



TR News March-April 2016: Technology-Enabled Transportation Services

DETAILS

60 pages | 8.5 x 11 | PAPERBACK

ISBN 978-0-309-44837-6 | DOI 10.17226/23615

AUTHORS

Technical Activities Division; Transportation Research Board; National Academies of Sciences, Engineering, and Medicine

BUY THIS BOOK

FIND RELATED TITLES

Visit the National Academies Press at NAP.edu and login or register to get:

- Access to free PDF downloads of thousands of scientific reports
- 10% off the price of print titles
- Email or social media notifications of new titles related to your interests
- Special offers and discounts



Distribution, posting, or copying of this PDF is strictly prohibited without written permission of the National Academies Press. (Request Permission) Unless otherwise indicated, all materials in this PDF are copyrighted by the National Academy of Sciences.

TRB NEWS

NUMBER 302

MARCH–APRIL 2016

3 NEW TRB SPECIAL REPORT

**Between Public and Private Mobility:
Examining the Rise of Technology-Enabled Transportation Services**

Katherine Kortum

The rapid innovation and growth in technology-enabled mobility services has raised many policy issues. A new TRB study explores how the services are used, how they relate to established transportation modes, and the implications for policy development, regulation, transportation planning, and infrastructure investment.

9 HIGHLIGHTS FROM THE TRB ANNUAL MEETING 2016

Research Convergence for a Multimodal Future

The many modes of transportation intersected with technology, public health, and systems resiliency at the 95th Annual Meeting of the Transportation Research Board. Approximately 12,600 participants shared and explored research findings and applications in sessions, workshops, committee meetings, exhibits, awards, networking events, and more, as shown in these photo highlights.

21 NATIONAL RESEARCH COUNCIL ARCTIC MATTERS PROJECT FINDINGS

Getting Around in a More Accessible Arctic

Anne Johnson, Solmaz Spence, Katie Thomas, Lauren Everett, and Nancy Huddleston

Climate change is affecting the Arctic at a pace more rapid than in other places in the world and is having dramatic effects on how and where people can travel. A series of National Research Council reports makes clear that rising sea levels, ecological changes, geopolitical shifts, new opportunities for resource extraction, and countless other changes in the Arctic will have immediate and lasting effects around the globe.

24 Marine Board Recognizes Arctic Shipping as a Priority Issue

Scott Brotemarkle

27 TRB SPECIAL REPORT 315

**Funding and Managing the U.S. Inland Waterways System:
What Policy Makers Need to Know**

Melissa Welch-Ross and Chris Hendrickson

Funding and managing the extensive and historic U.S. inland waterways system is a continuing challenge. A TRB study presents findings and recommendations for addressing infrastructure operations and maintenance, capital investment, federal appropriations, fees, and the need for implementing an asset management approach.

32 NCHRP REPORT 750, VOLUME 4

**Sustainability as an Organizing Principle for Transportation Agencies:
Transportation as a Means, Not an End**

Gary R. McVoy

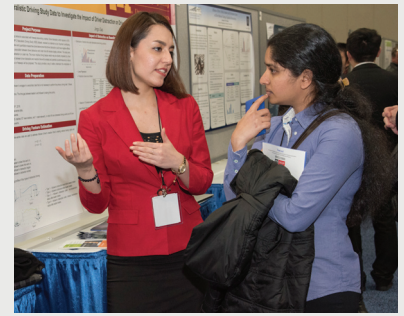
Transportation agencies can find support and direction in their essential service to society by pursuing the goal of triple bottom line sustainability—meeting today's social, environmental, and economic needs while providing for those of future generations. A report in the NCHRP Foresight series offers a framework that applies triple bottom line sustainability precepts to decision making.

37 NCHRP REPORT 793

**Incorporating Transportation Security Awareness into a State Agency's Routine
Operations and Training: A Shared Responsibility**

Pat Bye and Jeffrey Western

An NCHRP report highlights the importance of security awareness for all transportation agency employees and contractors and presents techniques to integrate all-hazards security awareness into routine operations, maintenance, and training—within resource and budget constraints.



9



21



41



COVER: Bikeshare users in San Francisco, California. A new TRB special report looks at policy issues raised by the rapid growth in technology-enabled mobility services. (Photo: Bay Area Bike Share)

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

Javy Awan, Editor and Publications Director
Lea Camarda, Associate Editor
Jennifer J. Weeks, Photo Researcher
Juanita Green, Production Manager
Michelle Wandres, Graphic Designer

TR News Editorial Board

Frederick D. Hejl, Chairman
Christine L. Gerencher
Edward T. Harrigan
Christopher J. Hedges
Russell W. Houston
Katherine Kortum
Thomas R. Menzies, Jr.
G.P. Jayaprakash, Research Pays Off Liaison

Transportation Research Board

Neil Pedersen, Executive Director
Mark R. Norman, Director of Program
Development and Strategic Activities
Russell W. Houston, Associate Executive
Director
Ann M. Brach, Director,
Technical Activities
Stephen R. Godwin, Director,
Studies and Special Programs
Gary J. Walker, Director,
Administration and Finance
Christopher W. Jenks, Director,
Cooperative Research Programs

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

Editorial Correspondence: By mail to the Publications Office, Transportation Research Board, 500 Fifth Street, NW, Washington, DC 20001, by telephone 202-334-2972, by fax 202-334-3495, or by e-mail jawan@nas.edu.

Subscriptions: North America: 1 year \$60; single issue \$12. Overseas: 1 year \$85; single issue \$12 plus shipping. Inquiries or communications concerning new subscriptions, subscription problems, or single-copy sales should be addressed to the Business Office at the address below, or telephone 202-334-3216, fax 202-334-2519. Periodicals postage paid at Washington, D.C.

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

Notice: The opinions expressed in articles appearing in TR News are those of the authors and do not necessarily reflect the views of the Transportation Research Board. The Transportation Research Board and TR News do not endorse products or manufacturers. Trade and manufacturers' names appear in an article only because they are considered essential.

Printed in the United States of America.

Copyright © 2016 National Academy of Sciences. All rights reserved. For permissions, contact TRB.

- 41 NCHRP REPORT 787
Design Management for Transportation Construction Projects: Design-Build and Construction Manager-General Contractor Methods
R. Edward Minchin, Jr., and Giovanni C. Migliaccio

In the past two decades, new methods have emerged to speed up the transportation construction process. An NCHRP report offers insights into the design management process under two of these fast-track approaches—construction manager-general contractor and design-build,

ALSO IN THIS ISSUE:

- 47 Research Pays Off
Composting Roadkill: Research and Implementation by the Virginia Department of Transportation
Bridget Donaldson and David Wilson



47

- 50 Profiles
Human factors psychologist and researcher Sue Chrysler; and traffic management and operations consultant Charles A. Fuhs
- 52 TRB Highlights
International Trade and Transportation: Annual Meeting Session Looks into Future Trends
Katherine F. Turnbull
Cooperative Research Programs News, 53
- 54 News Briefs
- 56 Bookshelf
- 60 Calendar

COMING NEXT ISSUE

Feature articles in the May-June issue explore bus transportation in the United States: the intercity bus renaissance and curbside long-distance services; the myths, history, status, and future of bus rapid transit, with a case study of a newly launched service; technology-enabled bus services; the state of rural bus transit; transformative trends in bus transit data; the impacts of real-time transit information on riders' satisfaction; a summary of a new TRB policy study on interregional travel; and more.



Passengers board a curbside intercity bus in New York City bound for Washington, D.C.

Between Public and Private Mobility

Examining the Rise of Technology-Enabled Transportation Services

KATHERINE KORTUM

The author is Senior Program Officer, Studies and Special Programs, Transportation Research Board, Washington, D.C., and served as study director for this project.

The rapid innovation and growth in technology-enabled mobility services has raised many policy issues. To learn more about the services, how they are used, how they relate to established transportation modes, and what implications they have for policy development, regulation, transportation planning, and infrastructure investment, the Transportation Research Board (TRB) Executive Committee initiated a study, convening a committee of subject-matter experts through the National Academies of Sciences, Engineering, and Medicine (see box, page 8).

The committee's findings and recommendations are published in TRB Special Report 319, *Between*

Public and Private Mobility: Examining the Rise of Technology-Enabled Transportation Services. The report includes discussion of a variety of mobility services, such as carsharing, bikesharing, taxis, and the new app-based ride service companies, known as transportation network companies (TNCs).

Protecting the Public Interest

Many of the new technology-enabled mobility services are welcome additions for travelers. The new options, however, pose significant public policy concerns—for example, the insurance for many services, especially TNCs, and helmet requirements for bikesharing.

Bikeshare users in San Francisco, California, use a credit card to pay for their ride. Mobility services facilitated by credit card readers and other technological advances raise public policy issues.



PHOTO: BAY AREA BIKE SHARE

TNCs are the most controversial new services, disrupting the regulated for-hire taxi industry and posing a series of challenges to transportation policy makers and regulators. The main challenge is to encourage and facilitate innovations that meet the public's mobility needs yet maintain a public policy that is consistent for the new services and the traditional taxi and livery services. At issue is protecting the public interest in matters of safety, driver pay and working conditions, and accessibility for people with disabilities.

Addressing this challenge in a rapidly growing and evolving industry requires political will, more information about the scale and nature of the services, and insightful guidance for the evolution of these services to enhance mobility and sustainability.

In the longer term, widespread use of services that involve concurrent vehicle sharing could have implications for land use patterns, automobile ownership, and public transit ridership in ways that could affect the goals of resource-efficient and environmentally sustainable lifestyles. Definitive statements are premature, but the potential benefits and risks of shared mobility services are an important topic for exploration.

Study Findings

Innovative mobility services are expanding travel choices and are being widely embraced by millions of travelers.

The rapid growth of these new services has occurred amid an upswing in travel via taxis and public transit that began more than a decade ago. App-enabled transportation services are among the most remarkable urban transportation innovations in a generation; the technologies deployed for these services are improving mobility in ways that have been proposed and discussed for decades but never realized on a large scale.

Transportation network companies (TNCs) such as Lyft have risen rapidly in popularity amidst a general rise in public transit and taxi use.



PHOTO: USER

By requiring users to possess both a credit card and a mobile phone, TNCs have the potential to exacerbate generational and socioeconomic divides.

Although TNCs have received the most media attention, car- and bikesharing, employee shuttles, microtransit services, and apps that aggregate all travel options are growing, evolving, and affecting travel behavior for many users in profound ways.

