Pedersen display an agreement for joint efforts and initiatives.


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New Leaders Guide Executive Committee

Malcolm Dougherty, Director of the California Department of Transportation (Caltrans) is the 2017 Chair of the TRB Executive Committee. He succeeds James Crites, Executive Vice President, Operations Division, Dallas–Fort Worth International Airport. Katherine Turnbull, Texas A&M Transportation Institute, is the 2017 Vice Chair.

At Caltrans, Dougherty oversees the building, maintaining, and operating of California's 50,000 lane miles of transportation, along with its $11 billion budget and 20,000 employees. In his 21 years at Caltrans, he has served as Chief Deputy, Chief Engineer, and District Director in the Fresno Area, as well as holding management positions in Design Project Management and Maintenance and Traffic Operations. He currently serves on the Board of Directors for the Intelligent Transportation Society, the American Association of State Highway and Transportation Officials, and the Western Road Usage Charge Consortium. Dougherty received a bachelor's degree in Civil Engineering from Rutgers University.

Turnbull is Associate Director, Texas A&M Transportation Institute, and heads the System Planning, Policy, and Environmental Research Group. She received a bachelor's degree in Political Science and History from the University of Minnesota, a master's degree in Urban Affairs from the University of Wisconsin, and a Ph.D. in Urban and Regional Science from Texas A&M. An internationally known expert on high-occupancy vehicle facilities, travel demand management, managed lanes, and intelligent transportation systems, Turnbull is a sought-after speaker for industry conferences and has served on numerous TRB committees and task forces. She is the recipient of the Ethel Birchland Lifetime Achievement Award and of the TRB W. N. Carey Distinguished Service Award.

New members of the Executive Committee include Charles Zelle, Commissioner, Minnesota Department of Transportation; Mary Brooks, Professor Emerita, Dalhousie University, and Chair of the TRB Marine Board; Alberto Ayala, Deputy Executive Officer, California Air Resources Board; Bevan Kirley, University of North Carolina Highway Safety Research Center, and Chair of the TRB Young Members Council; Patrick McKenna, Director, Missouri Department of Transportation; and James Tien, Distinguished Professor and Dean Emeritus, College of Engineering, University of Miami. A. Stewart Fotheringham, Professor, School of Geographical Sciences and Urban Planning, Arizona State University, was reappointed to the committee.

Todd Semonite, U.S. Army Corp of Engineers, and Karl Simon, United States Environmental Protection Agency, join U.S. Department of Transportation representatives Marie Therese Dominguez, Pipeline and Hazardous Materials Safety Administration; Jack Danielson, National Highway Traffic Safety Administration; Patrick Warren, Federal Railroad Administration; Joel Szabat, Maritime Administration; and Audrey Farley, Office of the Assistant Secretary for Research and Technology, as ex officio Executive Committee members.

2017 TRB Executive Committee Chair Malcolm Dougherty shares perspectives on the coming year's agenda.

(*Left:*) Longtime volunteer leader and frequent conference rapporteur Katherine M. Turnbull presents her insights during the Executive Committee business meeting; she holds the post of Executive Committee Vice Chair for 2017.

(*Right:*) Malcolm Dougherty presents outgoing Executive Committee Chair James Crites with a plaque honoring his leadership, commitment, and service in TRB.

EXECUTIVE COMMITTEE

Focused discussions with wide-ranging participation from transportation leaders characterize TRB Executive Committee sessions; participants included the following:

1 Victoria A. Arroyo, Georgetown University;

2 S. Jack Hu, University of Michigan;

3 Melinda McGrath, Mississippi DOT;

4 Steven Cliff, California Air Resources Board;

5 Geraldine Knatz, University of Southern California;

6 Robert Shea, Pennsylvania DOT;

7 Scott E. Bennett, Arkansas State Highway and Transportation Department;

8 Pat Thomas, United Parcel Service;

9 Nathaniel P. Ford, Sr., Jacksonville Transportation Authority;

10 Walter C. Waidelich, Jr., Federal Highway Administration;

11 Daphne Jefferson, Federal Motor Carrier Safety Administration;

12 Richard A. White, American Public Transportation Association;

13 Mary R. Brooks, Dalhousie University, and Chair, TRB Marine Board; and

14 Roger B. Huff, HGLC, LLC.

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Offshore Oil and Gas Industry Safety Culture

Implications for Commercial Transportation Safety Regulation

STEPHEN R. GODWIN

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The Macondo Well–*Deepwater Horizon* blowout, explosion, and oil spill of 2010 provides a case example of organizational failures that affected complex sociotechnical systems to produce a catastrophic accident. The multiple studies evaluating the causes of this catastrophe, including one by the National Academies of Sciences, Engineering, and Medicine, faulted the weak safety cultures of the companies involved (*1*).

A follow-up report, Transportation Research Board (TRB) Special Report 321, *Strengthening the Safety Culture of the Offshore Oil and Gas Industry*, defines safety culture, describes ways to improve safety culture among offshore oil and gas companies, indicates ways to assess safety culture, and summarizes ways to address and overcome the challenges to strengthening safety culture industrywide (*2*).

Studying safety regulation and the role of safety culture in another industry provides an opportunity to reflect on lessons that could apply to the safety regulation of commercial transportation carriers that also are at risk for catastrophic accidents. For example, how can a regulatory regime enhance and reinforce organizational safety culture? What are lessons from the regulatory experience offshore that may apply to the regulation of commercial transportation?

Fire boat response crews battle the blazing remnants of the offshore oil rig *Deepwater Horizon*, April 21, 2010.

PHOTO: FLORIDA SEA GRANT/FLICKR

Photo: Shell/Flickr

Many offshore oil and gas companies have established safety culture programs—such as Shell's Goal Zero—to cultivate a workforce and processes that perform without harm or mishap across all operations.

Being Before Doing

Organizational culture is complex and multidimensional and involves deeply held assumptions and values. The committee that prepared Special Report 321 relied on the work of Edgar Schein,[1] a leading theorist of organizational culture:

> Schein's...influential model of culture asserts that there are surface features of culture that can be seen and heard, including visible artifacts and communicated values and beliefs, whereas the essence of culture, comprising underlying assumptions, is "deeper" and difficult even for cultural insiders to perceive and articulate. (2, p. 143)

Safety culture may be defined as an organization's attitudes and values about protecting life and limb in the pursuit of the organization's principal goals, which usually are not safety itself. The distinction is between "doing" and "being"—certain actions define what organizations do about safety; safe outcomes, however, result from an organization's most basic motivations—what it is—recognizing, of course, that cultures may vary within organizations.

Safety Culture Journeys

Organizations with a strong safety culture naturally will choose to behave in ways that are safe. Achieving a strong safety culture, however, is a journey, not a destination. The achievement requires years of commitment. Special Report 321 points to an analysis of the way that the international oil and gas company Shell dramatically drove down accidents and injuries through a multiyear process of organizational learning and a deep commitment to safety organizationwide (3).

A commitment to safety, therefore, goes beyond simple compliance with a set of required actions—such as those mandated by regulations. Exemplary organizations' deep commitments to safety are to be celebrated, but individual companies may not represent the industry as a whole. The challenge for regulators is to determine how to foster the development of strong safety culture industrywide through regulatory and nonregulatory approaches.

Evolving Regulatory Regime

In 2013, the U.S. Department of the Interior's Bureau of Safety and Environmental Enforcement (BSEE), which regulates offshore safety, published a list of the characteristics of organizations that have developed strong safety cultures. The intent was to begin a dialogue about safety culture with the offshore industry.

BSEE drew from the experience of the nuclear power industry, which became deeply committed to improving its safety culture after a catastrophic accident. Chapter 2 of Special Report 321 describes the following characteristics of safety culture in detail:

- Leadership commitment to safety values and actions,
- Respectful work environment,
- Environment for raising concerns,
- Effective safety and environmental communication,
- Personal accountability,
- Inquiring attitude,
- Hazard identification and risk management,
- Safe work processes, and
- Continuous improvement.

The Macondo Well–*Deepwater Horizon* accident prompted many important changes in offshore regulatory approaches and industry activities, modeled on the experience of the nuclear power and chemical processing industries (2). BSEE now requires offshore oil and gas companies to employ safety management systems (SMSs) and to submit extensive reports on near misses and incidents to be shared industrywide to facilitate learning. The offshore industry has created an independent organization dedicated to safety, emulating the nuclear power industry, whose leadership has developed an industrywide commitment to safety culture.

Safety Management Systems

SMSs have been in wide use in industrial safety for decades. SMSs vary across industries but share common elements for safe operations, including

[1] Schein, E. H. *Organizational Culture and Leadership*, 4th ed. John Wiley, Hoboken, N.J., 2010.

requirements for specific, written plans for operating practices, hazards analysis, safe work practices, training, mechanical integrity, emergency response, incident reporting, and ongoing, independent audits of performance (*4*). SMSs are suited to industries involved in high-risk endeavors and emphasize risk assessment to avoid catastrophic failures.

In the 1990s, the Minerals Management Service—a predecessor of BSEE—prompted the offshore industry to develop a voluntary standard, American Petroleum Institute (API) Recommended Practice (RP) 75. As a result of the Macondo Well blowout, RP 75 became mandatory through regulation in 2013, with additional refinements.

SMSs have multiple parallels with safety culture, particularly an emphasis on hazards analysis—such as an inquiring attitude and risk management; on incident reporting—such as creating an environment for raising concerns and encouraging effective safety communication; and on safe work practices and processes. The SMS emphasis on processes, however, focuses on what organizations *do*—the processes they follow—to enhance safety.

RP 75 was developed, in part, to compensate for the long-standing SMS dependence on physical inspections of offshore facilities, which focus on the integrity of mechanical systems and on compliance with standards, not on organizational performance. The designers of the offshore industry's SMSs were interested in shifting away from simple compliance to an emphasis on safety performance (*4*).[2]

Relying on compliance with standards and on the physical inspection of facilities is a common regulatory approach to industrial safety, including commercial transportation safety. For the offshore industry, however, this approach risked creating a culture of compliance with minimum standards for equipment and work practices instead of a strong organizational culture committed to safety (*4*). Because of the many parallels with safety culture principles, SMSs can reinforce a strong safety culture, but only if a company truly values safety and does not simply comply with SMS requirements in a "check the box" fashion (*4*).

Safety Incident Reporting

Another important element of the regulatory regime for high-risk industries is a system for reporting near misses and incidents (*5*). Many companies in regulated industries have these systems, but the systems are internal, because the companies want to avoid exposure to legal liability if data about possible failures are shared.

Photo: Shell/Flickr

Engineers monitor oil equipment from remote control centers. Offshore oil companies are finding ways to create a safety culture that goes beyond minimum standards compliance.

Successful internal reporting systems depend on a culture that supports employees for reporting mistakes without punishing them for making the mistakes. Industry incident reporting systems complement and depend on the safety culture principles of personal accountability, an inquiring attitude, an environment for raising concerns, and methods of hazard identification and risk management. Nevertheless, reports of near misses need to be shared across the industry, so that other companies can learn from them.

One way to overcome corporate aversion to sharing is through independent reporting systems, which protect reporters who have not exercised criminal negligence. These systems typically provide informa-

Photo: Shell/Flickr

In Shell's oil spill response training, employees are encouraged to share concerns and incidents.

[2] TRB has a study under way examining the pros and cons of performance-based safety regulation, such as SMSs, and the contexts in which these approaches work most effectively. The report is expected later this year.

Photo: Jimmy Emerson, DVM, Flickr

NASA's Aviation Safety Reporting System provides a confidential venue for pilots, ground personnel, mechanics, flight attendants, air traffic controllers, and others involved in aviation operations to share information about unsafe situations they have encountered or observed.

tion to third parties that make the data anonymous and share the lessons learned with the industry and regulators.

Transportation safety professionals are familiar with NASA's Aviation Safety Reporting System, which by law protects reporters from retribution. The authorizing legislation for the Bureau of Transportation Statistics (BTS) allows for the protection of information in similar fashion. BSEE has made use of BTS's capabilities by establishing a near-miss reporting system for the offshore industry.[3]

[3] https://near-miss.bts.gov/.

Industry Leadership

Reformers of the offshore industry safety regime looked to the leaders of the nuclear power and chemical processing industries for models of independent, industry-led organizations dedicated to improving safety. Admiral James Ellis, the former head of the Institute of Nuclear Power Operators (INPO)—one of the model organizations—briefed the study committee that authored Special Report 321. Ellis explained that the top executives of nuclear power companies exerted strong peer pressure on each other to achieve the highest standards of safe performance.

Leadership, a key safety culture principle, is fundamentally important in the creation and function of these organizations. After the Macondo Well disaster, the offshore industry created the Center for Offshore Safety (COS) to serve as the industry's version of INPO.

In contrast to the more homogeneous nuclear power industry, which has a relatively small number of operators, the offshore industry is fragmented and diverse, with dozens of large operators and independent drillers served by hundreds of smaller companies with specialized expertise and services. Although the Special Report 321 committee noted the substantial achievements of the COS in just a few years, the committee also noted that a relatively modest share of the offshore industry is actively participating. Many of the current members of the COS are companies that already were committed to improving their safety performance.

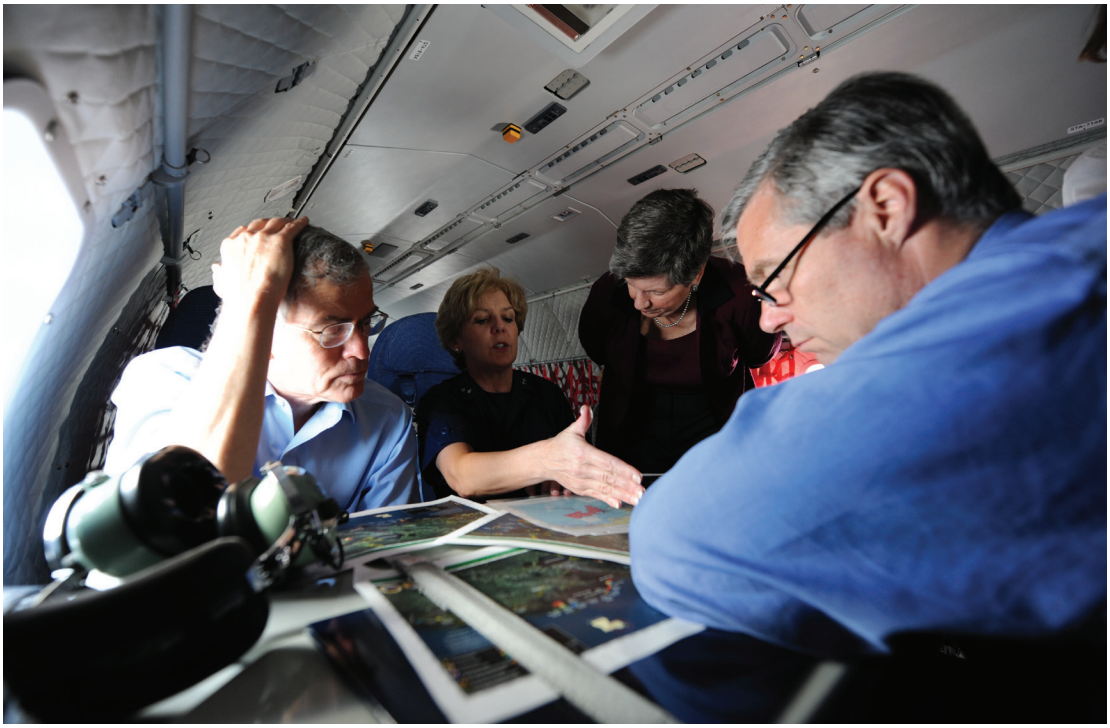

Photo: Deepwater Horizon Response/Lt. Cmdr. Rob Wyman

Government agency officials work with on-scene coordinators during the 2010 oil spill. The Maconda Well disaster instigated new safety reforms, including the creation of the Center for Offshore Safety.

Regulators' Challenge

Companies strengthen their safety cultures through leadership and deep organizational commitment. These actions are based on choices and values that are difficult, if not impossible, to require through rules. Regulations, such as required SMSs, can impose process requirements but can be truly effective only if embraced by companies.

Regulators can foster companies' commitment to the safety culture journey by providing flexibility and, possibly, incentives. Exemplary companies can serve as role models for the industry as a whole, but in a large, heterogeneous industry, the necessary commitment from all companies is not guaranteed.

This implies that regulators who want to foster safety through a stronger organizational safety culture need flexibility to reward the good performers but to maintain a vigorous enforcement capability for companies that merely comply with the regulations. To some extent, this same concern arises with the regulation of safety in the transportation sector.

Photo: Robert Couse-Baker/Flickr

Commercial transportation safety relies on safe equipment and operation, including managing employee fatigue by limiting workable hours.

Applicability to Modal Safety

The regulation of commercial transportation safety has a long and varied history—more than a century in the case of railroads. As with the offshore industry, transportation safety regulation across all modes relies heavily on equipment and operating specifications, on enforcement through government inspections, and on limits to the hours that employees can work to manage fatigue. These regulations are necessary but may not mitigate the risks of organizational failures.

Commercial transportation safety regulation has some of the elements of the evolving industrial safety regulatory model. Variations on SMSs, regulated and voluntary, appear in most modes, and may serve as mechanisms through which regulators can influence organizational safety culture.[4]

As noted, aviation has an exemplary incident reporting system industrywide, but other modes do not follow this model. Although the aviation industry has illustrated strong leadership in improving safety and safety culture, aviation and other modes have no organization comparable to INPO.

The literature on transportation organizational safety culture, which dates back more than two decades, is growing and reflects the importance of safety culture in all transportation modes. Literature searches indicate, however, that most of the research has occurred in the aviation and maritime modes, and most of the citations come from outside the United States. Lacking are case studies evaluating organizational performance over time and analyzing the role of safety culture at the industry level—even in aviation, which views safety culture as a widespread commitment across carriers.

Pilot Projects' Success

A series of modest-scaled pilot projects and evaluations addressing specific elements of safety culture in the U.S. railroad industry, however, offer an important counterexample. Conducted jointly by the Federal Railroad Administration and industry, the projects have led to measured safety improvements and to changes in organizational culture.[5] As in the offshore industry, exemplary companies in commercial transportation are committed to strengthening their safety cultures (*6*), but the level of industrywide commitment to safety culture seen in the nuclear power industry is not evident.

Regulators perhaps can foster stronger safety cultures in commercial transportation through SMS

[4] Studies of SMSs in transportation appear to be more extensive in Europe than in the United States. For a survey of the European experience, see Lappalinen, J. *Overcoming Obstacles to Implementing SMS*. Draft discussion paper prepared for the Roundtable on Safety Management Systems, International Transport Forum, Paris, January 2017. http://www.itf-oecd.org/sites/default/files/docs/overcoming-obstacles-implementing-sms.pdf.

[5] For an overview of these FRA projects and evaluations, see Ranney, J. M., M. K. Zuschlag, J. Morrell, M. K. Coplen, J. Multer, and T. G. Raslear. Evaluations of Demonstration Pilots Produce Change: Fourteen Years of Safety Culture Improvement Efforts by the Federal Railroad Administration. *TR News*, No. 286, May–June 2013, pp 28–36.

TRB Special Report 321, *Strengthening the Safety Culture of the Offshore Oil and Gas Industry*, is available from the TRB online bookstore, https://www.mytrb.org/Store/Product.aspx?ID=8295; to view the book online, go to http://www.trb.org/Publications/Blurbs/174395.aspx. A summary version of the report, *Beyond Compliance*, is available from the TRB online bookstore at https://www.mytrb.org/Store/Product.aspx?ID=8316 and can be viewed online at http://www.trb.org/Main/Blurbs/175037.aspx.

regulations. They can support incident reporting by providing systems that protect those who make reports—as BSEE has done for the offshore industry. Regulators may be unable to cause companies and industries as a whole to embrace safety culture improvements but may be able to incentivize company leadership by rewarding good safety performance with less direct or less frequent government oversight.

Key Questions

Research and policy analysis could demonstrate the potential benefits of a stronger safety culture in transportation industries—and of regulatory approaches to fostering this change. Some key questions include the following:

◆ Policies for enhancing organizational safety culture may have a strong intuitive appeal, but can evidence be developed to show that emphasizing safety culture enhances safety at either the company or the industry level?

◆ What are the components of a regulatory regime that can assist industry safety culture in mitigating the organizational failures that can lead to catastrophic accidents? Is the evolving regulatory model complete? If so, are the components essential, reinforcing, and effective in fostering stronger industry safety cultures?

◆ Which transportation modes, based on organizational and industry structure and on risk of catastrophic failures, are amenable to a regulatory approach built on strengthening safety culture?

◆ Can a mix of strict enforcement of rules on poorly performing organizations coexist with reliance on a performance- and incentives-based approach through SMSs, incident reporting, and industry leadership and self-regulation?

All of the modal administrations of the U.S. Department of Transportation that regulate commercial transportation have regulatory programs and research and technology programs. These programs can partner to explore the questions above, following the FRA model for evaluating the safety culture pilot projects in the railroad industry.

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Photo: John Turner/Flickr

The U.S. railroad industry has implemented pilot projects that have led to measurable safety improvements and a heightened safety culture.

PHOTO: DANIEL CHRISTENSEN/WIKIMEDIA

Innovations in Freight Planning

Addressing Trade, Future Scenarios, and Environmental Justice

DANIEL HAAKE AND CHRIS RYAN

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Freight trucks leave the Port of Miami, the 11th largest cargo container port in the United States.

Freight planning was once a small niche in transportation planning but has become a major focus in the federal surface transportation program. This newfound prominence is attributable to the growing awareness of the relationship between transportation and economic development. The federal program traditionally focused on the mobility of commuters. Today, this focus has expanded to transportation's support of the manufacturing and consumption of goods.

The impact of freight movements on the transportation system is clear. The national system moves more than 54 million tons of freight daily, and the Federal Highway Administration (FHWA) estimates that this total will increase by 45 percent by 2040.

Most state departments of transportation (DOTs) have completed or are in the process of completing statewide freight plans. These plans are designed not only to meet federal requirements but to encourage economic growth by decreasing the transportation costs for freight users. Although all statewide freight plans address this goal, some have gone beyond the statutory requirements to make a significant imprint on their state's economic future.

Formal Freight Plans

Before the passage of the Moving Ahead for Progress in the 21st Century Act (MAP-21), a few state DOTs had developed formal freight planning programs and plans. MAP-21 did not require states to create freight plans but strongly encouraged and incentivized the development of freight plans. The law allowed FHWA to enhance the level of federal funding for projects

Florida's formalized freight plan includes multimodal solutions for infrastructure, operations, and policy and regulation.

PHOTO: AJMEXICO/FLICKR

included in the plan. For example, a traditional highway project that normally would receive an 80 percent federal contribution could instead receive 90 percent.

Three years later, the Fixing America's Surface Transportation (FAST) Act changed the suggestion for a freight plan into a requirement. Although it removed the MAP-21 incentive, the FAST Act created a freight-focused formula, along with a discretionary program. To access the freight formula funds, a state must have an FHWA-approved, FAST Act–compliant plan in place by December 17, 2017.

The plan must address current and future freight needs comprehensively throughout the state and must

- Identify trends, needs, and issues;
- Describe policies and performance measures that guide investment;
- List freight corridors and facilities;
- Describe how the plan contributes to meeting national freight goals;
- Integrate innovation, technologies, and operational strategies;
- Describe improvements that may be needed to mitigate deterioration caused by heavy vehicles;
- Include an inventory of freight mobility issues, such as bottlenecks, along with strategies for mitigation;
- Consider congestion or delay caused by freight movements;
- Include a fiscally constrained freight investment plan; and
- Involve consultation with the state freight advisory committee, if applicable.

Most states have completed or are working to complete a FAST-compliant, statewide freight plan. Most plans will follow the requirements noted above, but a few have capitalized on the opportunity to transform the state's freight system.

The Minnesota Freight Advisory Committee released a new statewide freight system plan in November 2016.

PHOTO: MINNESOTA DOT

Improving Trade

In 2014, Florida DOT completed the Florida Mobility and Trade Plan (FMTP). Although designed to comply with MAP-21, the FMTP responded primarily to requirements in Florida House Bill 599. The 2012 legislation required creation of a plan to position the state for trade growth through strategic investments and policies.

Discerning a unique opportunity to serve as a catalyst for economic growth, Florida DOT took an approach vastly different from that for the development of other freight plans at the time. First, the agency designed the FMTP to be integrated. Instead of focusing on Florida's network, the plan looked at the network's interactions with commerce, trade, and energy sources.

Second, instead of focusing on the DOT and on the interactions of stakeholders with the agency processes, the FMTP focused on industry. This integrated and industry-focused approach created agility, enabling Florida DOT not only to be proactive but to be responsive to fast-paced opportunities for economic development.

Policy and Investment

The plan's design proceeded in two phases:

- The **policy element**, which described the overall freight policy and decision framework for investments, followed by
- An **investment element**, which identified and prioritized multimodal freight needs.

The policy element began with an analysis of freight user needs and system demands. The process included an outreach to more than 750 freight stakeholders and yielded a series of objectives aimed at trade growth.

Tactical strategies supported each of the seven objectives and focused the efforts of Florida DOT and its partners on implementation. The policy element identified an internal or external partner responsible for the implementation of each strategy.

The investment element focused on freight project prioritization and on the alignment of funding sources. Before prioritizing freight projects, however, Florida DOT had to define the qualifications of a freight project.[1] According to the FMTP's definition, a freight project must be at least one of the following:

- Freight focused—the primary purpose is to address a specific freight transportation need;
- Freight related—the primary purpose is to address multiple transportation concerns, including freight; or
- Freight impacted—the primary purpose is to address general transportation needs that will have a positive effect on freight mobility.

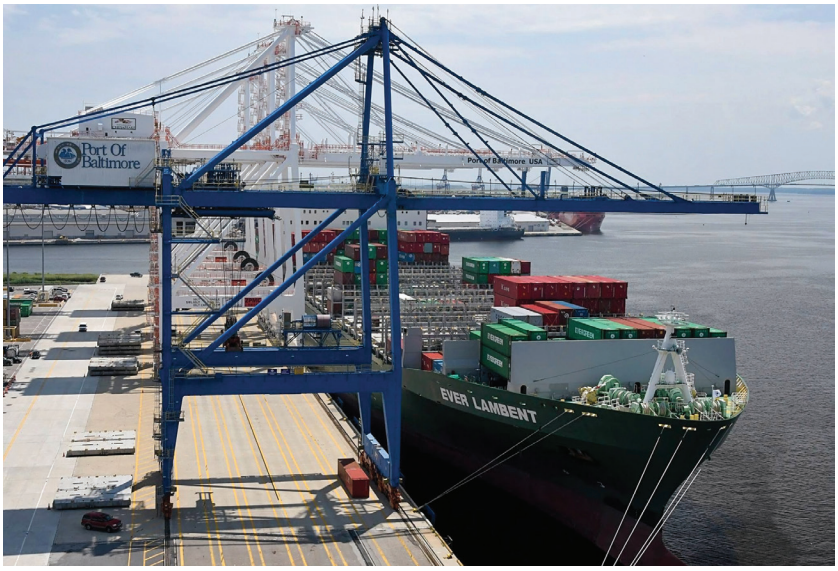

Photo: U.S. Army Corp of Engineers

The first container ship to pass through the newly expanded Panama Canal docks in Baltimore Harbor for offloading to rail and freight trucks.