Experience suggests that car- and bikesharing programs in the United States reduce personal vehicle travel, emissions, and vehicle ownership. Although travel by innovative mobility services represents a small share of total trips, the programs are having effects on travel behavior, and the continued rapid expansion of their reach and use may significantly affect personal travel in the years ahead.

On its current course, continued expansion of TNCs threatens to exacerbate the “digital divide,” although these services also have the potential to enhance mobility for low-income and older adults.

The lack of access to services by those without credit cards or connection to the Internet is an economywide phenomenon, and innovative mobility services are bringing this issue to the fore for transportation. Most shared mobility services require users to have a credit card on file with the service provider and to arrange service via a smartphone. Substantial numbers of Americans, however, fail to meet one or both of these prerequisites.

Roughly 8 percent of U.S. households lack bank accounts and credit cards. Moreover, 36 percent of Americans currently do not own smartphones, and the rate is higher in some groups—50 percent among those who earn less than \$30,000 annually and 73 percent among those over age 65.

Smartphone ownership rates have risen rapidly, but the leveling-off point is not clear, particularly for those with low incomes; the current ownership rates leave substantial portions of the population without



PHOTO: LYFT

access to most shared mobility services. This becomes a greater concern if growth in the new services—especially TNCs—reduces the availability of options such as taxi services, which can be summoned with a landline or basic mobile phone and which receive payment in cash.

If private providers fail to address these access issues on a broad scale, public agencies and regulatory authorities may turn to regulation, mandates, or incentives to make these services fully and equitably available. Shared mobility services have the potential to enhance mobility for disadvantaged populations—the services frequently cost less than taxi services and impose lower up-front costs for travelers than owning a personal vehicle.

Furthermore, if shared- or concurrent-ride TNC services continue to expand and to cost less per trip than most traditional door-to-door services, low-income travelers with access may benefit considerably. The expansion of the relatively new multiple-passenger shared-ride options presents an opportunity for even lower-cost door-to-door service—albeit with stops.

Regulated taxis offer critical lifeline transportation services for people with disabilities. Absent some public policy response, a TNC-fueled decline in taxi services could affect the availability of vehicle-for-hire services to a substantial number of travelers with disabilities.

Roughly 10 percent of the U.S. population—30.6 million people—have a physical limitation of some kind; 3.6 million use a wheelchair, and another 11.6 million rely on a cane, crutches, or a walker. Many cab companies operate wheelchair-accessible vehicles for the general public, often supporting medical providers, social services, and Americans with Disabilities Act—mandated paratransit.

Moreover, several jurisdictions—primarily large cities such as New York, Chicago, and Washington, D.C.—mandate a specified number of wheelchair-accessible taxis, although the efficacy in serving disadvantaged populations is unclear. The more lightly regulated TNCs have introduced pilot programs but have not yet provided wheelchair-accessible services on an extensive or reliable basis. If competition from the increasingly popular TNCs reduces taxi fleets and the number of drivers, the near-term result may be fewer door-to-door transportation services for wheelchair users.

Although some TNCs have refused to accept service dogs—most of the legal cases have yet to be resolved—TNC services can benefit the blind and the visually impaired. TNC apps provide voice options, allowing vehicle requests from a smartphone without



PHOTO: NEW YORK CITY DEPARTMENT OF TRANSPORTATION

the need to see and hail a taxi on the street. Cashless transactions eliminate questions about the change a taxi driver has provided, and the TNC driver does not know that the passenger is sight-impaired until after accepting the ride.

Public safety is a central public policy concern with the new shared mobility services.

Regulation traditionally has rectified market failures, such as a lack of information about the safety of vehicles and drivers and about the quality of the services. Customers of taxi stand and street-hail services, in particular, lack the opportunity to exercise informed choice among providers. Information and communication technologies may have reduced the need for some regulations aimed at service quality, as customers can choose among well-known global brands and can obtain basic information about drivers and vehicles before riding. Public safety, however, remains a regulatory concern.

Public entities at the municipal, regional, and state levels are implementing public safety regulations for TNCs and other shared mobility services, including regulations on helmet wearing by bike-share users. These evolving regulatory processes, however, reveal a long-standing weakness—the paucity of systematic evaluations of the effectiveness or costs of the current and proposed public safety regulations.

A wheelchair-accessible taxi picks up passengers in New York City, one of the cities that mandates a certain number of these vehicles in the taxi fleet.

A bikeshare user rides without a helmet in San Jose, California. State and local governments are implementing safety regulations affecting TNCs and shared mobility services.



PHOTO: RICHARD MASONER, FLICKR

For example, procedures for driver background checks often are based on common practice but have not been evaluated in a rigorous way. As a result, regulators, the taxi industry, and TNC operators may not be following best practices in background checks.

Equally important, minimum limits of automobile liability insurance for taxis, TNCs, and other for-hire services vary across jurisdictions and are not based on a systematic analysis of the risks of for-hire operations. Similarly, the technology may facilitate the production and sharing of driver ratings, photos of operators and vehicles, and electronic itineraries and may mitigate requirements for certain regulations on service quality and safety, but the benefits have not been documented.

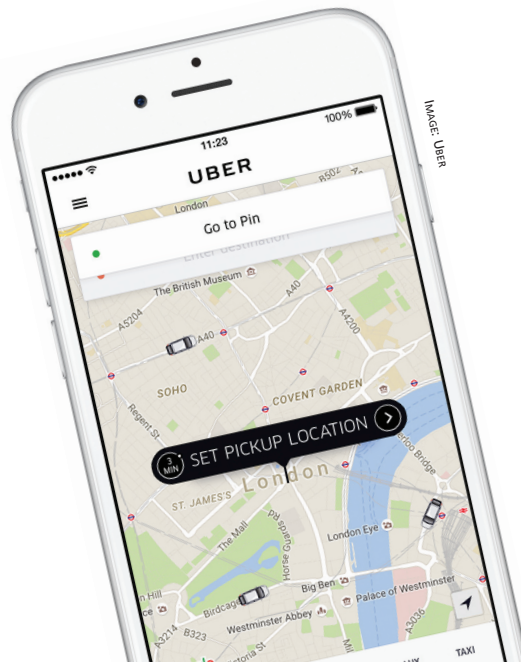
Finally, TNC drivers' reliance on smartphones may lead to distracted driving—this possibility should be examined. In sum, the most effective ways to ensure safe operation of vehicles by safety-conscious drivers, as well as appropriate allocation of the costs imposed by the risk of crashes, remain to be established and deserve careful study.

TNC drivers, like most taxi drivers and workers in the shared economy generally, are classified by their companies as independent contractors, not as employees. This status limits their access to benefits that are currently tied to employment.

Independent contractors typically do not receive employer-provided health insurance or employer contributions to Social Security and Medicare, sick leave, workers' compensation for injuries, disability insurance, and other employee benefits. Although many drivers report that they value the part-time and transitional employment opportunities with TNCs, some have sued, claiming that the control that the company exerts over them indicates they are employees under federal law.

The TNCs have responded that the drivers are contractors—the company exercises virtually no control over the time or place of trips, and the drivers own the vehicles. Legal precedents under the federal Fair Labor Standards Act, however, involve multiple tests—no single test is determinative.

The legal system is likely to decide this issue. Without state or federal legislation, however, classifying mobility service contractors as employees would have major ramifications for drivers, company finances, and consumer costs.



Like many TNCs, Uber is a multinational corporation.

The vast differences in the scale of TNCs compared with taxi services raise new considerations for regulators.

The rise of multinational corporations that provide taxi-like services in cities around the world contrasts sharply with the structure of the taxi and limousine industries. Although a few taxi fleets are large, regional enterprises, most consist of local firms, fleets of widely varying sizes, and highly varied employment and contractual relationships with drivers. In comparison, the TNCs are a few increasingly large entities that operate globally, which imparts multicity brand awareness and potential market power with customers, drivers, and regulators.

In heavily regulated taxi markets, state and local policy makers may need to reduce some constraints, so that taxi and limousine services can compete more effectively. Some aspects of regulation, however—such as labor standards and background checks—may be addressed more logically on a national scale.

Innovations in shared mobility services have the potential to change long-term travel and land use patterns.

By affecting the cost, convenience, and flexibility of travel, technology-enabled mobility services may alter travel behavior and land use patterns. Two possible effects are critical.

First, success in aggregating multiple travelers with similar origins and destinations into a single vehicle will reduce travel costs for users and the negative impacts of vehicle travel. The new services could increase carpooling and ridesharing, which could lead to increased average vehicle occupancies. Ultimately, the reduced vehicle travel could ameliorate automotive externalities such as congestion, nonrenewable energy use, and emissions.

Second, by increasing convenient travel alternatives, the new services may encourage lower levels of household vehicle ownership without sacrificing personal mobility. This would eliminate the bias implicit in vehicle ownership toward high-fixed, low-variable costs in mode choice decisions and could spur travel by public transit, walking, and biking; this could favor urban instead of suburban residential choices. These changes would have profound effects if automated driving becomes widespread.

Less expensive and more convenient travel options encourage more travel and may enhance mobility for dispersed—or “sprawl”—locations, increasing the attractiveness to residents and businesses. TNCs and related services, however, are concentrated currently in central, urban locations. In addition, because TNC drivers often travel without passengers between customers, dispersed services

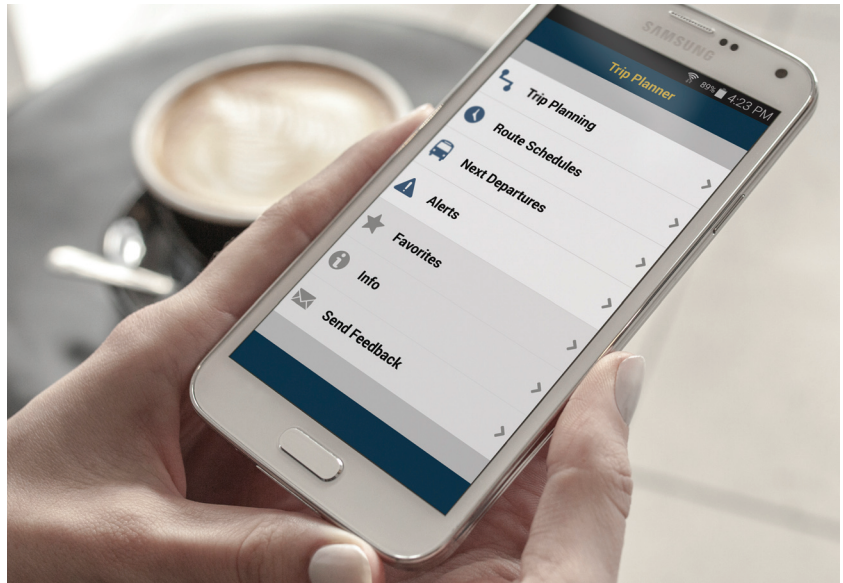


PHOTO: KING COUNTY

could increase total vehicle travel and contribute to congestion, energy consumption, and emissions.