Priorities and Financing

Florida DOT used this definition in working with agency partners and the private sector to develop a multimodal list of capacity and operational improvements. Because of the FMTP's integrated approach, the list's development avoided the traditional consideration of federal funding eligibility. The final project list included more than 700 projects with a total cost of more than $32 billion. Only 58 percent were highway projects.

The prioritization process involved 26 criteria designed to achieve the strategies outlined in the

FMTP Prioritization Process

Step 1. Develop freight project prioritization criteria for Florida.

Step 2. Rate projects according to selected criteria.

Step 3. Incorporate criterion importance weighting.

Step 4. Compile project scores and group by priorities.

Step 5. Evaluate return on investment for very high priority projects.

(Source: Florida DOT)

[1] See also Bucklew, K. J. Freight Project Selection and Prioritization: From Identifying the Need to Making the Investment. *TR News*, No. 307, January–February 2017, pp. 22–27.

Freight trucks in New York City's Harlem. Transportation planners recognize the need to increase infrastructure without negative impacts on minority and low-income populations.

PHOTO: EMMA MARIA/FLICKR

policy element and in Florida DOT's project selection process. Extensive public- and private-sector outreach efforts vetted and amended the criteria. The full prioritization process, outlined in the box on page 25, grouped projects without regard to mode into three categories based on the ability to meet the criteria and to generate a return on investment.

The investment element concluded with an extensive list of funding and financing options for each project type. The list included traditional funding sources and alternative funding sources such as public–private partnerships.

Scenario Planning

The major driver behind traditional long-range transportation plans is the forecast of future demand, which identifies future project needs. Normally, population and job growth projections drive these forecasts. Freight growth, however, is largely a function of global trends, which are much more volatile and unpredictable. The FAST Act accounts for this by establishing a five-year planning horizon for statewide freight plans, but what about states that integrate their freight plan into a larger long-range transportation planning process?

To overcome this challenge, the Missouri, Washington State, and Florida DOTs have adopted a scenario planning technique presented in National Cooperative Highway Research Program (NCHRP) Report 750, *Strategic Issues Facing Transportation, Volume 1: Scenario Planning for Freight Transportation Infrastructure Investment*.[2] Each state tailored its own approach, but all followed the framework developed in NCHRP Report 750.

The report described a repeatable scenario planning workshop technique that uses four extreme, yet plausible scenarios to help a state DOT prepare for an uncertain freight future. The workshop begins with an overview of scenario planning. Next, the workshop attendees break into assigned groups that ensure diversity. Each group conducts a facilitated discussion of the effects of their assigned scenario on freight flows and needs.

Although the four scenarios differ dramatically, a common set of freight needs emerges, which NCHRP Report 750 terms "no brainer" projects. These are the projects that a state should undertake no matter what. The process does not forecast the future but prepares states for an uncertain future.

Environmental Justice

Although the movement of freight is a physical manifestation of a growing economy, the movement itself creates negative effects not always borne by those who are reaping the benefits. Transportation planners recognize the importance of equity and the need to determine if current or proposed transportation infrastructure will produce disparate impacts on protected population groups; nevertheless, the precise

[2] www.trb.org/Publications/Blurbs/168694.aspx.

NCHRP Report 750, Volume 1, presents the scenario planning process for investments in freight infrastructure.

steps for completing environmental justice (EJ) analyses are often unclear—particularly for specialized areas such as freight transportation.

Analysis Methodology

A challenge for freight planners is to develop an EJ analysis methodology that arrives at a solution consistent with that of other modal practices yet recognizes the unique characteristics and challenges of freight transportation systems. The states of Minnesota and Wisconsin aimed to meet this challenge in developing their FAST Act–compliant statewide freight plans.

Each state took a two-part approach to the EJ analysis. The first step was a demographic overview of the population groups within each state. This included a table summarizing the population counts statewide, as well as within each planning district or region. Population groups incorporated into the summaries included the minority and low-income population groups protected under federal law, along with traditionally disadvantaged or at-risk groups, such as populations with limited English-language proficiency, seniors, youth, and persons with disabilities.

A map highlighted the areas in which the proportion of each target population group was above a specific threshold. This identified areas in which freight and other transportation infrastructure would have a higher likelihood of affecting a group adversely.

Differing Approaches

The Minnesota and Wisconsin approaches differed at this point. Wisconsin defined the threshold for each group as the statewide average of the target population's proportion. For example, if the statewide average for low-income population was 30 percent, then any area with a low-income population proportion above 30 percent was highlighted.

This approach provided an accurate snapshot of demographic distributions throughout the state. Nevertheless, when high concentrations of the target population were located in small geographical areas—such as major urban centers—the map could give the appearance that very few members of that group resided in the outlying areas.

Instead of using a statewide average, Minnesota used the average population proportion as the threshold for each of its eight planning districts. The resulting maps showed more areas throughout the state with above-average proportions of the target groups and provided a more local or regional context to the population distribution. Neither approach can be called the correct one; nevertheless, planners should understand how the choice of thresholds and reference areas could change the map significantly.

Buffer Analysis

Both states used a second approach—a buffer analysis to measure the demographics of the populations residing within one-quarter mile of the various components of the freight system. One-quarter mile approximates the range for adverse impacts from the freight system, such as noise, vibration, reduced air quality, safety hazards, and potential limits to access. Although the level of impact depends on a variety of local factors, a review of the research shows that a distance of one-quarter mile is appropriate in most circumstances.

The buffer analyses showed that many of the target population groups reside in greater proximity to the freight system components than the population as a whole and therefore are more likely to suffer adverse impacts from freight. For example, 1.0 percent of the total population resides within one-quarter mile of major rail facilities in the state, but 1.7 percent of the African-American population resides in the same area. This indicates that many population groups are more likely to be disproportionately impacted by adverse freight effects.

Policy Framework

Conducting these analyses will not necessarily satisfy all of an agency's EJ requirements. The analyses offer important contextual information and can provide a policy framework for more detailed, project-level analyses. Nonetheless, many other steps must be taken to ensure that all requirements are met—for example, a thorough public engagement process, outreach to stakeholder groups, and additional environmental reviews, as necessary.

Minnesota is working to buffer populations from adverse impacts of freight corridors.

Photo: Jerry Huddleston/Flickr

NCHRP SYNTHESIS 487

Public Perception of Mileage-Based User Fees

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For many decades, one of the largest and most stable sources of revenue for building and maintaining the nation's road and highway system was the so-called gas tax—state and federal taxes assessed per gallon of gasoline and diesel fuel. In recent years, however, the real value of gas tax revenues has declined significantly, leaving policy makers struggling to find money for transportation programs.

Increased vehicle fuel efficiency is a key reason for the declines in gas tax revenue, and increases in vehicle fuel efficiency will only accelerate. Vehicles now travel farther on a gallon of gas, which translates to paying less for every mile traveled. More and more alternative-fuel vehicles are on the road, and many owners buy no gas or diesel fuel at all.

Because of these current and predicted declines in gas tax revenue, policy makers are looking for a new source of stable, predictable funds for transportation. One option that has attracted interest is replacing the gas tax with a charge assessed for every mile traveled. A mileage fee—also referred to as a mileage-based user fee, vehicle-mile-traveled fee, or road-user charge—would be charged to vehicle owners in accordance with the number of miles driven

PHOTO: SHELL/FLICKR

Taxes assessed per gallon of fuel are no longer reliably funding road and highway systems, and researchers seek new avenues of income.

in their vehicle.

The National Cooperative Highway Research Program (NCHRP) undertook a synthesis project to explore public opinion about mileage fees, a critical topic for policy makers. At the most basic level, information on public opinion allows policy makers to judge whether a mileage fee is politically feasible. Equally important, understanding the nuances of why the public does or does not support mileage fees shows policy makers options for structuring such a fee in ways that will make it more acceptable.

Mileage Fees: What and Why?

How Mileage Fees Work

A mileage fee can be structured from simple—a flat rate charged for each mile—to complex, with the fee for each mile driven varying with the location, the traffic congestion, the vehicle type, or the vehicle emissions.

The fee collection mechanism can vary as well. The simplest scenario assesses mileage fees by taking periodic odometer readings—perhaps once a year—to measure the number of miles traveled. More complicated options use technologies such as an on-board Global Positioning System (GPS) or smartphone applications to track the vehicle's movement in time and space.

Most proposed systems would bill drivers periodically, like a monthly phone bill or annual vehicle registration fee. Either a government agency or a private firm contracted by the government could handle the billing and collections.

Mileage Fees in Practice

To date, only a few places in the United States and internationally require heavy vehicles to pay some variation of a mileage fee. The state of Oregon has levied a weight–distance toll on trucks for decades, relying on the manual recording of weights and travel distances. More recently, Germany, Austria, Switzerland, the Czech Republic, and New Zealand have successfully implemented electronically recorded mileage fee programs for heavy vehicles.

New Zealand is the only country that currently has a mileage fee for light-duty vehicles; all diesel vehicles, regardless of class, pay mileage fees. In the United States, neither the federal government nor any state has fully adopted mileage fees as a replacement for fuel taxes. Since 2015, however, Oregon has allowed vehicle owners to opt in to a program to pay a mileage fee instead of the gas tax.

Despite the limited implementation of mileage fees, U.S. interest is strong, with more than half of the states at various stages of exploring the idea. In addition to Oregon's small-scale voluntary program, California has a pilot program under way, other states have commissioned exploratory studies, and many have joined the Western Road-Usage Charge Consortium[1] or the Mileage-Based User Fee Alliance.[2]

Theoretical Benefits

Mileage fees offer many possible benefits from the perspective of a policy maker or planner. At the most basic level, the fees collect revenues from all vehicles, whether the vehicle is a highly fuel-efficient gas and diesel vehicle or one that uses no petroleum-based fuel at all. Thus, mileage fees overcome the chief problem with fuel taxes.

Other benefits depend on the technologies to track mileage and on the fee structures. For example, if some sort of GPS-based system collects mileage data, planners would have far richer and more precise data about vehicle travel patterns than ever before, allowing for improvements in traffic operations management and long-term planning.

In addition, if the fee structure offers cheaper rates for travel during low-traffic periods or on routes that are uncongested, the fees could encourage some drivers to avoid travel in congestion hot spots and thereby reduce congestion. Similarly, a rate structure that charges less per mile to fuel-efficient or low-emissions vehicles could encourage drivers to purchase vehicles with reduced environmental impacts.

[1] https://www.rucwest.org/.
[2] www.mbufa.org.

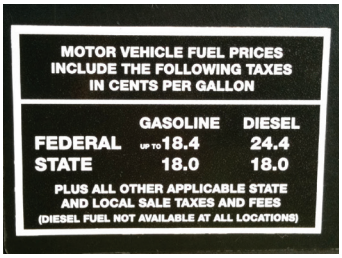

Photo: Drew Stephens/Flickr

Fuel tax information on a gas pump.

Photo: Mike Mozart/Flickr

The need to find new sources for revenue is driven in large part by more fuel efficient cars and more alternative-fuel vehicles.

Online media coverage of mileage fees. Oregon's voluntary fee-per-mile in place of the gas tax is the only state program currently in place.

Photo: Heidi Willis

Synthesis Methods

The NCHRP synthesis project aimed to help policy makers explore one important consideration for a potential shift to mileage fees—namely, public opinion. The project findings, published in NCHRP Synthesis 487, *Public Perception of Mileage-Based User Fees*, respond to such questions as whether or not the public supports mileage fees, the reasons why they do or do not, and additional research needed on public opinion (*1*). The report also explores how public opinion may vary according to geography, demographics, time, and common themes, trends, and factors that influence public acceptance or rejection.

The synthesis relied on multiple data sets and analytical methods. Information on public opinion about mileage fees came from three sources:

- 38 public opinion surveys;
- 12 qualitative research studies, such as focus groups; and
- 359 media stories that covered mileage fees, from 2010 to 2014.

Combining the survey results with quantitative data sources provides a rich source of information on levels of support and on reasons why people support or oppose mileage fees. The surveys contained 167 unique questions related to mileage fees; the responses were analyzed to assess what proportion of the public supported the concept of mileage fees. To flesh out reasons that may explain support or opposition to mileage fees, a content-analysis process evaluated the qualitative study findings and the media stories.

Despite high interest in mileage fees from governments, there is low support currently among consumers who have not participated in them.

Photo: BrokenSphere/Wikimedia

Does the Public Support Mileage Fees?

One key research question in the NCHRP study was to assess how many Americans support the concept of mileage fees.

Few People Do

The meta-analysis of past surveys, qualitative research, and media stories on mileage fees all confirm the same, simple finding: few people support mileage fees. An analysis of 33 survey questions asking if people support the mileage fee concept found only 24 percent mean support across the surveys, with support in any one survey ranging from 8 percent to 50 percent.

Related to respondents' support for the general concept of a mileage-based user-fee system is their support for replacing the gas tax with a mileage fee. The average support across the 23 survey questions addressing the hypothetical replacement of a gasoline tax with a mileage fee system was 23 percent. Support ranged from 8 percent to 42 percent.

The qualitative research supports the more generalizable survey finding that most participants do not support the mileage fee concept. Every one of the qualitative studies reviewed reported in depth the many concerns that respondents raised about mileage fees, but only a few positive opinions appeared in the study reports. The authors of many of the qualitative studies concluded that the public saw no reason to replace the gas tax with a mileage fee.

This simple story about past levels of support should not be the end of a discussion on public opinion, however. The research results provide tentative evidence that mileage fee support may rise over time, especially if pilot programs or other activities familiarize people with the mileage fee concept.

But Support Will Likely Grow

The study found several reasons to anticipate growing

Photo: Peter Stevens/Flickr

The greatest concern voiced by focus groups was that the mileage fee technology would allow states to collect data such as location, time, or odometer readings.

support for mileage fees. A look across all 38 surveys shows that mean support for replacing the gas tax with a mileage fee has increased slightly over time. In addition, surveys of participants in two mileage fee pilot programs found relatively high levels of support, suggesting that direct experience with a mileage fee can increase support for these fees. Finally, the media story analysis found that the percentage of stories taking a positive tone toward mileage fees increased gradually between 2010 and 2014.

The evidence suggesting that mileage fee support may increase over time aligns with findings from social psychology research indicating that message repetition is a key in changing public opinion and attitudes.

Two contextual factors further support the idea that, over time, the public may warm to the idea of mileage fees. First, as noted by the authors of almost all the qualitative studies, members of the public know virtually nothing about the current sources of transportation revenue. Most study participants had no idea about fuel tax rates or how much people paid per year in fuel taxes. People therefore formed their opinions about mileage fees with a poor understanding of the revenue alternatives.

The second contextual point is that the survey respondents provided opinions about a concept they most likely understood poorly. The mileage fee concept is complex, and the survey questionnaires do not provide respondents with a detailed explanation of how the fee would function. Because most people have not experienced a mileage fee, they have no knowledge that would help them to understand the survey questions about the fees.

Reasons for Opposition or Support

Survey questions about support or opposition to a mileage fee may give policy makers information about the likelihood of public push-back on a mileage fee proposal, but these results tell nothing about the reasons behind respondents' views. In contrast, the qualitative studies and the media story analysis provide a rich and detailed picture of the factors that influence people to support or oppose mileage fees. Understanding the reasons that people support or oppose mileage fees can help policy makers craft proposals that are more likely to be acceptable to the community.

Results from the qualitative analysis show that privacy and fairness were the themes most commonly discussed, although other issues arose as well, including fears that the fees would not be administered properly and that some households would struggle to make large, periodic payments.

Privacy

Privacy was a prominent theme in the focus group studies and the media stories. The topic arose in virtually all the qualitative studies, and the authors of several of the studies highlighted privacy as one of the main objections to a mileage-based user-fee system.

Mileage-based fee structures could include options to encourage driving during less busy times of day and on less congested roads.

Photo: Ken Lund/Flickr

Photo: Bethesda Beat Staff/Flickr

The Capital Beltway outside Washington, D.C. Those who are required to commute for their jobs would pay heavily under a congestion-priced system.

Participants were most alarmed by technology that collected data on the location or time of travel, but even simpler odometer-based systems raised concern. The analysis of the media coverage supports the notion that privacy is a common concern—half of all media stories discussed privacy issues in some way. In the surveys, seven of the 10 privacy questions showed that at least half of respondents indicated privacy was a concern.

Fairness

The qualitative studies and the media stories also framed the mileage-based user-fee system in terms of fairness. Many focus group participants, for example, were concerned that fuel-efficient vehicle owners would pay comparatively more in mileage-based user fees than they were paying under a gas tax system, and less fuel-efficient vehicle owners would pay comparatively less. To these people, a switch from the gas tax to a mileage-based user fee would penalize those who were "doing their part" to protect the environment and reduce greenhouse gas emissions.

Others thought that a mileage-based user fee was fairer than the gas tax because all drivers—including those in fuel-efficient and alternative-fuel vehicles—would pay similar amounts of tax to support roads.

Additional fairness discussions centered on the impact of mileage fees on lower-income drivers, rural drivers, truckers, and commuters, as well as on the opportunities for unethical drivers to cheat the system by avoiding payment. The survey data do not provide clear evidence about which fairness issues are most important but do support the notion that fairness is a serious concern.

Rural drivers, among others, may bear more burden under the mileage fee than they currently do under the gas tax system.

Photo: Lute Alumni/Flickr

Other Reservations

Concerns about administering the mileage fees were widespread in the qualitative studies. The most common worries centered on distrust of the technology and of the government's ability to administer a mileage fee program. Respondents predicted that both would generate billing errors. To a lesser extent, participants also expressed concerns about the cost of the program and the logistics associated with billing in-state drivers who drive out of state or with charging out-of-state drivers who drive in the mileage-fee state.

The media stories and qualitative research revealed several other less prominent concerns. One worry was the loss of the gas tax as a policy tool to incentivize the purchase of fuel-efficient vehicles. Another concern was the challenge households would face in paying a mileage fee bill charged periodically in large amounts—compared with gas taxes, which drivers pay frequently in small amounts.

Mileage fees with a congestion-pricing component were often viewed as unfairly expensive for people with inflexible jobs. Finally, the relative complexity of a mileage fee also emerged as an issue in the media stories and in the focus groups—people would prefer a simplified fee structure.

Raise the Gas Tax

Woven throughout the discussion of most of the concerns was a recurring preference for raising the gas tax instead of implementing a new mileage fee. Participants often maintained not only that the gas tax still performed adequately, but that the gas tax avoided many disadvantages of a mileage fee, such as high administrative costs, privacy concerns, hard-to-pay lump sum amounts, and loss of the cost-saving

Photo: David van der Mark

Under a mileage fee system, those who own electric and fuel-efficient cars, such as this Tesla, would share in the cost of maintaining roads and highways.

incentives for drivers of fuel-efficient vehicles. People also appreciated the simplicity of the gas tax compared with the inherent complexity of even the most straightforward mileage fee system.

Recognizing Benefits

Although the focus groups, media stories, and surveys highlighted concerns about a mileage fee system, the public sometimes saw potential benefits. Some people appreciated that mileage fees would ensure that drivers of electric and fuel-efficient vehicles paid a fair share of road maintenance costs. Further, in the media stories, some people described the mileage fees as possibly solving the problem of funding transportation infrastructure into the future, and others described the fees as a "sustainable" or "innovative" source of revenue.

Research Needs

The findings reported in NCHRP Synthesis 487 point to several useful avenues for research, such as the following:

1. New qualitative and survey research could explore the specific perceptions of populations of special concern, as defined by federal civil rights regulations and guidance documents. These groups are typically low-income and minority residents. Research documenting opinions about mileage fees among these groups is scant, yet their views are an important component in an equity analysis of mileage fees.

2. Survey and qualitative research could explore whether factors influencing support for other transportation revenue options may influence support for mileage fees. Relevant factors may include assessing respondents' prior knowledge about transportation revenue options, educating respondents about current revenue sources and trends, and informing respondents that mileage fee revenues would be dedicated to specific types of transportation programs. This research can help policy makers design and explain mileage fee programs in ways that do not generate unnecessary opposition.

3. A large-sample, longitudinal state or national survey could delve into public opinions about mileage fees. The survey could reveal how specific population subgroups—for example, low income, minority, and rural—perceive mileage fees and could explore a range of topics related to the fees. A longitudinal survey could reveal how public opinion about mileage fees may change in response to changes in the economy, in vehicle technology, and in transportation funding policy.

4. More pilot programs could provide valuable survey and qualitative research opportunities. The survey research indicates that participation in a mileage-fee pilot changes participants' opinions; additional pilot studies could confirm if personal exposure to a mileage fee increases support. Additional pilot programs also would help policy makers predict public reaction to the implementation of a mileage fee.

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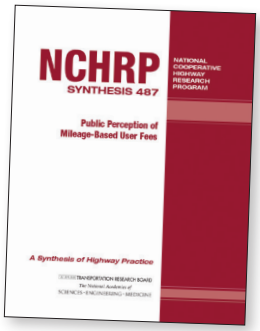

NCHRP Synthesis 487, *Public Perception of Mileage-Based User Fees*, is available from the TRB online bookstore, https://www.mytrb.org/Store/Product.aspx?ID=8068; to view the book online, go to www.trb.org/Publications/Blurbs/173605.aspx.

More information is needed to gauge how specific demographic groups perceive mileage fees, particularly in low-income areas.

Photo: Mattia Pancirolu/Flickr

POINT OF VIEW

The Brave New World of Driverless Cars

The Need for Interdisciplinary Research and Workforce Development

MISSY CUMMINGS

The author is Professor, Department of Mechanical Engineering and Materials Science, Duke University, Durham, North Carolina.

The National Highway Traffic Safety Administration (NHTSA) recently released federal guidelines for manufacturers on the testing and deployment self-driving cars (*1*). Shortly after, the California Department of Motor Vehicles (DMV) released a revised draft of regulations that essentially allowed manufacturers to test cars with no human in the car on public roads, as long as the manufacturers abided by the federal government's 15-step assessment guidelines.[1]

These two developments—along with similar announcements by cities including Boston, Massachusetts; Pittsburgh, Pennsylvania; and Austin, Texas—make clear that driverless cars are a near-term reality. The general public soon will be driving in an environment that includes driverless cars under testing. Theoretically, when these test vehicles generate enough miles to convince state DMVs and NHTSA that driverless cars are safe, then everyday consumers will be able to buy their own driverless cars or to summon a rideshare driverless car.

If driverless cars work as advertised, people with impaired vision or mobility will have new forms of transportation that could change their lives; moreover, the approximately 38,000 annual fatalities caused by driver error could be reduced significantly. These are laudable goals.

[1] https://www.dmv.ca.gov/portal/wcm/connect/211897ae-c58a-4f28-a2b7-03cbe213e51d/avexpressterms_93016.pdf?MOD=AJPERES.

PHOTO: WAYMO.COM

Self-driving vehicles offer new travel possibilities for people with physical impairments. Steve Mahan, former director of the Santa Clara Valley Blind Center, was the first nonemployee to test Google's self-driving car alone on public roads.

Nevertheless, these claims of benefits should be interpreted in the context of the significant amount of money being poured into this industry. Global automotive research and development expenditures are estimated at $94.2 billion for 2016—more than three times the 2016 global expenditures on aerospace and defense (*2*).

Ready for Deployment?

Industry generally and optimistically predicts that driverless cars will be ready for widespread deployment sometime between 2018 and 2025.[2] Two recent fatalities of drivers of Tesla vehicles, one in China and one in the United States, however, have highlighted the complexities and frailties of semiautonomous systems. Both drivers were using a feature known as Autopilot. These fatalities, as well as other related accidents, call into question the capabilities of the systems and the lack of a process for testing and certification.

[2] www.driverless-future.com/?page_id=384.

PHOTO: KARLA LOPEZ/FLICKR

Google's fully automated car draws an interested crowd. New guidelines open the way for states to allow driverless cars on public roads.

In the Tesla fatality in China, a driver in Autopilot mode slammed into the back of a street cleaner on a highway. Five months later, a Tesla driver, also in Autopilot mode, was killed in Florida when the car's technology failed to detect a tractor trailer turning ahead, and the car, traveling at 74 mph, hit the truck broadside.[3]

Tesla maintains that both drivers were at fault for not paying attention to Autopilot, technically a "driver assist" technology in a car that is not intended to be fully autonomous. Apparently the drivers did not understand this nuance—perhaps they were misled by the name Autopilot. Similar examples of "mode confusion" are well known in aviation and will only increase as automation becomes more prevalent in cars.

These two fatalities highlight several issues raised before the Senate Commerce Committee in March 2016—namely that the entry of driverless cars into the market may reveal many unknowns, but in the meanwhile, manufacturers are failing to address many problems that are known (3). For example, Tesla knew about the inability of Autopilot to detect static objects on highways, and the owner's manual warned drivers that the car may not brake for stationary vehicles, especially when the car is driving faster than 50 mph.[4] A significant flaw in the car's perception system—that is, how the car "sees" the world—and the lack of transparency to the drivers led to these two fatalities, and these are problems not easily solved.

[3] www.nytimes.com/2016/09/15/business/fatal-tesla-crash-in-china-involved-autopilot-government-tv-says.html.

[4] http://money.cnn.com/2016/07/07/technology/tesla-autopilot-name.

Photo: Nissan

Researchers and engineers at Nissan work to design technology capable of managing complex driving situations.

Sensors and Postprocessing

The sensors that help driverless cars see can include some combination of radar, lidar or light detection and ranging, computer vision, and ultrasound devices. No single technology can provide complete coverage; because some combination of these sensors must be used, a complex data fusion is required. Moreover, each of these sensors has known limitations, as illustrated by the Tesla fatalities; notably, inclement weather—fog, rain, and snow—has presented problems.

The postprocessing of the data gathered by the sensors requires significant estimating and pattern matching, often referred to as machine learning. As a result, when an expected driving scene does not match the scene observed by the sensors—which may themselves be flawed—an autonomous car may

Photo: Jeroen Mirck/Flickr

Recent crashes have reinforced the understanding that autopilot systems still require driver intervention in certain driving conditions.

Photo: Melody Joy Kramer

Even small traffic incidents can create large safety problems for driverless car companies.

not be able to reason accurately about the world around it and determine the correct next actions in the required time.

These sensor and postprocessing difficulties are widely known in automotive robotics and in all robotics industries that rely on these technologies—including unmanned aerial vehicles or drones, manufacturing robots, and medical robotics. Significant academic and industry research efforts are under way to improve these technologies and processes; however, substantially fewer efforts are developing test strategies to ensure that these stochastic systems work not only in expected driving conditions but also in the boundary conditions in which catastrophic failures occur.

Because driverless cars strongly rely on pattern recognition and probabilistic reasoning, the test strategies that were used for deterministic systems do not work. Because these stochastic systems have embedded complexities, the cars cannot compute a solution to a four-way intersection the same way each time, for example. For driverless cars and for many unmanned systems, an industrywide consensus is lacking on how to test such probabilistic systems to guarantee some level of safety.

Assessing Safety

Driverless car companies have generated a "miles driven" metric to assure safety. RAND Corporation has stated that driverless cars must drive 275 million miles without a fatality to prove that these cars are as safe as human drivers, at a 95 percent confidence level (*4*). Tesla logged 130 million miles before the U.S. fatality—the most of any company—falling significantly short of the RAND Corporation metric.