Finally, lower fares may draw travelers from public transportation to shared-ride services in large numbers. This too could increase total vehicle miles traveled, emissions, and energy consumption. Which of these competing forces will predominate remains to be seen, and the effects may play out in different ways, depending on local circumstances.

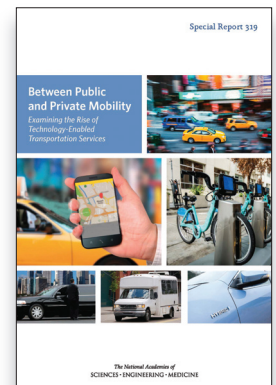
Study Recommendations

Innovative mobility services already are enhancing mobility for millions and have the potential to yield even greater benefits and to serve other societal goals. To realize the potential of these services, policy makers and regulators will need to address the issues discussed in this report. The committee offers the following recommendations to expand the promise of these services with effective and appropriately scaled public oversight:

1. Policy makers and regulators should formulate public policies and regulations designed to steer the development of innovative services to improve mobility, safety, and sustainability.

1a. To the extent that technology features can accomplish the same customer service protections that previously required regulatory intervention, regulations should be adapted to embrace that opportunity. Local and state governments should reassess current taxi, limousine, and (where separately adopted) TNC regulations for market entry, geographic coverage, span of service, and the like in light of these new services and the service quality information available to passengers and drivers.

A free mobile app from King County, Washington, displays transit information from 11 public transit agencies, including buses, rail, and ferries.



TRB Special Report 319, *Between Public and Private Mobility: Examining the Rise of Technology-Enabled Transportation Services*, is available from the TRB online bookstore, <https://www.mytrb.org/Store/Product.aspx?ID=8082>; to view the book online, go to www.trb.org/Publications/Blurbs/173511.aspx.

Study committee Chair Brian Taylor, UCLA, answers audience questions at the release of Special Report 319 in Washington, D.C., in December 2015.



Ib. These assessments also should examine public safety requirements for drivers and vehicles, which should be applied in similar fashion across competing industry segments, ensuring consistency and a level playing field.

Ic. Similarly, in consideration of both the multi-jurisdictional travel patterns in metropolitan areas and the large scale of business operations, state and local governments should assess how the regulations governing the various industries relate to one another, particularly when multiple jurisdictions regulate different industry segments within the same geographic area. Policy makers and regulators should consider whether traditional for-hire and shared mobility services are best monitored and regulated at the state, regional, or local level on the basis of market and service characteristics and regulatory capabilities.

Id. Policy makers and regulators at the state and federal levels should conduct systematic eval-

uations of safety requirements, examining the core issues of effectiveness and cost.

Ie. Given the importance of accessibility for all users (which is frequently operationalized in terms of vehicles that can accommodate wheelchairs), policy makers and regulators should address the potential disparity between access for people with various disabilities and other travelers as these new services expand.

2. Policy makers, planners, and regulators should identify the information needed to set policies on, plan for, and regulate mobility services, and should require this information from all regulated entities.

3. Policy makers and regulators should carefully examine and consider the pros and cons of alternative employment classifications for TNC and taxi drivers.

4. Policy makers and regulators should seek to integrate the features of TNCs and other innovative shared mobility services into transportation systems and services in ways that leverage the new services' strengths and features.

Continued Transformation

Innovative urban mobility services will continue to evolve, and the research and public policy communities will need to react quickly and in partnership. Use of these and yet-to-be-developed technology-enabled transportation services is likely to continue transforming passenger travel, and the many stakeholders will need to cooperate to ensure that the outcomes are in the public interest.

Collaboration among these various stakeholders may set precedents, as connected and automated vehicles develop and become common. Addressing this report's findings can provide a foundation for the technological evolution of the U.S. transportation system.

Committee for Review of Innovative Urban Mobility Services

Brian D. Taylor, UCLA Luskin School of Public Affairs, Los Angeles, California, *Chair*

Ryan Chin, Massachusetts Institute of Technology, Cambridge

Melanie Crotty, San Francisco Bay Area Metropolitan Transportation Commission (resigned from committee as of June 14, 2015)

Jennifer Dill, Portland State University

Lester A. Hoel, University of Virginia (emeritus)

Michael Manville, Cornell University, Ithaca, New York

Steve Polzin, University of South Florida, Tampa

Bruce Schaller, Schaller Consulting, Brooklyn, New York

Susan Shaheen, University of California, Berkeley

Daniel Sperling, University of California, Davis

Marzia Zafar, California Public Utilities Commission, San Francisco

Susan Zielinski, University of Michigan, Ann Arbor

Research Convergence for a Multimodal Future



(Above:) At a live-streamed address on Wednesday, January 13, U.S. Secretary of Transportation Anthony R. Foxx examined how past infrastructure decisions fragmented communities and aggravated inequality—and the critical role of transportation in bringing communities together and advancing economic and social equity.

(Below:) A packed audience hears Chairman’s Luncheon speaker Chris Urmson describe Google’s self-driving car initiative and its challenges and opportunities.

The many modes of transportation intersected with technology, public health, and systems resiliency at the 95th Transportation Research Board Annual Meeting, January 10–14, 2016, in Washington, D.C. Approximately 12,600 transportation research practitioners, academics, policy makers, and representatives from private industry 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, and networking events. Approximately 75 sessions focused on the timely, cross-cutting topics of transformational technology, health and transportation, and resiliency; 37 sessions explored the meeting’s theme, “Research Convergence for a Multimodal Future.”

Hani Mahmassani, William A. Patterson Distinguished Chair in Transportation and professor, Northwestern University, and Director, Northwestern University Transportation Center, delivered the 2016 Thomas B. Deen Distinguished Lecture on “Micromodels and Megadata: Taming Complexity for Deep Insight and Robust Decisions” to a standing-room-only audience. Chris Urmson, Director of the Google Self-Driving Car Program and Adjunct



A daylong workshop on unmanned aircraft systems (UAS) featured several panel discussions as well as drone flight demonstrations.

Professor at Carnegie Mellon University, delivered the Chairman’s Luncheon address on the future of vehicle automation.

Details and highlights appear on the following pages.

Annual Meeting photographs by
Risdon Photography.



INTERSECTIONS

1 Alison Conway, City University of New York and Young Members Council chair, meets with new and young professionals at the Welcome and Attendee Orientation Session.



2 Transportation System Policy, Planning, and Process Section Chair Libby Rushley outlines planning-related activities for new TRB Annual Meeting attendees.

3 The Technical Activities Council coordinates the activities of the more than 200 volunteer standing committees and oversees the Annual Meeting program.



3 2016 TRB Technical Activities Council (*front row, left to right:*) Dennis Hinebaugh, Hyun-A Park, Chair Daniel Turner, Barbara Ivanov, Robert Shea, (*back row, left to right:*) Paul Jovanis, David Harkey, Technical Activities Director Ann Brach, D. Stephen Lane, David Wilcock, Alison Conway, Stephen Popkin, Peter Briglia, Eric Shen, and Ram Pendyala.

4 Ann Henebery, Eno Center for Transportation; Mark Teschauer, American Public Transportation Association; Chris Plano, Spy Pond Partners; Emily Han, Eno Center for Transportation; and Moji Jimo, Washington Metropolitan Area Transit Authority, at a reception for young transportation professionals.



5 Moges Ayele, Federal Highway Administration (FHWA); Stephen Arhin, Howard University; and Maritime Administrator Paul (Chip) Jaenichen at an event for the TRB Minority Student Fellows Program.

6 Nearly 200 exhibits showcased a variety of transportation-related products and services and attracted active interest.



7 The Exhibit Hall featured several vehicle and equipment displays.



SESSIONS & WORKSHOPS

1 Benjamin Colucci, University of Puerto Rico, Mayaguez (*right*), introduces Alfonso Garcia, University of Texas at El Paso (*left*), presenting research on inelastic joint behavior modeling at a session on Innovative Doctoral Research from the Dwight David Eisenhower Transportation Fellowship Program.

2 (*Left to right*): Veronica O. Davis, Inspiregreen; Mishal Aljanbou, UCR; and Johannes Schlaich, PTV Group, participate in a transportation planning workshop.

3 Pat Wu, Facebook, details progress on drone regulations at the UAS workshop.

4 Carol Luschen, Texas Department of Transportation (DOT), examines the use of the INVEST sustainability rating system on the Harbor Bridge project in Corpus Christi.

5 Ken Rose presents the Centers for Disease Control and Prevention perspective at a session on Institutionalizing Health in Transportation Agency Practice.

6 Federal Railroad Administrator Sarah Feinberg takes part in a panel discussion on building effective relationships between transportation leaders and the press.

7 Mark Bontrager, Space Florida, offers the perspective of a spaceport operator on Commercial Space: Exploring the Path Forward.

8 Martine Micozzi discusses international collaboration opportunities at a session reviewing the progress of the EU-U.S. transportation research partnership.

9 Tae J. Kwon, University of Waterloo, explores the Use of Roadway Weather Information Systems and Vehicle Sensor Data in Surface Transportation.



10 Federal Motor Carrier Safety Administrator T. F. Scott Darling delivers the keynote address at a session on the agency's safety activities and priorities.

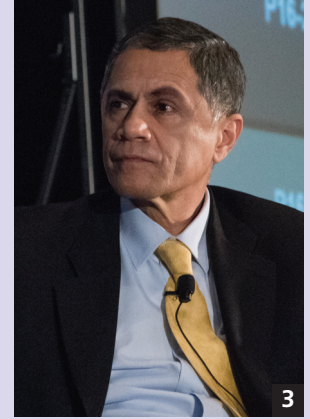
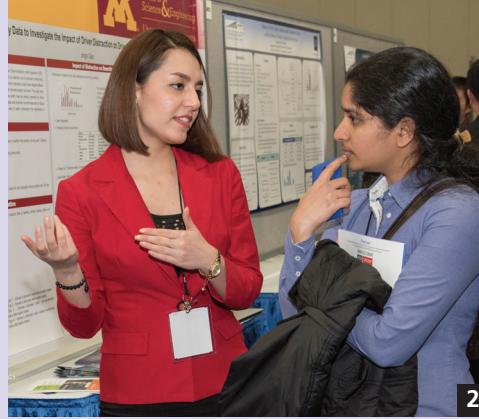
11 Carrie Bond, U.S. Army Corps of Engineers, addresses Best Practices with Transportation Liaisons.