Miles driven is not an acceptable solution for demonstrating that a technology is safe for public roads, especially when the numbers are generated in sunny climates with white lines clearly visible on well-maintained highways. Tests should challenge the stochastic reasoning of these autonomous systems, as well as the responses of the cars in the corner cases—the worst possible scenarios the cars could encounter—including snow, ice, fog, environments dense with pedestrian and bicyclist traffic, and unexpected maneuvers from other cars.

NHTSA's guidelines lay out a 15-point plan for states to follow in assessing whether driverless car technology is ready for use on public roads (*1*). This assessment plan only addresses high-level areas of concern, such as privacy, system safety, and object and event detection and response. The NHTSA plan does not offer guidance or assistance on assessing each of the 15 areas, leaving each state to interpret and perform its own evaluations, which no doubt will vary widely.

The evaluation of driverless cars is extremely difficult and requires engineers who are experts in both the hardware and the software, as well as in artificial intelligence. In its guidelines, NHTSA admits its lack of staff qualified to make the assessments and suggests that it may develop a network of experts for help in understanding the issues.

No other plans are under way, however, to centralize or to disseminate expert knowledge at either the federal or state level. As a result, state governments will be expected to acquire the expertise to assess the validity and comprehensiveness of driverless car test plans in a short time, despite the lack of commonly accepted standards or a consensus on how to conduct such testing. Because the testing and evaluation of autonomous systems is a nascent field with little foundational research, either theoretical or empirical, the expectation that state governments can do what researchers have not yet demonstrated is a tall order.

Photo: Nissan

The ability to drive a car remotely raises questions about the responsibility of informing those on the road at the same time.

Informed Consent

Without a principled approach to the testing of autonomous systems, the implications for the general public are not clear. California soon will allow tests of driverless cars on public roads, with a remote operator monitoring the system. This raises the important issue of informed consent for the public. Although NHTSA's 15-point plan sanctions such tests, the guidelines do

not address the applicability of the federal regulation mandating that all humans involved in an experiment should explicitly give their consent.[5]

Should drivers be given the option to share the road with one or more driverless vehicles undergoing testing, especially without safety monitors? These cars have no established minimum safety standards, and the state evaluators who would determine road worthiness and public safety are not likely to have the appropriate background to make the judgment. At a minimum, discussion is warranted about clearly marking the driverless cars that are undergoing testing, so that drivers who are sharing the road have some understanding of the test environment for which they did not volunteer.

Areas for Research

What do these issues mean to the research community? The promise and potential benefits of driverless cars will be transformative, but further research and development is needed as the rush to deploy driverless car technology has outpaced the technical underpinnings. Significantly more research is needed in a range of areas, including sensor development, artificial intelligence and machine learning, the testing and evaluation of autonomous systems, and the legal, ethical, and public policy implications of driverless cars.

More interdisciplinary work is needed across these fields to communicate the capabilities and limitations of these probabilistic systems. For example, more work is needed in explainable artificial intelligence, to understand the best ways of communicating the outcomes of machine learning algorithms to researchers and policy makers. The Tesla fatalities highlight the gap between the engineers who design complex systems and human users who do not understand the systems.

Human–robot interaction is another major area for research to ensure that reciprocal intent is communicated effectively between all entities within the sociotechnical systems of driverless cars—including the cars, the human operators, pedestrians, bicyclists, and others. Broader sociotechnical questions include the effects on public transportation, the fuel types and requirements of the vehicles, and the effects of projected demand on air quality and congestion.

Educating a Workforce

Universities and colleges need to increase the numbers of students entering these fields—the demand exceeds the supply of electrical, mechanical, and computer engineering students and of software developers, who are the core of the driverless car community (5). The growing sociotechnical issues call for the development of programs that address the interdisciplinary aspects of driverless cars—government and industry badly need graduates with that knowledge and expertise. Universities must adapt to these increasing demands, as must government agencies and the foundations that provide scholarships and incentives for relevant new programs.

Educating a multidisciplinary robotics workforce is critical both in the United States and worldwide; driverless cars represent only one rapidly growing robotics industry. Commercial drones, manufacturing robotics, medicine, and other industries attempting to introduce more autonomous operations are competing for the same people, and the chokepoint currently resides in higher education.

PHOTO: NISSAN

Engineers at a Nissan automated technology testing center. The demand for qualified employees in the industry is growing.

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[5] *Code of Federal Regulations*, Title 45, Part 46: Protection of Human Subjects. https://www.hhs.gov/ohrp/regulations-and-policy/regulations/45-cfr-46/.

POINT OF VIEW presents opinions of contributing authors on transportation issues. Readers are encouraged to comment in a letter to the editor on the issues and opinions presented.

Janet L. D'Ignazio

ICF International

At ICF International, Janet L. D'Ignazio has led a transportation practice supporting federal, state, and local agencies and private firms in issues related to transportation and the environment: climate change, air quality, improved project delivery, integrated planning, and transportation demand management. In her approximately 40 years working for and alongside transportation agencies, D'Ignazio is a process expert with expertise in redesigning and implementing transportation processes to achieve streamlined project delivery, collaboration, customer focus, and environmental stewardship. She spent 10 years as a planner and transit systems manager at the local level, as well as seven years as a manager responsible for $200 million in state multimodal capital, operating, and regulatory programs, including local transit, intercity passenger bus, rail and ferries, and freight rail.

"Collaboration is a necessary tool for ensuring that decisions are timely and cost-effective and that they meet the needs of our customers."

"Process innovation is an area that is ripe for exploration," D'Ignazio notes. "The myriad of overlapping, sometimes even conflicting, requirements with roots in multiple federal and state laws have led to processes that are inefficient and frustrating. A research agenda in which our processes can be questioned, analyzed, adjusted, or even discarded and rebuilt is essential for the transportation industry to respond to the fast-paced changes of the 21st century."

D'Ignazio has served in leadership positions at two state departments of transportation (DOTs). As the chief planning and environmental officer at North Carolina DOT from 1998 to 2003, she led the planning, programming, environmental review, and permitting activities for the state's $1 billion annual transportation improvement program; helped develop strategic plans for the agency; established benchmarks and performance measures; facilitated major organizational changes; and more. She also has guided many initiatives to streamline project delivery for surface transportation projects, including innovative approaches to environmental mitigation and integrating planning with requirements of the National Environmental Policy Act (NEPA) and Section 401 of the Clean Water Act. For these initiatives, North Carolina DOT received an Environmental Excellence Award from the Federal Highway Administration and a Best Practices in Environmental Leadership Award from the American Association of State Highway and Transportation Officials. D'Ignazio also helped lead the early development of the Ecosystem Enhancement Program, an award-winning, multiagency state and federal partnership providing ecosystem-based mitigation for transportation projects.

"One of the driving values of my professional career has been the value to the customer," D'Ignazio comments. "What can we do as an agency to improve the services and projects that we are providing?"

From 1987 to 1998, D'Ignazio served as Assistant Deputy Director for Public Transportation and Chief Quality Officer at Michigan DOT. She spearheaded the effort to launch Transportation Service Centers—satellite centers that acquainted communities with Michigan DOT processes and functions. She also participated in strategies to maintain customer service and project delivery while meeting cost-containment goals—for example, through targeted high-benefit, quick-response process improvements; elimination of processes or services that added only minimal value; and a comprehensive assessment of approval paths.

D'Ignazio observes that collaboration is another driving theme of her career. "Complex processes are rarely owned by a single functional organization or agency; they are complex because they cross organizational units, disciplines, and responsibilities," she notes. "Collaboration is a necessary tool for ensuring that decisions are timely and cost-effective and that they meet the needs of our customers."

D'Ignazio received a bachelor's degree in political science from Brown University and a master's in regional planning from the University of North Carolina, Chapel Hill. Early in her career, she served as a transportation planner and as an assistant to the general manager for the Town of Chapel Hill and as an assistant general manager at ATE Management & Services, Inc. She also was a senior research fellow at the North Carolina State University Center for Transportation and the Environment from 2003 to 2006.

"Research helps explore how the theory and principles of collaborative decision making can be applied to the regulated and technically driven decision making involved in building transportation infrastructure," she comments.

At TRB, D'Ignazio is a member of the Task Force on Data for Decisions and Performance Measures. She has served on many Cooperative Research Program project panels, such as a Transit Cooperative Research Program panel on the Cost-Effectiveness of Transportation Demand Management Strategies and a National Cooperative Highway Research Program panel on Detailed Planning for Research on Providing Highway Capacity in Support of the Nation's Economic, Environmental, and Social Goals. She also has served on the standing committees on Strategic Management and on Statewide Multimodal Transportation Planning.

Implementing Sustainability Research Saves Illinois Tollway More Than $200 Million

STEVEN GILLEN

The author is Deputy Program Manager of Materials, Illinois State Toll Highway Authority, Downers Grove.

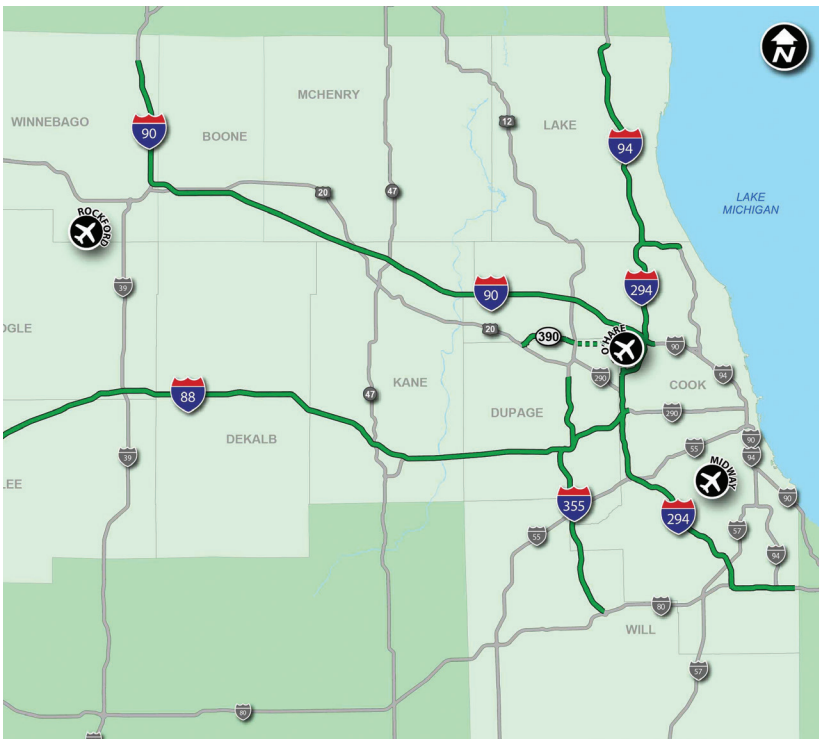
The Illinois Tollway has steadily increased the implementation of research findings over the past 12 years, producing new standards and policies for pavements, materials, and recycling. The tollway recently reviewed the documentation of construction costs and found that the adoption of more innovative and sustainable material specifications saved an estimated $218.5 million between 2004 and the start of 2016. Normalized to 2015 dollar values, the cost savings demonstrate that sustainable recycling of aggregate, asphalt, and concrete materials have yielded substantial economic benefits, in addition to environmental and social benefits.

Aggregates

In 2004, approximately $9 billion of an $18-billion, 25-year capital program were allocated to reconstruct and expand much of the Illinois Tollway (see Figure 1, below). Before then, the tollway did not use cost-efficient methods to reprocess pavements into recycled aggregates, although other agencies had developed and successfully implemented on-site processing techniques and concrete pavement rubblization (*1*).

The Illinois Tollway rubblized nearly 32 miles of concrete pavement in place along the Interstate 88 (I-88) extension for reuse as the new base for an asphalt pavement. Compared with the cost of totally reconstructing the mainline roadway, the cost of this strategy saved the tollway approximately $29.5 million. The Illinois Tollway's program management organization, HNTB, confirmed that the remainder of the capital projects saved an estimated $83.5 million through 2015 by recycling all pavements into the new bases of the reconstructed and widened roadways.

FIGURE 1 Illinois Tollway system map.



Asphalt

After realizing the economic benefits of adopting new initiatives for recycling or improving sustainability through aggregate production, the Illinois Tollway began investigating how similar savings could be achieved with more sustainable asphalt materials without sacrificing performance or durability. Through several consulting engineer contracts, starting in 2006, researchers performed tasks and reported the results; these activities evolved into an Illinois Tollway–sponsored research program in 2009, which established direct agreements with university research teams to produce formal studies (*2*).

Ground Tire Rubber–Modified Asphalt Binder

In 2006, the Illinois Tollway joined a task force initiated by the Cook County Highway Department to field-test high-performance stone matrix asphalt (SMA) mixes with asphalt binder modified at the asphalt terminal to include shredded scrap tires at up to 12 percent of the mix. The mix samples were evaluated for long-term performance.

Results showed that the expected life of SMA mixes modified with ground tire rubber (GTR) would be equivalent to that of the standard polymer-modified SMA mixes used by the Illinois Department of

Transportation (DOT). Moreover, the mixes could be produced without the cellulose fibers needed to minimize the draindown or surface flushing of asphalt binder. Samuel Carpenter of the University of Illinois performed the informal research task.

GTR-modified SMA mixes save an estimated $7.50 per ton by eliminating the need for fiber reinforcement. This equates to a savings of $2.2 million for the 300,000 tons of SMA the Illinois Tollway produced from 2008 to 2011. The two choices for modified asphalt in SMA mixes allow for more competitive bidding on the Illinois Tollway's SMA overlay projects and may reduce bid prices while maintaining product quality.

Fractionated Reclaimed Asphalt Pavement

The Illinois Tollway began investigating fractionated reclaimed asphalt pavement (FRAP) through research at the University of Illinois in 2007. Researchers found that asphalt mixes could contain an average of 15 percent more RAP with fractionation and that the pavement would have the same high performance as RAP mixes used by the tollway and by Illinois DOT (*3*). The increased FRAP reduced the costs of the asphalt mixes by $10 to $15 per ton.

A reconstruction and widening project placed approximately 800,000 tons of high-FRAP asphalt mixes on the Jane Addams Memorial Tollway (I-90–I-39) in 2008 and 2009, with an estimated cost savings of $10 million. These levels of savings have continued after implementing higher quantities of FRAP.

Recycled Asphalt Shingles

In 2009, with the help of a grant from the U.S. Environmental Protection Agency, the Illinois Tollway teamed with Iowa State University and the University of Illinois to study the combination of recycled asphalt shingles (RAS) with high FRAP in shoulder mixes (*4*). The up to 5 percent RAS allowable in asphalt mixes can reduce the need for virgin asphalt binder by approximately 20 percent.

The same year, a project placed polymer-modified SMA mixes that used RAS as a fiber substitute on I-90–I-39, and the University of Illinois conducted performance tests on the pavement (*5*). In 2010, the University of Illinois studied SMA mixes modified with increased FRAP and RAS content and with high levels of asphalt binder replacement, using a variety of warm-mix asphalt processes. The results from all studies confirmed the long-term durability of asphalt mixes with properly processed RAS (*6*).

The Illinois Tollway now permits RAS in all asphalt mixes at levels up to 5 percent. The savings with RAS depend on the asphalt mix but are estimated at $5 to $15 per ton. Approximately 2.6 million tons of asphalt mixes with RAS were produced etween 2010 and 2015, yielding a savings of around $21 million.

Photo: Illinois Tollway

Long windrow of recycled material awaiting reuse on I-88.

The University of Illinois recently completed a study evaluating field core samples of aged SMA mixes from the tollway system. The findings confirmed that high levels of asphalt binder replacement with RAS and FRAP in high-performance SMA mixes do not reduce durability when the by-product materials are properly processed (*7*).

By implementing these asphalt-related initiatives, the Illinois Tollway increased the use of recycled materials and reduced the use of liquid asphalt, virgin aggregates, and fiber reinforcement in all asphalt mix designs without compromising quality. These changes in the asphalt mix designs resulted in savings of $74 million dollars for the tollway from 2007 through 2015.

Concrete

Project R-21 of the second Strategic Highway Research Program produced tools and technologies for composite pavement systems (*8*). Building on these and on research at the University of Illinois, the Illinois Tollway developed specifications for composite two-lift concrete pavement to rebuild the west-end I-90 pavements with higher levels of recycled aggregate and supplementary cementitious materials (SCM) from waste sources (*9, 10*). The two-lift jointed plain concrete pavement (JPCP) on I-90 reduced unit prices significantly, compared with prices for other recent tollway projects that used JPCP. The estimated cost savings for more than 1 million square yards of two-lift JPCP on I-90 in 2013 and 2014 was approximately $23.5 million.

Additional informal research through the laboratories of the CTL Group led to increasing the amounts of SCM in mixes with optimized aggregate gradations; this has improved the sustainability of concrete mixes for standard pavement designs and has reduced bid prices. For the 841,205 square yards of 13-inch JPCP built on I-90 in 2015, the tollway calculated a total savings of approximately $8 million from the new standards and policies.

Looking Ahead

By putting sustainability research into practice, the Illinois Tollway has saved more than $200 million in the past 12 years (see Table 1, above right) and expects to save hundreds of millions of dollars more. Ongoing initiatives include warm-mix asphalt for most Illinois Tollway asphalt mixes, the development and application of precast concrete pavements and durable high-early-strength concrete patching mixes, the reengineering of the design for continuously reinforced concrete pavements, and the development of standards and policies for accelerated bridge construction. These initiatives do not have large up-front cost savings but are expected to yield substantial life-cycle savings by reducing maintenance needs and extending the service life of bridges and pavements.

TABLE 1 Estimated Cost Savings, by Materials

Applications	Years	Total Cost Savings
Aggregate	2004–2015	$113,000,000
Asphalt	2007–2015	$74,000,000
Concrete	2013–2016	$31,500,000
Total approximate savings		$218,500,000

For more information, contact Steven Gillen, Illinois State Toll Highway Authority, 2700 Ogden Avenue, Downers Grove, IL 60515; 630-241-6800; sgillen@getipass.com.

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EDITOR'S NOTE: Appreciation is expressed to Nancy M. Whiting, Transportation Research Board, for her efforts in developing this article.

Suggestions for Research Pays Off topics are welcome. Contact Stephen Maher, Transportation Research Board, Keck 486, 500 Fifth Street, NW, Washington, DC 20001; 202-334-2955; smaher@nas.edu.

Building Smart Communities for the Future

Research Roundtable Conducts Workshop

MEGAN NICHOLSON

The author is Associate Program Officer, Government–University–Industry Research Roundtable, Policy and Global Affairs, National Academies of Sciences, Engineering, and Medicine, Washington, D.C.

More than half the world's population lives in urban areas, and the United Nations has projected that will reach 70 percent by 2050. The global trend of rapid urbanization, coupled with shifting demographics and disruptive technological change, has prompted many countries to plan for smart cities and communities—urban centers that use intelligent, connected devices and automated systems to maximize the allocation of resources and the efficiency of services.

The Government–University–Industry Research Roundtable (GUIRR) of the Policy and Global Affairs division of the National Academies of Sciences, Engineering, and Medicine held a meeting June 21–22, 2016, to explore connectedness and sustainability in developing smart communities. The workshop identified the challenges and opportunities associated with the rollout of intelligent systems and the partnerships between governments, universities, and industry that are integral to these advances.[1]

Carlo Ratti, director of the SENSEable City Lab, Massachusetts Institute of Technology (MIT), delivered the keynote address. "The Internet has entered physical space—becoming the Internet of Things—and it is changing the way we interface with the space around us," he observed. "Through networks and sensors, we can understand the city in a different way and respond....By 2020, the number of connected devices is expected to grow to 50 billion, ... producing a massive amount of data in our cities...."

[1] For a report in brief on the workshop proceedings, visit https://www.nap.edu/catalog/23663/building-smart-communities-for-the-future-proceedings-of-a-workshop.

Photo: Sara Frueh, NASEM ONPI

Keynote speaker Carlo Ratti: using networks and sensors to understand the city in a different way.

As an example, Ratti noted that any two points in Manhattan are connected by hundreds of thousands of car trips in a year. The MIT lab determined that ridesharing could get people to their destinations on time and could cut the vehicle fleet by 40 percent. If every shared car removes a car from the streets, the result would be less congestion and fewer emissions.

Many cities are considering the opportunities and risks of deploying the Internet of Things on a large scale to improve services, but urban centers cannot do the work alone. Benjamin Levine, director of the MetroLab Network, described how his organization connects city and university partners: "Cities have challenges ... such as inequality and problems with the built environment. Universities [can function] almost as R&D departments for city governments. In return, cities function as test beds, letting universities learn more about how technologies work."

Jonathan Fink, Vice President for Research and Strategic Partnerships at Portland State University, explained that Portland's projects focus on improving communities' access to technology and economic opportunities via transit corridors. One corridor, which includes one of the poorest and most diverse neighborhoods, will have a bus rapid transit line within four years connecting to the downtown. Sensors deployed before, during, and after construction will help assess the impact.

Fink noted that the Obama Administration's Smart City Challenge "advanced Portland's progress on transportation issues by five years. It has been

Portland transit bus downtown. Sensors are being deployed to assess the impact of a bus rapid transit line connecting an impoverished corridor to the downtown.

transformative, and we'd like to see more of these challenge grants."

Industry also is playing a critical role in the development of smart communities. Sameer Sharma, general manager of Intel's Smart Cities Initiative, identified ways for companies and partners to deploy Internet of Things devices and to communicate with each other. He considers smart cities infrastructure the priority for cross-sector collaboration, noting that cities want to protect critical infrastructure such as roads, bridges, and data centers, to respond quickly to emergencies, and to achieve resilience of services.

Andrew Turner, chief technology officer at Esri R&D Center, explained his company's use of geography and geospatial mapping to help cities achieve resiliency while prioritizing sustainability. Turner and his colleagues are applying a new pattern called geodesign. "Esri wants to make [maps] bidirectional," Turner explained, "so that users not only can look at a map, but also ask questions of the map and of the environment ... using sensors and data."

Esri's Urban Observatory project allows comparisons of 20 themes across 30 cities on common scales. Users can compare the urban footprint, population density, and sprawl; as users zoom in on one city, the maps of other cities adjust to the same scale. In this way, a user can see traffic congestion and the effects of policies across cities. "We're trying to take the technology that's been used by governments for decades and ... provide it as a public digital infrastructure to help the civic population participate," said Turner.

PHOTO: SARA FRUEH, NASEM ONPI

Intel's Sharma: collaborating across sectors to deploy Internet of Things devices for smart cities infrastructure.

John Garrity, former adviser on global technology policy at Cisco, noted, "A lot of work ... has focused on advanced economies and industrialized sectors, but ... the Internet of Things [can] make a difference in low- and middle-income countries and outside urban areas by improving broadband service delivery in peri-urban and rural areas."

Cisco has explored pairing sensors with basic-feature phones—for example, to detect water in an irrigation canal and send a text to the farmer, who then can turn on the microirrigation pump from the phone's keypad. Garrity pointed out several challenges, including the reliability of the devices, power outages, and interoperability.

Digital technology innovation will enable smart cities and communities to develop in response to local challenges. A continued and concerted effort by local and federal governments, universities, and industry to understand the key characteristics of smart communities and to assess their impacts on economic development is needed to inform policy making.

PHOTO: IAGRI TANZANIA, FLICKR

Microirrigation system for a sorghum crop in Tanzania. Pairing sensors with basic-feature phones can assist farmers in monitoring and controlling crops in arid, rural areas.

Forum for Dialogue

The Government–University–Industry Research Roundtable convenes senior representatives from government, universities, and industry to define and explore critical issues of shared interest related to the national and global science and technology agenda; to frame the next critical question stemming from debate and analysis; and to incubate activities of value to stakeholders. For more information, visit www.nas.edu/guirr; to sign up for e-mails, go to sites.nationalacademies.org/PGA/guirr/PGA_082113.

IN MEMORIAM

Herbert S. Levinson, 1925–2017

Herbert S. Levinson, a global leader in transportation planning and design, a member of the National Academy of Engineering, and a past member of the Transportation Research Board (TRB) Executive Committee, passed away February 17, 2017. He was 92.

In his nearly 70-year career, Levinson wrote more than 200 technical articles, research papers, and books; TRB published more than 30 of these, including a recent article he coauthored for *TR News* on bus rapid transit (*TR News* 303, May–June 2016). His books and papers have been cited by transportation and engineering researchers and policy makers, and his research and writing contributed significantly to the development of the *Transit Capacity and Quality of Service Manual*, a seminal work that has evolved through three editions and has gained adoption and adaptation by transit services in other nations.

Levinson served on many TRB committees, notably as chair of the Standing Committee on Bus Transit Systems; he was named an emeritus member of the Standing Committees on Access Management and on Transit Capacity and Quality of Service. He was a member of the Committee for an International Comparison of National Policies and Expectations Affecting Public Transit, which produced the 2001 policy study, *Making Transit Work: Insight from Western Europe, Canada, and the United States* (TRB Special Report 257).

Levinson's work on the Pennsylvania Avenue Development Corporation Team in Washington, D.C., earned him the Presidential Design Award for Excellence in 1994, and in 1997, TRB honored him with the Roy W. Crum Distinguished Service Award for his outstanding contributions to transportation planning and traffic engineering. The National Academies of Sciences, Engineering, and Medicine named him a National Associate in recognition of his extraordinary pro bono service to the Academies.

Levinson spent much of his career teaching professionals, students, and young faculty at Yale University, the University of Connecticut, and the Polytechnic University of New York; most recently he served as Icon Mentor for the Region 2 University Transportation Research Center at the City College of New York. Levinson managed his own consulting firm; his career also included employment by the Chicago Park District and Wilbur Smith Associates.

David G. Burwell, 1947–2017

Cofounder of the Rails-to-Trails Conservancy and longtime advocate for transportation and environmental policy reform David Burwell died on February 1 after a three-year battle with leukemia. Burwell served as the first environmental representative on the Transportation Research Board (TRB) Executive Committee, from 1992 to 1998, and chaired the Task Force on Transportation and Sustainability from 2002 until 2005, among many other TRB volunteer leadership roles.

Burwell worked to preserve green spaces, communities, and history while providing sustainable transportation solutions. His mother's work in creating the Shining Sea Bikeway, a rail–trail on Cape Cod, helped spark Burwell's interest in using public policy and federal highway funds to expand projects beyond paved roads. In 1986, he cofounded the Rails-to-Trails Conservancy, an organization that works with the National Park Service to convert abandoned railroad tracks into biking and hiking paths. The conservancy has built more than 22,000 miles of trails on rail corridors in all 50 states and the District of Columbia.

Burwell earned his bachelor's degree in government from Dartmouth College and a law degree from the University of Virginia. He practiced law in Massachusetts and Vermont before moving to Washington, D.C., as director of transportation and infrastructure at the National Wildlife Federation.