SESSIONS & WORKSHOPS

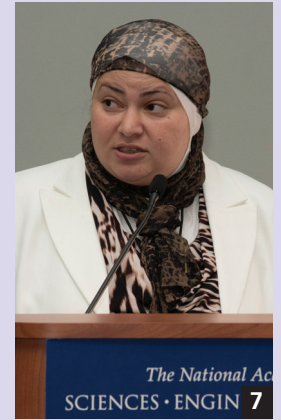
(continued)

1 U.S. DOT Assistant Secretary for Transportation Policy Carlos Monje, Jr., moderates a panel discussion on the Beyond Traffic draft framework.



2 Raha Hamzeie presents her research utilizing safety data from the second Strategic Highway Research Program (SHRP 2).

3 Victor Mendez, Deputy Secretary of Transportation, presides over Innovation: Creating Smarter Cities.



4 Mario Cordero, Federal Maritime Commission, leads a panel discussion on supply chain optimization efforts as part of a series of freight-related sessions.

5 Jennifer Hopwood, Xerxes Society, examines Pollinators on the Verge: Policies, Practices, and Implications for Conservation in Roadside Habitats.

6 Victor Knox, U.S. National Park Service (NPS), reflects on multimodal innovation and vision for public lands transportation at a session commemorating the centennials of the NPS and U.S. Forest Service.



11 Winners and sponsors of the 2015 Communicating with John and Jane Q. Public competition: (front, left to right) Stefanie Kiedrowski, Gail Holley, Russell Henk, Leslie Lara, Rita Morocoima-Black, Claudia Bilotto, (back, left to right) Ram Pendyala, Stacey Tisdale, Mike Mason, Ashlee McLaughlin, and Terri Parker.



7 Marwa Hassan, Louisiana State University, shares research on Rejuvenators for Asphalt Mixtures.

8 Ruben Brage-Ardao, Imperial College London, examines Determinants of Station Service Cost in Metros.



9 Jenise Young, Texas Southern University, presents the paper "Exclusivity and Shared Use: Examining the State of the Practice in U.S. High-Intensity Bus Service."

10 Raj Dongre addresses rutting susceptibility test improvements in PG Binder Specification Evolution.





1



2



3

3 State DOT Roundtable 1 speakers (*left to right*): Kyle Schneweis, Nebraska Department of Roads; Paul Trombino III, Iowa DOT; Pete Rahn, Maryland DOT; and Scott Bennett, Arkansas State Highway and Transportation Department.



4



5



6



7



8



9



10

SESSIONS & WORKSHOPS (continued)

1 Perry Chavez, California State Polytechnic University, Pomona, reviews research on Equity Implications of Different Transportation Impact Threshold Systems in Los Angeles County.

2 Lynn Peterson (*right*) shares experiences as past Washington State Transportation Director at a roundtable with David Bernhardt (*left*) of Maine DOT and other state transportation secretaries.

3 State DOT CEO Roundtable 1: Mainstreaming Innovative Technology.

4 Laura Schewel, Streetlight Data, explores Big Data and Freight Transportation: Private-Sector Applications and Agency Implications.

5 Maria Lindholm, Chalmers University of Technology, discusses the urban redevelopment of Gothenburg, Sweden, at Accommodating Freight Early and Often in the Planning Phases of City Redevelopment.

6 Matt Miyasato (*far left*) moderates a panel session on zero-emissions freight with (*left to right*) Michael Simon, Felix Oduyemi, Jolene Hayes, and Thomas Jelenic.

7 Shailen Bhatt, Colorado DOT, addresses transportation system resilience at the State DOT CEO Roundtable 3.

8 Susan Martinovich, CH2M, presents the winners of a competition for best practices in communicating data to support decisions.

9 Eric Kerness, Kerness Consulting, examines Best Practices for Dispute Resolution in Alternative Delivery Contracts.

10 Thomas Bennert, Rutgers University, shares research on Long-Term Binder Aging and Recycled Engine Oil Bottoms.

SESSIONS & WORKSHOPS

(continued)

1 Omar Smadi presents an evaluation of work zone safety using SHRP 2 Naturalistic Driving Study data.

2 Weina Meng, Missouri University of Science and Technology, shares insights on Innovations in Concrete Properties Technology.

3 Georgia Aifadopoulou, Hellenic Institute of Transport, participates in a question and answer segment of Accommodating Freight Early and Often in the Planning Phases of City Redevelopment.

4 International panelists gathered for a session on Planning for Multimodal Transportation in the 21st Century.

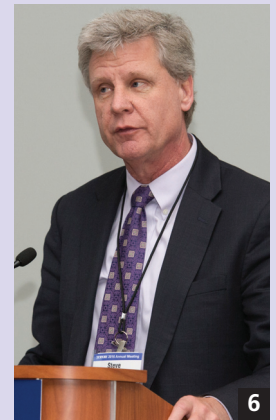
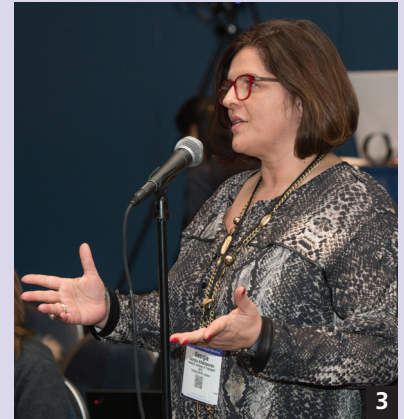
5 Emily Castor, Lyft, delivers remarks at a session on TRB Special Report 319, *Between Public and Private Mobility: Examining the Rise of Technology-Enabled Transportation Services*.

6 Steven DeWitt, ACS Infrastructure Development, Inc., addresses Risk Opportunities in Alternative Project Delivery.

7 A researcher discusses Using Mobile Phone Data in Travel Surveys.

8 Consultants Mortimer Downey (left) and Alan Pisarski present lessons learned from 50 years of the National U.S. Department of Transportation Act.

9 Robert Schneider, University of Wisconsin, Milwaukee, leads a session on Pedestrian Behavior and Safety at Roadway Crossings.



10 Irina Finkelstein, WSP-Parsons Brinckerhoff, welcomes participants to a workshop on the National Environmental Policy Act and Climate Change.

11 Devan Morris, San Francisco Department of Public Health, shares research on Advances in Geospatial Technology Applications in Transportation.





COMMITTEES

1 The Transportation in the Developing Countries Committee proceeds through its meeting agenda.

2 C. Douglass Couto (*left*) and past chair Frances Harrison, Spy Pond Partners, at a meeting of the Information Systems and Technology Committee.



3 Planning and Environment Group chair Ram Pendyala shares upcoming events with the Transportation System Policy, Planning, and Process Section.

4 Sherif Ishak, Louisiana State University, leads a meeting of the Artificial Intelligence and Advanced Computing Applications Committee.

5 Reyhaneh Rahbar Rastegar, University of New Hampshire, addresses the Nonbinder Components of Asphalt Mixtures Committee.



6 Chair Ted Dahlburg (*right*) presents Akiko Yamagami with a commendation for her service as Urban Freight Transportation Committee communications coordinator.

7 The Disadvantaged Business Enterprises (DBEs) Committee focuses on DBEs in transportation.



8 Marlys Osterhues, FHWA, participates in a meeting of the Ecology and Transportation Committee.

9 Keith Killough, Arizona DOT (*left*), and Montie Wade, Texas A&M Transportation Institute, weigh discussion at a meeting of the Transportation Planning Applications Committee.

COMMITTEES

(continued)

1 G. P. Jayaprakash reports on TRB news and updates at a meeting of the Transportation Earthworks Committee.

2 Shundrekia Stewart, BNSF Railway Company, participates in a meeting of the Freight Rail Transportation Committee.



COMMITTEE LEADERSHIP AWARDS

3 Marsha Anderson Bomar, Stantec Consulting (left), and 2015 Young Members Council chair Alison Conway (right) present the Outstanding Young Member Award to Frank Gross, VHB (center).

4 (Left to right:) Transportation in the Developing Countries Committee Chair Om Agarwal, emeritus member Ralph Gakenheimer, TRB representative Bernardo Kleiner, and communications coordinator Setty Pendakur.

5 Kathryn Zimmerman became an emeritus member of the Pavement Management Systems Committee.



Committees Leading by Example

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

- ◆ Community Building and Mentoring: Rail Freight Transportation Committee, chaired by George Avery Grimes;
- ◆ Advancing Research: Regional Transportation Systems Management and Operations Committee, chaired by Les Jacobson;
- ◆ Contributing to TRB and the Transportation Community: Transportation Planning Applications Committee, chaired by Julie Dunbar; and
- ◆ Communications: Transportation History Committee, chaired by Asha Weinstein Agrawal, with an Honorable Mention to the Ecology and Transportation Committee, chaired by Alexander F. Levy.

TRB Honors Longtime Volunteers

In recognition of their long-term contributions and exceptional service to TRB's standing committees, the following individuals received emeritus membership at the 2016 Annual Meeting:

- ◆ Gary Duncan, Traffic Signal Systems Committee;
- ◆ Walter M. Dunn, Jr., Freeway Operations Committee;

- ◆ David W. Fowler, Polymer Concretes, Adhesives, and Sealers Committee;
- ◆ Ralph Gakenheimer, Transportation in the Developing Countries Committee;
- ◆ Barbara T. Harder, Conduct of Research Committee;



- ◆ Alan E. Pisarski, Transportation History Committee;
- ◆ Sandra L. Tucker, Library and Information Science for Transportation Committee;
- ◆ Carol A. Zimmerman, Transportation Needs of National Parks and Public Lands Committee; and
- ◆ Kathryn A. Zimmerman, Pavement Management Systems Committee.