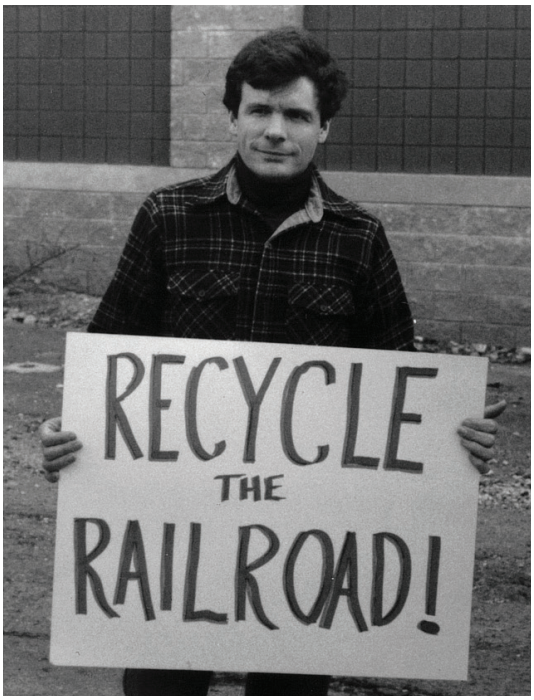


Photo: Carol Parker, Rails-to-Trails Conservancy

David Burwell on the Capital Crescent Trail, Washington, D.C., 1986.

CALENDAR

TRB Meetings

May

17–18 Innovations in Freight Data Workshop
Irvine, California

21–24 5th Urban Street Symposium*
Raleigh, North Carolina

June

4–6 1st World Transport Convention*
Beijing, China

4–8 3rd North American Symposium on Landslides*
Roanoke, Virginia

8–9 6th International Symposium on Naturalistic Driving Research*
The Hague, Netherlands

9–12 International Conference on Transportation Infrastructure and Materials*
Qingdao, China

12–15 1st International Roadside Safety Conference: Safer Roads, Saving Lives, Saving Money
San Francisco, California

12–16 World Conference on Pavement and Asset Management*
Baveno, Italy

14–17 Workshop on Future *Highway Capacity Manual* Updates
Minneapolis, Minnesota

28–30 10th International Conference on the Bearing Capacity of Roads, Railways, and Airfields*
Athens, Greece

July

6–7 3rd International Symposium on Transportation Soil Engineering in Cold Regions
Guide, Qinghai, China

11–13 Automated Vehicles Symposium*
San Francisco, California

15–19 GeoMEast International Conference: Innovative Infrastructure Geotechnology*
Sharm El-Sheikh, Egypt

16–18 International Bridge, Tunnel, and Turnpike Association–TRB Joint Symposium on Managed Lanes and All-Electronic Tolling*
Dallas, Texas

19–21 Maintenance and Rehabilitation of Constructed Infrastructure Facilities*
Seoul, South Korea

23–26 Transportation-Related Noise and Vibration Committee Summer Conference
Minneapolis, Minnesota

24–26 22nd International Symposium on Transportation and Traffic Theory*
Evanston, Illinois

27–28 8th International Visualization in Transportation Symposium: Visualization in Action
Washington, D.C.

30–Aug. 2 56th Annual Workshop on Transportation Law
Salt Lake City, Utah

TBD Historic and Archeological Preservation in Transportation Committee Summer Conference
Minneapolis, Minnesota

TBD Resource Conservation and Recovery Summer Conference
Duluth, Minnesota

August

21–22 9th New York City Bridge Conference*
New York, New York

22–25 16th Biennial Asilomar Conference on Transportation and Energy*
Pacific Grove, California

27 American Society of Civil Engineers International Conference on Highway and Airfield Technology
Philadelphia, Pennsylvania

September

6–8 Transit Geographic Information Systems Conference
Washington, D.C.

11–13 2nd TRB Conference on Transportation Needs of National Parks and Public Lands: Partnerships for Enhancing Stewardship and Mobility
Washington, D.C.

26–27 11th University Transportation Centers Spotlight Conference: Rebuilding and Retrofitting the Transportation Infrastructure
Washington, D.C.

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

*TRB is cosponsor of the meeting.

Photo: Paul, Flickr

The Tesla Roadster Sport advertised an impressive 245-mile range on battery power; some current models boast well over 300-mile ranges.

Plug-In Electric Vehicles Gain Consumer Interest

According to a survey from the National Renewable Energy Laboratory, nearly 46 percent of consumers consider plug-in hybrid electric vehicles (PHEVs) to be equal to or better than traditional gasoline vehicles. Slightly fewer (41 percent) stated that all-electric vehicles were as good as, or better than, traditional gasoline vehicles. Forty-six percent of respondents could name a specific plug-in electric vehicle (PEV) by make and model, and 43 percent had seen a PEV in a parking lot.

Nearly one-quarter of respondents expected to buy or lease a PHEV for their next vehicle; 19 percent stated they would consider an all-electric vehicle for their next vehicle purchase or lease.

A major barrier to all-electric vehicle acceptance is the length of a charge—nearly half of respondents said they would consider buying a PHEV if the vehicle could travel 300 miles on a single charge. Only one-fifth of respondents knew the locations of charging stations on their daily travel routes; these respondents tended to view PEVs more positively and were more likely to consider purchase. Respondents under age 35 also viewed PEVs more positively than those in other age groups.

For more information, visit www.afdc.energy.gov/uploads/publication/consumer_views_pev_benchmark_2nd_ed.pdf.

U.S. Bikeshare Trips Multiply in 2016

More than 88 million bikeshare rides have been taken since 2010, when the first bikeshare systems were established, according to the first-ever nationwide count of bikeshare rides in the United States, released by the National Association of City Transportation Officials (NACTO).

Of the 28 million trips taken, 85 percent occurred in five large cities, confirming research that shows the importance of station density in bike sharing. The proliferation of smart bike systems has allowed greater flexibility in pickup and return, increasing low-cost transportation options and opportunities, as well as saving time.

Cities like Chicago, Illinois, and Philadelphia, Pennsylvania, offer income-based subsidies, providing more transportation and commuting options to people of all income levels. With an increasing network of protected bike lanes, bikeshare systems are not only becoming more affordable but also safer.

To read the full report, visit NACTO's Bike Share Ridership Data at www.nacto.org/bike-share-statistics-2016/.

Photo: Richard Masoner, Flickr

Cyclists in San José take advantage of Bay Area Bike Share's expanding city availability.

PHOTO: PELOTON TECHNOLOGY

Companies such as Peloton are developing and testing automated technology that allows trucks to travel faster and closer together, improving lane capacity, emissions, and gas usage.

Truck Platooning Demo at Port of Los Angeles

Government and private industry partners in California conducted a demonstration in March of partially automated truck platooning, deploying cooperative adaptive cruise control (CACC), technology designed to enhance safety, increase capacity, and reduce greenhouse gas emissions.

Developed by the University of California, Berkeley, Partners for Advanced Transportation Technology (PATH) in coordination with Volvo Group of North America, CACC allows groups of freight trucks to drive in closer proximity than usual by using forward-looking sensors and vehicle-to-vehicle communication to control speed and separation of the vehicles. This platooning reduces brake reaction time and aerodynamic drag between vehicles, improving safety and fuel economy.

Platooning also boosts highway capacity. Simulations suggest that vehicles traveling close together may eventually facilitate an increase of up to 50 percent more trucks, essentially equivalent to adding an extra lane of freeway.

The demonstrations simulated real world experiences similar to transport routes between the port and industrial centers throughout Los Angeles County, including staged-vehicle cut-ins. Truck drivers expressed optimism but noted the need to override the system until side sensors are added and to build better understanding and trust between the platoon drivers.

PATH will conduct more tests this spring in the Bay Area and along the Interstate 710 corridor. Eight other states are also working to allow testing of driver-assistive truck platooning on their highways this year.

To view the full news release, visit Port of Los Angeles News at www.portoflosangeles.org/newsroom/2017_releases/news_030817_Truck_Platoon_Demo.pdf.

Enhanced Airport Wayfinding for the Visually Impaired

Improved wayfinding and accessibility for blind and visually impaired travelers at airports require communication between service providers and users, as well as shared responsibility, according to a study for the Federal Aviation Administration by the University of Minnesota. Researchers identified the demographics of visually impaired travelers and the wayfinding challenges they face at airports and developed recommendations for enhancing airport terminal accessibility.

Recommendations include guided assistance to ensure that a visually impaired traveler arrives at his or her destination within the airport; relief stations for service animals within the airport's secured zones; design elements such as high-luminance contrast on steps and ramps, glass doors, and signs; maps that incorporate acoustic, tactile, and visual elements; the use of consistent terminology for wayfinding descriptions; and the development of smartphone apps for wayfinding.

For more information, visit www.airporttech.tc.faa.gov/Download/Airport-Safety-Papers-Publications-Detail/dt/Detail/ItemID/572/Indoor-Airport-Wayfinding-for-Blind-and-Visually-Impaired-Travelers.

INTERNATIONAL NEWS

Ridesharing in Automated Vehicles

Acceptance of vehicle automation decreases as the level of automation increases, according to a report from the International Transport Forum. The study analyzes user acceptance of automated vehicles (AVs) for ridesharing, using small-scale demonstrations of AVs, mostly in Europe, and online user opinion surveys.

To replace private vehicle ownership successfully, shared, low-speed, urban AVs must be reliable and safe, always available, and able to go anywhere in any weather, the findings indicate. The vehicles must be clean, comfortable, and safe and must have enhanced privacy features, along with easy access for dependents and their equipment. Collaboration between manufacturers, users, and government agencies will provide citizens with the most suitable AV options for each specific environment, the report concludes.

For more information, visit www.itf-oecd.org/sites/default/files/docs/human-factors-user-requirements-acceptance-ride-sharing.pdf.

Survey Examines Passenger Sensitivity to Travel Costs

Metrolinx, an Ontario government agency partnering with local communities to build Canada's largest transit infrastructure program, is relying on results from a 2016 survey on fare elasticity to help shape projects.

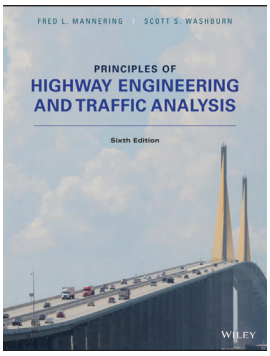
More than 3,500 respondents answered questions about mode of travel, location of travel, and time of travel to determine fare sensitivities in the Greater Toronto and Hamilton Area (GTHA). The survey questions explore fare elasticities for various travel segments, broken down by peak and off-peak periods; trips originating or ending in downtown Toronto, the City of Toronto, or surrounding municipalities; and the mode of travel—rail, automobile, local or regional transit, and cycling. The results have improved forecasts of how specific groups of passengers may respond to changes in price and service.

The survey is the first regional study of its kind in decades and will provide GTHA transit agencies with data to evaluate current and future pricing strategies, service changes, and other projects affecting revenue and ridership.

For more information, contact Reiner Kravis, Reiner.Kravis@metrolinx.com.

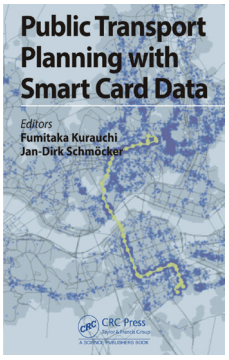
Photo: Dylan Passmore, Flickr

Passengers board a Toronto public transit bus.



Principles of Highway Engineering and Traffic Analysis, 6th Edition
Fred L. Mannering and Scott S. Washburn. Wiley, 2016; 416 pp.; $64; 978-1-119-29933-2.

This best-selling, newly updated volume tackles common highway-related problems, with a focus on highway transportation. New textbook features include practice problems and scenarios related to autonomous vehicles.



Public Transport Planning with Smart Card Data
Fumitaka Kurauchi and Jan-Dirk Schmöcker. CRC Press, 2016; 274 pp.; $179.95; 978-1-498-72658-0.

Smart cards for fare collection are becoming standard in the public transportation networks of large, advanced cities around the world. This volume addresses how passenger behavior can be estimated using smart card data, how these data can be combined with other trip databases, and how transit system service levels can be better evaluated.

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

TRB PUBLICATIONS

Guidelines for Certification and Management of Flexible Rockfall Protection Systems
NCHRP Report 823

Authors offer advice on rockfall fence systems for transportation agencies, outline data needed to evaluate testing results, and present guidelines for asset management for rockfall fence systems.

2016; 31 pp.; TRB affiliates, $34.50; nonaffiliates, $46. Subscriber categories: geotechnology, maintenance and preservation.

Methodology for Estimating the Value of Travel Time Reliability for Truck Freight System Users
NCHRP Report 824

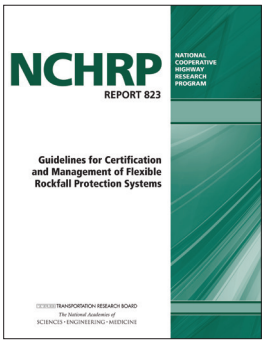
Presented in this volume are a survey methodology and a truck freight reliability valuation model for evaluating proposed highway infrastructure and operations investments, as well as a research approach for a more detailed survey and modeling protocol.

2016; 104 pp.; TRB affiliates, $47.75; nonaffiliates, $61. Subscriber categories: highways, freight transportation, operations and traffic management.

***Planning and Preliminary Engineering Applications Guide to the* Highway Capacity Manual**
NCHRP Report 825

This report will help planners apply the methodologies of the 6th edition of the *Highway Capacity Manual* (HCM) to common planning and preliminary engineering analyses, including scenario planning and system performance monitoring. Three case studies—a freeway master plan, an arterial bus rapid transit analysis, and a long-range transportation plan analysis—illustrate the techniques presented.

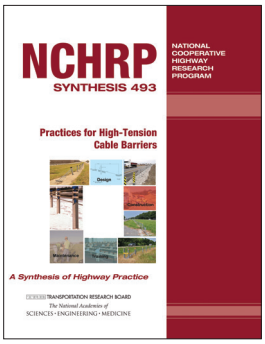
2016; 259 pp.; TRB affiliates, $63; nonaffiliates, $84. Subscriber categories: planning and forecasting.