1



2



3



4



5



6



7

7 Veronique Van Acker was recognized for her research on lifestyle and modal choices.

8 (Left to right:) Michael Paul Pratt, Srinivas Reddy Geedipally, and Adam Pike were honored for outstanding paper in the field of operations and maintenance.



8

PAPER AWARDS

1 The D. Grant Mickle Award recognizes an outstanding paper in operations and maintenance. (Left to right:) Mark Hickman, Felipe Ladrón de Guevara, and Larry Head.

2 (Left to right:) Karen Dixon, Raul Avelar, and Patricia Escobar received the Patricia F. Waller Award for their paper on crash screening methods.

3 The K. B. Woods award for outstanding paper in design and construction was presented to (left to right) William Likos, Dan Ding, and J. Erik Loehr.

4 The William W. Millar award honors the best paper in the field of public transportation. (Left to right:) Patricia Hendren, Yvonne Carney, Richard Harcum, and Millar, past president of the American Public Transportation Association and award namesake. Not pictured: Justin Antos.

5 The Pyke Johnson Award for best paper in the field of planning and the environment was awarded to (left to right) Francisco Câmara Pereira, Fang Zhao, Moshe Ben-Akiva, Yafei Han, and Rudi Ball. Not pictured: Youngsung Kim and Christopher Zegras.

6-8 The Fred Burggraf Award is given to researchers age 35 or younger.

6 Nathan Moore and Jeffrey LaMondia's award-winning paper focused on using bicycle level of service for decision making.

MAJOR AWARDS

1 Hani Mahmassani, Northwestern University, delivered the 2016 Thomas B. Deen Distinguished Lecture.

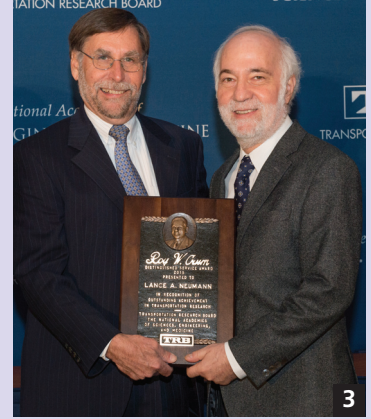


1

2 2016 Executive Committee Chair Jim Crites (left) presented the W. N. Carey, Jr., Distinguished Service Award to Kirk T. Steudle, Michigan DOT. Steudle was honored for his leadership of the TRB Executive Committee and many other TRB committees, panels, and task forces.



2



3

3 Lance A. Neumann, Cambridge Systematics (left), received the Roy W. Crum Distinguished Service Award from 2015 Executive Committee Chair Dan Sperling.



4

4 For long-term, innovative leadership in people-oriented transportation initiatives, Carol Abel Lewis, Texas Southern University (right), received the Sharon D. Banks Award from TRB Executive Director Neil Pedersen.

5 Chris Urmson outlined Google's pioneering self-driving car program to a capacity crowd, showing visualizations of the Google car as it used sensors and software to navigate complex traffic situations.



5

EXECUTIVE COMMITTEE

Policy session speakers included (left to right):

6 Leslie Meehan, Tennessee Department of Health;



6

7 Victor Dzau, National Academy of Medicine; and



7

8 Mark Rosenberg, The Task Force for Global Health, Inc.



8

9 After speaker presentations, Executive Committee meeting participants gathered in breakout discussions on the topic of advancing public health through transportation.



9

10 Marine Board Chair James Card delivers a report on the work of the TRB Executive Committee Resilience Task Force.



10

New Executive Committee Leaders Step Up

James Crites, Executive Vice President, Operations Division, Dallas–Fort Worth International Airport (DFW), is 2016 Chair of the TRB Executive Committee. He succeeds Daniel Sperling, Professor of Civil Engineering and Environmental Science and Policy, University of California, Davis. Paul Trombino III, Director, Iowa Department of Transportation, is the 2016 Vice Chair.

At DFW, Crites administers the airport's public safety, operations, and environmental affairs departments. He joined DFW in 1995 from American Airlines, where he served as director of planning and marketing research. His leadership in facilities development planning and business opportunities assessment was integral to DFW's Airport Development Plan, a 20-year master roadmap for infrastructure renewal and modernization, preparing the airport for future challenges. Crites received a bachelor's degree in business administration from the University of Illinois and a master's degree in operations research from the Naval Postgraduate School in Monterey, California.

Trombino was appointed director of Iowa DOT in 2011. He came to the agency after 17 years at Wisconsin DOT, where he served as director of the bureau of transit, local roads, rails and harbors; regional operations director of the highway division; director of statewide structures; and manager of highway bid lettings. Trombino received bachelor's degrees in civil engineering from the University of Wisconsin, Milwaukee,

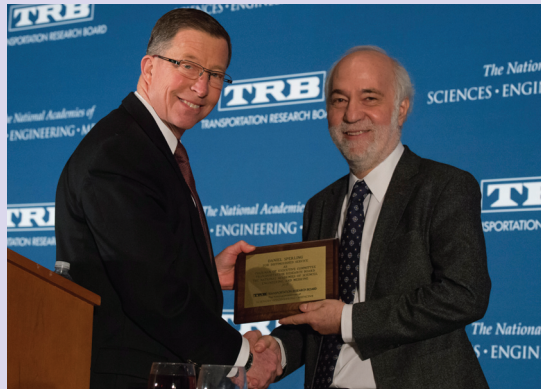


Crites

and in economics from the University of Wisconsin–Madison. He is a licensed professional engineer in the states of Iowa and Wisconsin.

Pat Thomas, United Parcel Service, Inc.; Katherine Turnbull, Texas A&M Transportation Institute; and Dean Wise, BNSF Railway Company, are new members of the Executive Committee. Reappointed members include Scott Bennett, Arkansas State Highway and Transportation Department; Malcolm Dougherty, California Department of Transportation; John Halikowski, Arizona DOT; Susan Hanson, Clark University (retired);

Steve Heminger, Metropolitan Transportation Commission; Jeffrey Holt, Bank of Montreal; and Gary Thomas, Dallas Area Rapid Transit.



2015 and 2016 Executive Committee Chairs Dan Sperling (right) and James Crites (left).

EXECUTIVE COMMITTEE (continued)

New and reappointed Executive Committee members included (left to right):

- 1 Jeffrey Holt, Bank of Montreal;
- 2 Katherine Turnbull, Texas A&M Transportation Institute;
- 3 Malcolm Dougherty, California Department of Transportation; and
- 4 Dean Wise, BNSF Railway Company.



EXECUTIVE COMMITTEE

(continued)

1 2015 Chair Dan Sperling guides the Executive Committee through its meeting agenda.

2 TRB Executive Director presents updates on TRB's strategic initiatives.

3 Paul Trombino, 2016 Executive Committee Vice Chair, offers insights on research focus areas for TRB.

4 As chair of the Subcommittee for NRC Oversight, Susan Hanson guides TRB's committee and panel appointments and report review.

5 Reuben Sarkar represents the U.S. Department of Energy, a new TRB sponsor.

6 Jennifer Cohan, Delaware DOT, discusses avenues of technological research.

7 Guest Ed Christopher shares background on TRB's public health and transportation initiatives.

Also participating in Executive Committee deliberations were

8 Roger Huff, HGLC;

9 Nan Shellabarger, Federal Aviation Administration;

10 Gary Thomas, Dallas Area Rapid Transit;

11 Ysela Llort, consultant;

12 Michael Trentacoste, FHWA; and

13 Geraldine Knatz, University of Southern California.

14 U.S. National Transportation Safety Board chair Christopher A. Hart outlines the board's "Most Wanted List" of advocacy priorities.





The Aurora Borealis, or Northern Lights, shines above Bear Lake, Eielson Air Force Base, Alaska.



Photo: Joshua Strang, U.S. Air Force

Getting Around in a More Accessible Arctic

ANNE JOHNSON, SOLMAZ SPENCE, KATIE THOMAS, LAUREN EVERETT, AND NANCY HUDDLESTON

Johnson is a writer with Creative Science Writing, Chapel Hill, North Carolina. Spence is Communications and Media Specialist; Thomas is Senior Program Officer; Everett is Program Officer; and Huddleston is Director of Communications and Media, Division on Earth and Life Studies, National Academies of Sciences, Engineering, and Medicine, Washington, D.C. Johnson, Spence, Thomas, and Everett are authors of Arctic Matters: The Global Connection to Changes in the Arctic.

Viewed in satellite images as a white coat draped over the top of the globe, the Arctic appears distant and isolated. Yet in the past few decades, rapid climatic changes have transformed the Arctic from one of Earth's most inaccessible places to a new destination for shipping and transportation, resource exploration, scientific research, and tourism. These changes bring both opportunities and risks to the region.

By definition, global climate change is reflected in a host of changes all over the planet. These changes, however, do not occur uniformly across the globe, and changes in the Arctic are occurring more rapidly than anywhere else. For example, temperatures in the Arctic are rising at twice the rate of the average rise in global temperature. The temperature of the Arctic Ocean also is increasing. With the higher temperatures, snow cover has decreased, melting off more quickly in spring and summer.

The warmer temperatures have caused a dramatic

decrease in the sea ice left at the end of summer. From satellite data, scientists have found that the coverage area of sea ice each September has declined by more than 40 percent since the late 1970s, and the trend has accelerated since 2007. The striking decrease in summer ice has caused winter ice to become thinner and less stable (Figure 1, page 22).

Not only is sea ice diminishing, but ice on the land masses encircling the Arctic Ocean is melting rapidly. Glaciers that have endured since the last Ice Age or longer are becoming smaller. Those that border bodies of water are breaking off more frequently into icebergs, a process called calving. As land ice melts, much of the melt ultimately flows into the sea, contributing to a rise in sea levels worldwide.

Changes in the Arctic climate are having dramatic effects on how and where people can travel. Large areas of open ocean are becoming newly accessible to shipping. Melting ice and snow are changing the ways that people drive across and dig into the land, in some cases threatening the lives and livelihoods of



FIGURE 1 Visualizations show a sharp decline in summer sea ice coverage from 1980 (*left*) to 2012 (*right*) and also loss of thicker, multiyear ice, shown in bright white. Summer sea ice extent has declined approximately 40 percent since the 1970s.

indigenous Arctic groups. Thawing permafrost—the frozen layer of subsurface soil in the Arctic—threatens the stability of roads, bridges, and runways. A major challenge in the Arctic today is to seize new opportunities as they arise in the region while adapting to change and minimizing risks.

The Northern Route

Increased Traffic

In the past, few ships ventured into the perilous waters of the Arctic Ocean or into the various straits and seas. Those that passed through primarily serviced oil production facilities, transported mining products, and delivered supplies to coastal communities.

The situation is changing rapidly. In the summer of 2012, the U.S. Coast Guard estimated that 480 ships transited the Bering Strait between Alaska and Russia, a route that received much less vessel traffic 10 years earlier. More ships are entering the Arctic to explore for oil and gas, conduct research missions, and transport oil and other commodities. Tourism vessels are also on the rise.

The increased vessel traffic increases the risks to people and the environment. Although sea ice is shrinking, the Arctic remains a harsh and dangerous environment for navigation, because remnant sea ice can pose hazards, particularly with changing weather and sea conditions.

In the fall, open routes can freeze solid within days. Many areas are poorly charted and have limited communications infrastructure, making navigation and emergency response exceedingly difficult. Ports of refuge are few and far between, and many emergency response capabilities in the U.S. Arctic are limited and restricted to southern Alaska. These rapid changes also may have an impact on subsistence hunting and on the migratory patterns of marine mammals.

Assuring Safety

The U.S. Coast Guard is the lead federal agency in assuring safe navigation in U.S. waters and works with other nations to support maritime safety in international waters. The Coast Guard is using a critical new technology, the automatic identification system (AIS), to make Arctic shipping safer. Almost all commercial vessels operating in U.S. waters are now equipped with AIS transponders that continuously transmit information about the vessel and its route, allowing the Coast Guard to convey warnings, monitor ships' positions, and send help when needed.

Although technology is improving, communication and international cooperation remain critical in ensuring the safety and security of ships navigating the Arctic. In 2013, the Transportation Research



Comparative views of the Muir Glacier, Glacier Bay National Park, in 1976 (*top*) and 2003 (*bottom*), reveal losses of land ice.

Board published a conference summary, *Safe Navigation in the U.S. Arctic*, exploring the challenges and needs related to vessel traffic in U.S. Arctic waters.¹

Oil and Mineral Extraction

Increased oil activities open the region to an increased risk of spills. Managing an oil spill is extremely challenging in temperate and calm conditions, but the remoteness and harsh conditions of the Arctic make it particularly difficult to mount a speedy and effective response. Severe storms or water routes suddenly frozen over can block responders. In winter, the reduced daylight poses special challenges. Communications infrastructure and response equipment are limited in many areas of the Arctic, hindering responders' ability to coordinate efforts.

Sea ice and other environmental variables—such as rapidly changing weather and dense fog—can complicate a response to an oil spill, and no single technique applies in all situations. Operators working in the Arctic need to assess the environmental trade-offs associated with different response options and to deploy any or all—or none, if warranted—of the measures available to reduce the impacts on the ecosystem.

Oil spills can harm ecosystems and societies anywhere, but communities in the Arctic are particularly vulnerable. Because many Arctic residents rely on hunting and fishing to feed their families, even temporary damage to the ecosystem can be catastrophic. Not only can a source of sustenance be lost, but also the customs that go along with the practices and the preparation. The wild animals and ecosystems of the Arctic are similarly vulnerable to spill-related toxins and food chain disruptions.

The 2014 National Research Council report *Responding to Oil Spills in the U.S. Arctic Marine Envi-*

¹ www.trb.org/Publications/Blurbs/168726.aspx.



PHOTO: AMANDA NOIKROSS, U.S. COAST GUARD

ronment identifies priorities for improving the ability to respond to a serious oil spill in the Arctic.²

An oil drill ship departs Puget Sound for the Arctic.

Tourism at the Ends of Earth

Warm or cold, the Arctic remains extraordinary—the stunning landscapes, fascinating wildlife, and unique cultures long have attracted tourists and adventurers. As Arctic waters and land become easier to navigate, the number of people with the means and motivation to tour the Arctic is rapidly increasing.

Cruise ships and small personal vessels are venturing farther into the Arctic each year, and tourists have become the largest human presence in many Arctic regions. A steady flow of tourists can be a boon to the local economies of Arctic communities, creating jobs in shops, restaurants, hotels, and tour companies.

But tourism also has downsides for the indigenous communities—for example, tourists may violate traditional customs or damage cultural sites and artifacts. Cruise ships can have an impact on traditional hunting and fishing in the summer, when

² www.nap.edu/catalog/18625/responding-to-oil-spills-in-the-us-arctic-marine-environment.



PHOTO: BUING, FLICKR

Shipping traffic in the Arctic is increasing.

Marine Board Recognizes Arctic Shipping as a Priority Issue

SCOTT BROTEMARKLE

The Transportation Research Board (TRB) Marine Board has considered Arctic shipping as a priority topic for several years and has conducted activities reflecting this focus.^a Formed in 1965, the TRB Marine Board is an internationally recognized source of expertise on maritime transportation, marine engineering, and technology. As part of its charge, the Marine Board identifies research needs and provides a forum for exchange of information on new technologies, laws and regulations, economics, the environment, port operations, coastal engineering, and other issues that affect the marine transportation system.

In October 2012, the Marine Board developed and conducted a workshop, Safe Navigation in the U.S. Arctic.^b The workshop identified the inherent risks of navigation in the Arctic, reviewed the capability for maritime emergency response in Arctic waters, and explored partnerships and international cooperation for vessel traffic management and infrastructure improvements to enhance navigation safety.

The workshop sessions examined these concerns from the perspective of high-risk operations and plausible incidents—namely, a passenger vessel grounding accident and an oil spill response. In addition, the workshop addressed information and data needs for mariners and for emergency response agencies, research needs and gaps in understanding, risk assessment techniques, and resource models for funding and implementing systems for traffic management, navigation data delivery, and emergency response.

The Marine Board contributed to the oversight of the National Research Council's 2014 report, *Responding to Oil Spills in the U.S.*

^a www.trb.org/MarineBoard/PriorityIssues.aspx.

^b www.trb.org/Main/Blurbs/168726.aspx.

Arctic Marine Environment.^c The report surveys the state of the science of oil spill response and environmental assessment in the Arctic region north of the Bering Strait. The study examines the best preparations for response to an oil spill event, in the context of the proliferation of oil and gas exploration, forecast increases in cargo shipping, and the prospects of adventure cruise tourism in the high latitudes of U.S. Arctic waters.

In April 2015, the United States assumed the responsibility of chairing the Arctic Council for a two-year term, and the U.S.-led agenda has renewed the focus on Arctic Ocean safety. To assist with this charge, working with the U.S. Department of State, the Marine Board devoted part of its fall 2015 meeting to a focus session on responding to emergencies in the Arctic. Stakeholder experts addressed emergency preparedness and emergency response capability; lessons learned from exercises, recent marine accidents, and oil spill responses in the Arctic since 2012; the state of relationships with neighboring Arctic nations within the context of emergency response plans, exercises, and availability of shared

resources; and emergency response infrastructure needs and priorities.

With the expected trend of longer ice-free seasons increasing maritime transport in the U.S. Arctic, the Marine Board will continue paying close attention to the risks and resource issues associated with Arctic shipping.

The author is Senior Program Officer, Marine and Intermodal Freight, and Staff Director, Marine Board, Transportation Research Board, Washington, D.C.

^c www.nap.edu/catalog/18625/responding-to-oil-spills-in-the-us-arctic-marine-environment?utm_expid=4418042-5.krRTDpXJQISoXLpdo-1Ynw.0.



Conference Proceedings on the Web 11, Safe Navigation in the U.S. Arctic, summarizes a 2012 conference in Seattle, Washington.^b

Personnel from the U.S. Coast Guard and City of Nome, Alaska, conduct a mass rescue exercise to enhance regional emergency preparedness.



PHOTO: TOM PAUSER, U.S. COAST GUARD



Tourists explore the ice in the Canadian Arctic, August 2013.

obtaining subsistence resources to last through the winter is important and when many animals feed, mate, and tend their young—and are at their most vulnerable.

In addition, tourism increases the pressure on land, water, wildlife, and other natural resources. Ships may intentionally or inadvertently discharge sewage, oil, invasive species, and debris into sensitive Arctic environments. Increased tourism traffic through Arctic land and water also increases safety risks and adds to the burden on limited emergency support personnel.

National Security Far North

Melting sea ice makes the Arctic more accessible to commercial and military interests. In addition, the growing interest in exploiting the region's rich natural resources could spark disputes over territory and transit rights among the countries bordering and pursuing business interests in the Arctic.

The likelihood of conflict in the Arctic is low but cannot be ruled out. The relationships between Arctic nations could become more strained in the future as the stakes rise in the competition for Arctic resources. Experts have raised concerns about the limited surface capability and operational infrastructure of the U.S. Navy in the region and have suggested that the United States reinstitute a cold-weather training program and improve the mapping, communications infrastructure, and navigation charts for the region. In addition, the U.S. fleet of icebreakers—vessels capable of clearing a path through ice-covered water—needs updating to boost the nation's ability to train, operate, and engage in the Arctic.

The 2011 National Research Council report *National Security Implications of Climate Change for U.S. Naval Forces* addresses U.S. preparedness for national security threats in the Arctic.³

Changes for Arctic Peoples

The Arctic is home to approximately 4 million people, from city dwellers to oil prospectors to hunters and herders living on the land. Many are members of indigenous groups whose ancestors have lived in the Arctic for millennia. Altogether they are citizens of eight countries and speak dozens of distinct languages. The unique and diverse communities of the Arctic face an uncertain future.

Thawing permafrost poses significant problems for residents. The thawing changes the shape of the land, and streams or bodies of water can form in previously dry areas. The resulting erosion wreaks havoc on buildings, roads, pipes, and other infrastructure and costs communities hundreds of millions of dollars to make repairs and to keep up with changing conditions.

In addition, melting snow and ice pose problems for subsistence hunters, who typically rely on over-ice forms of transportation, such as dog sleds and snowmobiles, to reach the habitats of animals like seals,

³ www.nap.edu/catalog/12914/national-security-implications-of-climate-change-for-us-naval-forces.

The U.S. Navy submarine *USS Hampton* surfacing at the North Pole during an operational exercise beneath the polar ice cap.





PHOTO: ANSGAR WALK

A family with a traditional qamutick or sled near Cape Dorset, an Inuit hamlet in Nunavut, Canada.

walrus, and caribou. Reductions in ice or snow reduce the hunters' range and make travel riskier.