Practices for High-Tension Cable Barriers
NCHRP Synthesis 493

Explored in this volume is the current state of the practice for high-tension cable barrier systems (HTCB) used in the medians of access-controlled roadways in the United States. Because of the proprietary nature of the systems, information also was obtained from each of the HTCB manufacturers.

2016; 53 pp.; TRB affiliates, $36; nonaffiliates, $48. Subscriber categories: bridges and other structures, construction, highways, maintenance and preservation.



Life-Cycle Cost Analysis for Management of Highway Assets
NCHRP Synthesis 494

With a literature review, survey, and case studies, this report documents the state of the practice of life-cycle cost analysis and risk-based analysis into state highway agencies' asset management plans for pavements and bridges on the National Highway System.

2016; 35 pp.; TRB affiliates, $34.50; nonaffiliates, $46. Subscriber categories: finance, highways, hydraulics and hydrology.

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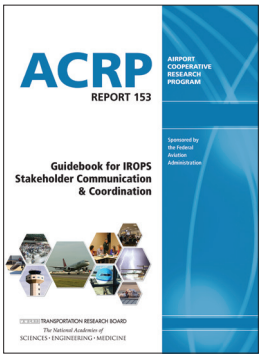

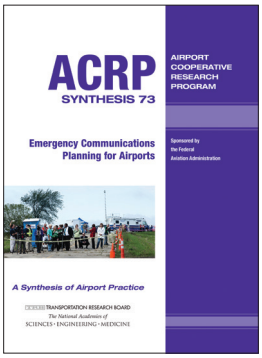

Guidebook for IROPS Stakeholder Communication and Coordination
ACRP Report 153

This guidebook provides details on strategies and tools for reducing the impacts of irregular operations (IROPS) on passengers and can assist communication and coordination as airports and airlines implement IROPS contingency plans. A spreadsheet tool accompanies the report.

2016; 234 pp.; TRB affiliates, $60.75; nonaffiliates, $81. Subscriber categories: aviation, operations and traffic management, safety and human factors.

Water Efficiency Management Strategies for Airports
ACRP Report 154

This guidebook offers tools for airport operators to design and institute a water efficiency management program specific to their facility. Addressed are water management tools and practices used worldwide within and outside of the airport industry; methods for collection, management, and analysis of data relevant to airport water management; and more.

2016; 134 pp.; TRB affiliates, $50.25; nonaffiliates, $67. Subscriber categories: aviation, energy and environment.

Guidebook for Managing Compliance with Federal Regulations: An Integrated Approach
ACRP Report 156

Authors present guidance on managing compliance with federal regulations pertaining to the operation and management of airports. A regulation compliance management tool accompanies the report, comprising an index of applicable statutes, federal regulations, executive orders, U.S. Office of Management and Budget circulars, and other documents.

2016; 64 pp.; TRB affiliates, $38.25; nonaffiliates, $51. Subscriber category: aviation.

Emergency Communications Planning for Airports
ACRP Synthesis 73

This synthesis explores emergency communications planning and is specifically designed for use by airport senior management, public information officers, first responders, and emergency managers.

2016; 87 pp.; TRB affiliates, $45.75; nonaffiliates, $61. Subscriber categories: aviation, security and emergencies.

Combining Mixed-Use Flight Operations Safely at Airports
ACRP Synthesis 74

This synthesis documents practices in safely accommodating mixed-use aeronautical activity at airports, including gliders, helicopters, ultralight vehicles, skydiving, applications for agriculture and firefighting, and more.

2016; 155 pp.; TRB affiliates, $53.35; nonaffiliates, $71. Subscriber categories: aviation, security and emergencies.

Livable Transit Corridors: Methods, Metrics, and Strategies
TCRP Research Report 187

This handbook defines transit corridor livability and offers a set of methods, metrics, and strategies—framed within a five-step visioning and improvement process—that communities can use to improve livability in their transit corridors.

2016; 142 pp.; TRB affiliates, $50.25; nonaffiliates, $67. Subscriber categories: public transportation, planning and forecasting.

Shared Mobility and the Transformation of Public Transit
TCRP Report 188

This report examines the relationship of public transportation to shared modes, including bikesharing, carsharing, microtransit, and ridesourcing services.

2016; 114 pp.; TRB affiliates, $48; nonaffiliates, $64. Subscriber category: public transportation.

Manual to Improve Rail Transit Safety at Platform–Vehicle and Platform–Guideway Interfaces
TCRP Report 189

The authors provide treatment strategies to prevent incidents and improve safety, focusing on rail transit systems with level or near–level boarding—that is, the vehicle floors are level or near level with the platform.

2017; 91 pp.; TRB affiliates, $50.25; nonaffiliates, $67. Subscriber category: public transportation.

Onboard Camera Applications for Buses
TCRP Synthesis 123

This report explores current technologies, research, and opportunities for use of surveillance systems on buses to improve operations, safety, security, training, and customer satisfaction.

2016; 70 pp.; TRB affiliates, $15; nonaffiliates, $20.

TRB PUBLICATIONS *(continued)*

Subscriber categories: public transportation, safety and human factors, vehicles and equipment.

Planning and Design for Fire and Smoke Incidents in Underground Passenger Rail Systems
TCRP Synthesis 124

This publication addresses planning, design, and operations to address fire and smoke incidents, and identifies current practices including lessons learned, challenges, and gaps in information.

2017; 92 pp.; TRB affiliates, $15; nonaffiliates, $20. Subscriber categories: policy, safety and human factors, society.

Traffic Signal Systems, Volumes 1–2
Transportation Research Records 2557–2558

Topics explored in these volumes include the impact of green light optimized speed advisory on unsignalized side-street traffic, a performance analysis of centralized and distributed systems for urban traffic control, and assessing longitudinal arterial performance and traffic signal retiming outcomes.

2016; Vol. 1: 121 pp.; TRB affiliates, $51; nonaffiliates, $68; Vol. 2: 112 pp.; TRB affiliates, $53.25; nonaffiliates, $71. Subscriber categories: Vol. 1: operations and traffic management, safety and human factors; Vol. 2: operations and traffic management, safety and human factors, public transportation.

Intelligent Transportation Systems and Connected and Automated Vehicles
Transportation Research Record 2559

Authors present research on operational concepts for truck maneuvers with cooperative adaptive cruise control, determining the readiness of automated driving systems for public operation, traffic information systems delivering in-vehicle messages on predefined routes, and more.

2016; 148 pp.; TRB affiliates, $60.75; nonaffiliates, $81. Subscriber categories: operations and traffic management, safety and human factors, vehicles and equipment.

Traffic Flow Theory and Characteristics, Volumes 1–2
Transportation Research Records 2560–2561

These two volumes explore topics such as the effect of modeling on the control of traffic networks, various aspects of large-scale evacuation, integrated simulation of traffic and mobile wireless telecommunication systems, the human factor in traffic flow, and the effect of automated vehicle behavior on arterial and freeway networks.

2016; Vol. 1: 128 pp.; TRB affiliates, $57; nonaffiliates, $76; Vol. 2: 108 pp.; TRB affiliates, $53.25; nonaffiliates, $71. Subscriber categories: Vol. 1: operations and traffic management, planning and forecasting; Vol. 2: operations and traffic management, planning and forecasting.

Traffic Control Devices
Transportation Research Record 2562

The seven papers in this volume examine multiple aspects of traffic control, such as two-way stop-controlled intersections, the effectiveness and placement of rapid-flashing beacons, and the efficiency of marked on-street parking.

2016; 72 pp.; TRB affiliates, $46.50; nonaffiliates, $62. Subscriber categories: operations and traffic management, safety and human factors.

Travel Demand Forecasting, Volumes 1–2
Transportation Research Records 2563–2564

A global analysis of the various aspects and potential of tolling, methods of multimodal transit networks, estimating intrazonal travel impedances, the use of predicted bicycle and pedestrian routes, modeling carsharing, and the measures for predicting traffic flow on urban roads are just a few of the 31 subjects covered in these two volumes.

2016; Vol. 1: 160 pp.; TRB affiliates, $60.75; nonaffiliates, $81; Vol. 2: 156 pp.; TRB affiliates, $60.75; nonaffiliates, $81. Subscriber categories: Vol. 1: planning and forecasting, data and information technology; Vol. 2: planning and forecasting, data and information technology.

Travel Behavior, Volumes 1–2
Transportation Research Records 2565–2566

This two-volume collection of papers reviews the human impacts of decision-making in travel, including risk-taking behaviors, patterns of older adults' travel decisions, time budgeting for various modes of commuting, changes in transit use among parents, the perception of travel time reliability across different modes of transportation, and more.

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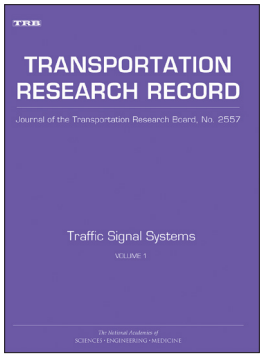
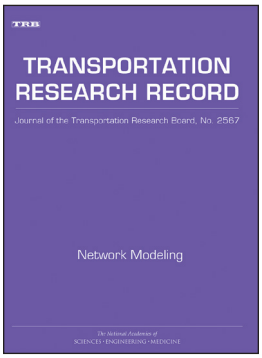


TRB PUBLICATIONS *(continued)*



2016; Vol. 1: 120 pp.; TRB affiliates, $46.50; nonaffiliates, $62; Vol. 2: 120 pp.; TRB affiliates, $53.25; nonaffiliates, $71. Subscriber categories: Vol. 1: planning and forecasting, data and information technology; Vol. 2: planning and forecasting, data and information technology.

Network Modeling
Transportation Research Record 2567

Optimizing vehicle relocation in carshare systems, improving the performance of curbside parking, reducing costs associated with hazmat transportation, and exploring the possibility of dynamic lane reversal for autonomous vehicles are a few of the subjects presented in this volume.

2016; 148 pp.; TRB affiliates, $60.75; nonaffiliates, $81. Subscriber categories: planning and forecasting, data and information technology.

Planning
Transportation Research Record 2568

This volume explores aspects of transportation planning, including the design and outcome of crowdsourcing at the U.S. DOT, Oregon's statewide approach to investing and implementing transportation options, and the potential applications of the Transportation System Health framework in identifying strategic goals, determining priorities, and selection performance measures.

2016; 120 pp.; TRB affiliates, $48; nonaffiliates, $64. Subscriber categories: planning and forecasting, administration and management.

Aviation
Transportation Research Record 2569

Papers in this volume examine factors affecting aviation, including developing abilities to track fleet operations at smaller airports, a new modeling approach to aid in mitigating delays, and positive research into technology for expedient and durable airfield pavement repair.

2016; 87 pp.; TRB affiliates, $49.50; nonaffiliates, $66. Subscriber category: aviation.

Air Quality
Transportation Research Record 2570

Authors delve into the problems and solutions for curbing emissions from light-duty vehicles in ramp operations, urban transit buses, and biodiesel exhaust, as well as the resulting carbon footprint and cost of human exposure.

2016; 156 pp.; TRB affiliates, $57.75; nonaffiliates, $77. Subscriber categories: environment, energy.

Environment
Transportation Research Record 2571

The web of recycled material, composting roadkill, wildlife behavior near unfenced underpasses, noise pollution from light rail, and the correlation of heavy metal contamination and traffic in urban areas are some of the topics covered in this volume.

2016; 89 pp.; TRB affiliates, $49.50; nonaffiliates, $66. Subscriber categories: environment, energy.

Energy, Alternative Fuels, and Climate Change
Transportation Research Record 2572

This collection of 12 papers spans the range of research into how electric, natural gas, and hybrid vehicles are impacting the environment.

2016; 120 pp.; TRB affiliates, $46.50; nonaffiliates, $62. Subscriber categories: energy, environment.

Construction
Transportation Research Record 2573

Topics covered in this report include civil integrated management, project delivery methods, best-value procurement, asphalt reclamation, bridge and highway construction plans, and pavement performance specifications.

2016; 184 pp.; TRB affiliates, $63.75; nonaffiliates, $85. Subscriber categories: construction, pavements, bridges and other structures.

Asphalt Materials and Mixtures, Volumes 1–3
Transportation Research Records 2574–2576

Papers in these three volumes provide information on the evaluation, effects, and properties of binders, examinations of flexibility and fracturing of asphalt, ways to improve recycled asphalt mixtures, and research on fatigue performance and cracking parameters, and more.

2016; Vol. 1: 152 pp.; TRB affiliates, $60.75; nonaffiliates, $81; Vol. 2: 224 pp.; TRB affiliates, $66.75; nonaffiliates, $89; Vol. 3: 128 pp.; TRB affiliates, $57; nonaffiliates, $76. Subscriber categories: Vol. 1: materials, pavements; Vol. 2: materials, pavements; Vol. 3: materials, pavements.

Concrete Materials
Transportation Research Record 2577

The effects of calcium nitrate on concrete properties, investigating mix design parameters, reducing joint damage, and various aspects of concrete bridge deck construction, performance, and connections are presented in this volume.

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

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

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

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

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

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◆ Submit original artwork if possible. Glossy, high-quality black-and-white photographs, color photographs, and slides are acceptable. Digital continuous-tone images must be submitted as TIFF or JPEG files and must be at least 3 in. by 5 in. with a resolution of 300 dpi. A caption should be supplied for each graphic element.

◆ Use the units of measurement from the research described and provide conversions in parentheses, as appropriate. The International System of Units (SI), the updated version of the metric system, is preferred. In the text, the SI units should be followed, when appropriate, by the U.S. customary equivalent units in parentheses. In figures and tables, the base unit conversions should be provided in a footnote.

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