Towns along the coasts are especially vulnerable. Historically, large swaths of sea ice along the shoreline have provided a buffer against coastal storms and waves. As sea ice declines, however, coastal communities are facing the full brunt of increasingly strong storms. In addition, sea-level rise threatens low-lying communities, and advancing seas and stronger storms may force some communities to relocate. The 2014 National Research Council report *The Arctic in the Anthropocene: Emerging Research Questions* explores the need for actionable Arctic science to improve understanding of the environmental and societal changes and their effects on the Arctic and the rest of the world.⁴

⁴ www.nap.edu/catalog/18726/the-arctic-in-the-anthropocene-emerging-research-questions.

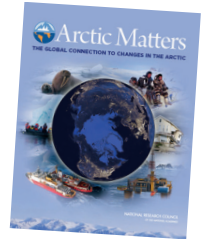
Resilience in the Face of Change

Arctic residents already are finding new ways to survive and thrive. Residents are diversifying their sources of income and are shifting the times and places for hunting, gathering, herding, and fishing. To make travel safer, residents are working to improve their communications infrastructure and to increase the use of GPS and other specialized equipment to navigate treacherous terrain and assess sea ice conditions. At the community level, Arctic residents are investing in greater protection against extreme weather—for example, with infrastructure for flood and water management.

Climate change and uncertainties are affecting the Arctic at a pace more rapid than in other places in the world. The Arctic Matters resources make clear that rising sea levels, ecological changes, geopolitical shifts, new opportunities for resource extraction, and countless other changes will have immediate and lasting effects around the globe.

Acknowledgments

For more information about *Arctic Matters: The Global Connection to Changes in the Arctic*, visit <http://nas-sites.org/arctic>. Support for this project was provided by the National Oceanic and Atmospheric Administration, the National Science Foundation, the U.S. Global Change Research Program, and the National Academy of Sciences.



Further Reading

The *Arctic Matters* booklet is based on the following National Research Council reports:

- The Arctic in the Anthropocene: Emerging Research Questions*, 2014
- Responding to Oil Spills in the U.S. Arctic Marine Environment*, 2014
- Linkages Between Arctic Warming and Mid-Latitude Weather Patterns: Summary of a Workshop*, 2014
- Opportunities to Use Remote Sensing in Understanding Permafrost and Related Ecological Characteristics: Report of a Workshop*, 2014
- Abrupt Impacts of Climate Change: Anticipating Surprises*, 2013
- Climate Change Evidence and Causes: An Overview from the Royal Society and the U.S. National Academy of Sciences*, 2014
- Safe Navigation in the U.S. Arctic: Summary of a Conference*, Transportation Research Board, 2013
- Seasonal-to-Decadal Predictions of Arctic Sea Ice: Challenges and Strategies*, 2012
- Sea-Level Rise for the Coasts of California, Oregon, and Washington: Past, Present, and Future*, 2012
- Frontiers in Understanding Climate Change and Polar Ecosystems: Summary of a Workshop*, 2011
- National Security Implications of Climate Change for U.S. Naval Forces*, 2011



PHOTO © MIKE KENNEY PHOTOGRAPHY 2014

On March 1, 2014, 65 mushers and their teams of dogs left Anchorage, Alaska, on a quest to win the Iditarod—a race covering 1,000 miles of mountain ranges, frozen rivers, dense forest, tundra, and coastline. According to local news reports, a lack of snow covering the trail's harsh terrain made the race especially challenging, and many mushers pulled out because of injuries and broken sleds.

Funding and Managing the U.S. Inland Waterways System

What Policy Makers Need to Know

MELISSA WELCH-ROSS AND CHRIS HENDRICKSON

Welch-Ross is Director of Special Initiatives, Division of Behavioral and Social Sciences and Education, National Academies of Sciences, Engineering, and Medicine, Washington, D.C.; she served as director for this TRB study. Hendrickson is Hamerschlag University Professor of Engineering, Carnegie Mellon University, Pittsburgh, Pennsylvania, and a member of the TRB Executive Committee; he chaired the study committee.

The U.S. inland waterways include more than 36,000 miles of commercially navigable channels and roughly 240 working lock sites (Figure 1, page 28). The U.S. Army Corps of Engineers (USACE) manages the federal inland waterways system with funding from the Corp's navigation budget. The chief—and most expensive—component of providing for navigation service is the installation, maintenance, and operation of lock and dam infrastructure to enable the upstream and downstream movement of cargo.

Funding and managing this extensive and historic navigation system is a continuing challenge. In 2014, the Transportation Research Board (TRB) Executive Committee initiated a consensus study of the inland waterways system in response to reports of deteriorating and aged infrastructure, levels of

capital investment perceived as inadequate, a growing backlog of capital needs, and the decline in federal appropriations for inland navigation. In June 2015, the study committee (see box, page 31) released TRB Special Report 315, *Funding and Managing the Inland Waterways System: What Policymakers Need to Know*.

Federal Investments

Historically, the federal government has invested in the building of the inland waterways system to aid in the physical expansion of U.S. territory and in the growth of the U.S. economy. Because of historical precedent, the federal role in the management and funding of the inland waterways for commercial navigation is greater than it is for the other freight modes.

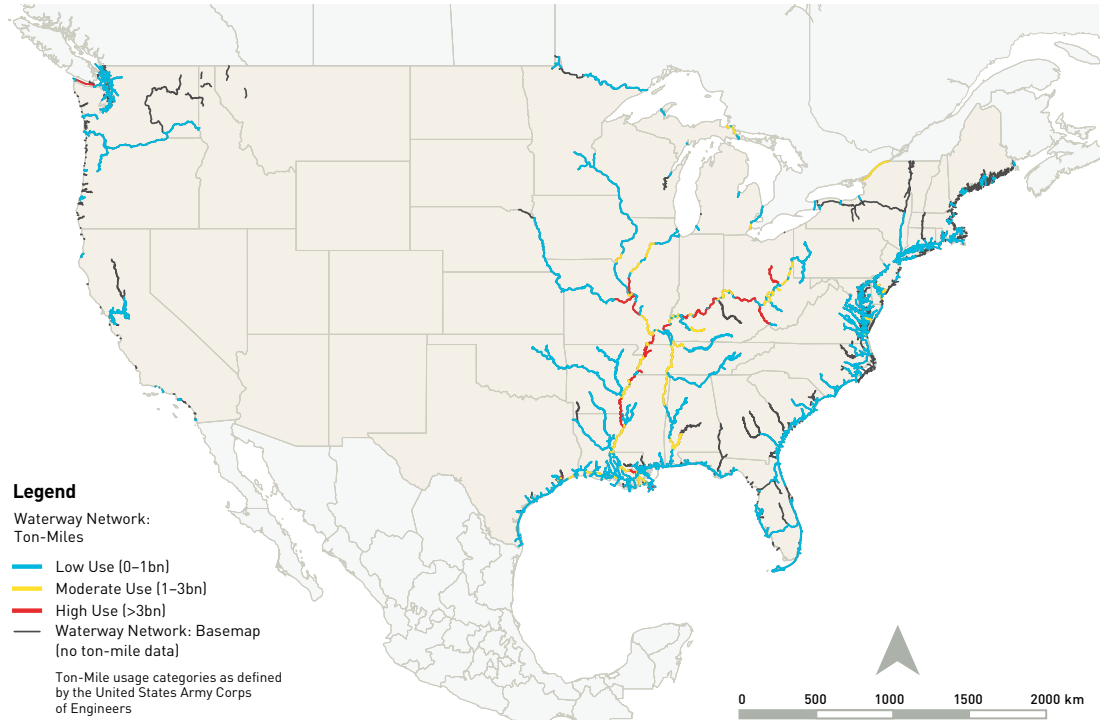
Federal general revenues cover all operation and



Emsworth Locks and Dams on the Ohio River, U.S. Army Corps of Engineers Pittsburgh District.

PHOTO: CHRIS HENDRICKSON

FIGURE 1 Inland waterways network usage in ton-miles.



U.S. Army Corps of Engineers (USACE) Sacramento District engineers prepare climbing ropes to complete an inspection of the Tainter floodgates at New Hogan Dam in California.

maintenance (O&M) expenses for the inland waterways, but states pay 100 percent of the O&M expenses for the intercity highways used by motor carriers, with funding mostly from user fees. Private industries generally pay the O&M expenses of railroads and pipelines.

Paying for the provision of commercial navigation on the inland waterways has been a subject of debate for decades. Before 1978, the federal government paid all costs associated with construction and maintenance of the inland waterways. Legislation passed

in 1978 and 1986 established the current funding and cost-sharing framework. Today, 11,000 miles of the inland waterways are subject to a federal fuel tax paid by the barge industry into the Inland Waterways Trust Fund; this covers up to 50 percent of the cost of the construction and the major rehabilitation of the lock and dam infrastructure.

The federal government pays 50 percent of the construction costs from general revenues and 100 percent of the cost of O&M. The budget defines O&M expenses as repairs costing up to \$20 million; repairs that exceed \$20 million and meet other criteria are considered major rehabilitation and are classified as capital expenditures.

Changing Focus for Funding

Policy debates about funding for the inland waterways have focused largely on capital projects; this was appropriate for a growing system. Now that the system is built-out and mature, however, O&M funds from federal general revenues account for most of the annual budget request for inland navigation.

Proposals for user charges for the system date back to the 1940s, with supporters including the Office of Management and Budget, the Government Accountability Office, and the presidential administrations of both parties since President Franklin Delano Roosevelt. The shipping industry has not supported the proposals for charging users.



PHOTO: JOHN PRETTYMAN, USACE

The goal of the TRB study was to assess the following:

- ◆ The role and importance of the federally funded inland waterways system in transportation,
- ◆ The system's costs and benefits,
- ◆ The estimated levels of investment required to achieve an efficient inland waterways system and the options for the funding, and
- ◆ Who should pay for the required investment.

The TRB consensus committee examined the available evidence and arrived at four major conclusions.

1. The inland waterways system is a small but important component of the national freight system.

In terms of total ton-miles of freight, the inland waterways system moves 6 to 7 percent of all domestic cargo, mostly bulk commodities (Figure 2, below).

The primary expense in providing for barge service is the maintenance of locks and other infrastructure that enable cargo movements. Many locks are more than 50 years old, but age is not a useful indicator of condition. Many locks have undergone rehabilitation; lock performance therefore does not correlate with age.

The large backlog of authorized capital projects also is not a reliable indicator of the funding needed to maintain reliable freight service. The navigation share of these projects is modest, and the backlog does not include maintenance costs; moreover, Congress has authorized more projects than can be funded.

2. A sustainable and well-executed plan for maintaining system reliability and performance to ensure

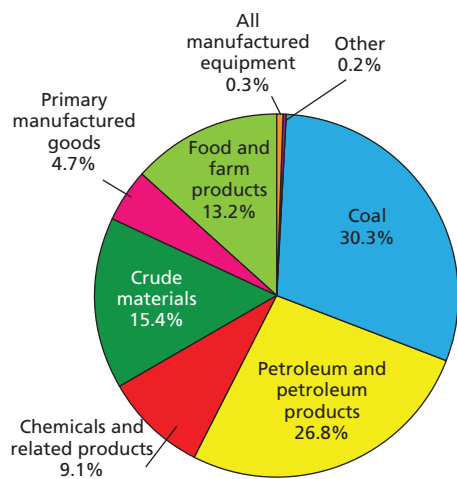


FIGURE 2 Inland barge navigation (in tons).



Photo: USACE

efficient use of limited navigation resources is the most critical need for the inland waterways system.

Time lost because of delays at locks and because of locks taken out of commission for repairs increases costs for shippers. The lack of availability is an important consideration in decisions about investments to maintain reliable freight service.

Throughout the system, scheduled and unscheduled lock outages are the causes of approximately 20 percent of the time lost in transportation. A targeted O&M budget could prioritize the facilities that are most in need of maintenance and for which the economic cost of disruption would be highest.

USACE has started a process of prioritizing O&M spending using these criteria, but the process is not fully developed. Despite the need to focus on system reliability, much of the policy discussion about the inland waterways system has centered on the user charges to support the Inland Waterways Trust Fund, which is dedicated to capital improvement projects.

O&M accounts for roughly \$650 million annually, approximately three-quarters of the requested inland navigation budget. The 113th Congress passed an increase in the barge fuel tax, but this only has heightened the urgency of establishing a plan for maintenance; under the federal law, any new revenues from the barge fuel tax can be used only for construction.

Because funds for capital projects from the barge fuel tax must be matched by the federal government, O&M directly competes with construction for federal general revenues. Unless a new funding strategy prioritizes O&M and repairs, repairs may continue to be deferred until the cost reaches \$20 million, which classifies as a capital expenditure; this would lead to further deterioration and an inefficient, less reliable system.

Dredged material is deposited into the Ohio River downstream of the McAlpine Locks in Louisville, Kentucky. USACE is in charge of infrastructure maintenance activities.



PHOTO: PATRICK FELTEN, FLICKR

A new Galveston Causeway Railroad lift bridge over the Gulf Intracoastal Waterway allowed widening of the navigation channel through the draw span.

3. More reliance on a user-pays funding strategy for the commercial navigation system is feasible, would generate new revenues for maintenance, and would promote economic efficiency.

With the exception of a one-time infusion of funds from the federal economic stimulus legislation in 2009, the funds appropriated for inland navigation have declined in the past decade in terms of constant dollars for both O&M and construction. In a climate of federal budget constraints and with O&M becoming a greater part of the inland navigation budget, beneficiaries could help pay for the system. In the 2014 Water Resources Reform and Development Act,¹ Congress called for a study of whether and how the various beneficiaries of the waterways might be charged.

Prioritizing Maintenance

Because users of the inland waterways are not responsible for the cost of O&M, the incentives are strong to overcapitalize the system; a user-pays

¹ Section 2004, Inland Waterways Revenue Studies.



PHOTO: LEE ROBERTS, USACE

The Cordell Hull Lock and Dam on Tennessee's Cumberland River is 1,306 ft and includes a hydroelectric power generating plant.

approach would help to rectify that. Dedicating the revenues from users to O&M instead of capital expenditures would focus maintenance spending on the assets that users value most and would result in a system that is more cost-effective and efficient.

Commercial navigation is a primary beneficiary of the inland waterways, and commercial carriers impose significant marginal costs on the system. The inland waterways cover a large geographic area, but the freight flows are highly concentrated. Seventy-six percent of barge cargo (in ton-miles) moves on 22 percent of the 36,000 inland waterway miles. About 50 percent of the inland waterway ton-miles moves on six major corridors—the Upper Mississippi River, the Illinois River, the Ohio River, the Lower Mississippi River, the Columbia River System, and the Gulf Intracoastal Waterway—these represent 16 percent of total waterway miles.

Some inland waterway segments have minimal or no freight traffic. The nation needs a funding strategy that targets funds to the waterway segments and facilities that are essential to freight transportation, and away from projects that are not as important. USACE's budgeting process has adopted this triage approach.

Any user-pays system would require trade-offs. The report describes several criteria for choosing a user-charge option: the ease of administration, the revenue potential, the distribution of the burden across user groups, and the design components to reinforce the efficient use of resources and cost-effective expenditures.

The committee observed that a trust fund for maintenance would ensure that all new funds collected would be dedicated to inland navigation. USACE then would have greater latitude to disburse the funds for maintaining the system according to the criteria approved by Congress and with the involvement of the Inland Waterways Users Board, whose current role is limited to advice on capital spending.

Supporting Additional Benefits

In a user-pays system, an important consideration is how to pay for segments of the inland waterways on which freight traffic has waned but which still have other beneficiaries depending on the funds from commercial navigation service.

These other local benefits from the inland waterways include hydropower generation, recreation, flood damage avoidance, municipal water supply, irrigation, increased property values, sewage assimilation, and mosquito control. National benefits may include lower consumer costs—the availability of barge shipping may result in more competitive railroad pricing, known as water-compelled rates—as



The Columbia River is the largest river in the Pacific Northwest and an integral part of the U.S. inland waterways network.

well as environmental benefits from the lower fuel emissions from barges compared with other modes.

The study committee, however, decided that the available information did not allow conclusions about these additional benefits. Some localities are implementing alternative plans and mechanisms to pay for the maintenance needed to continue receiving benefits from the segments and facilities deemed not essential to freight transportation.

Determining the amount that beneficiaries would need to pay for the commercial navigation system and allocating the costs among the beneficiaries would be a complex task. This would require identifying the economic value of parts of the system to the beneficiaries of commercial navigation, as well as making a systemwide assessment of the assets necessary to achieve a reliable level of freight service.

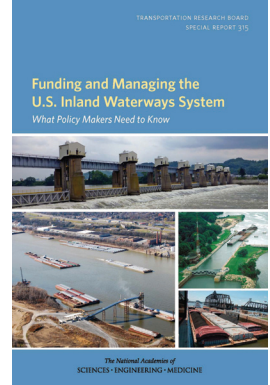
4. Asset management can help prioritize maintenance and ascertain the level of funding required for the system.

Determining the level of funding to sustain a reliable inland waterways system depends on the level of service expected from the system, which in turn identifies the parts of the system to be maintained. Regardless of who pays for the system, a program of economically efficient asset management (EEAM), fully implemented and linked to the budgeting process, could prioritize maintenance spending and ascertain the funding levels required for reliable freight service.

USACE has adopted a generally appropriate framework for asset management that is mostly consistent with EEAM, but the framework is not yet fully developed or deployed across the USACE districts. The framework recognizes the economic consequences of strategic investment and does not assume that all navigation infrastructure needs to be maintained at the original condition.

The approach appropriately includes assessments of three main EEAM considerations: the probability of the infrastructure's failure; the infrastructure's usage or demand, defined as low, moderate, or high levels of freight traffic on the waterway; and the economic consequences of a failure for shippers and carriers.

A fully developed and applied asset management approach could prioritize the allocation of resources for O&M to the waterways with economic value to shippers and carriers and could indicate areas for major rehabilitation or other capital spending. The committee's report offers suggestions for implementing an asset management approach.



TRB Special Report 315, *Funding and Managing the U.S. Inland Waterways System: What Policy Makers Need to Know*, is available from the TRB online bookstore, <https://www.mytrb.org/Store/Product.aspx?ID=7865>; to view the book online, go to <http://www.trb.org/Publications/Blurbs/172741.aspx>.

Committee on Reinvesting in Inland Waterways: What Policy Makers Need to Know

- Chris T. Hendrickson**, Carnegie Mellon University, Pittsburgh, Pennsylvania, *Chair*
- Leigh B. Boske**, University of Texas at Austin
- Michael S. Bronzini**, George Mason University, Fairfax, Virginia
- James J. Corbett, Jr.**, University of Delaware, Newark
- G. Edward Dickey**, Independent Consultant, Baltimore, Maryland
- C. James Kruse**, Texas A&M Transportation Institute, Houston
- B. Starr McMullen**, Oregon State University, Corvallis
- Leonard A. Shabman**, Resources for the Future, Washington, D.C.
- Thomas H. Wakeman III**, Stevens Institute of Technology, Hoboken, New Jersey



Members of the Committee on Reinvesting in Inland Waterways presented information on the study at a report release in Washington, D.C., in June 2015.

Sustainability as an Organizing Principle for Transportation Agencies

Transportation as a Means, Not an End

GARY R. McVOY

The author is Principal, McVoy Associates LLC, Slingerlands, New York, and served as chair of the NCHRP project panel for this report.

Transportation agencies can find support and direction in their essential service to society by pursuing the goal of triple bottom line (TBL) sustainability. Transportation agencies and organizations routinely face fundamental questions that are difficult to answer under current paradigms:

- ◆ How should agencies allocate funding among the modes?
- ◆ Which assets should agencies maintain and at what level?
- ◆ How much should agencies spend on increasing capacity?
- ◆ How can agencies streamline environmental approval processes?
- ◆ How should agencies organize and staff departments?
- ◆ What makes a program or policy sustainable?

Although most of these questions stem from a short-term, localized disconnect between costs and needs, deeper issues are at work. Most transportation agencies struggle with emerging issues of safety, reliability, resilience, freight, access, livability, economic development, environment, and social equity, applying approaches forged during the Interstate era.

Taking the Long View

The National Cooperative Highway Research Program (NCHRP) developed the Foresight Series of reports to provide agencies with a 50-year, strategic perspective for addressing many of these questions.¹ NCHRP Report 750, Volume 4, *Sustainability as an Organizing Principle for Transportation Agencies*, offers a framework that applies TBL sustainability precepts to decision making.²

Sustainability focuses on meeting today's social, environmental, and economic needs while providing for those of future generations; some label these concerns as people, planet, and prosperity. The premise of Volume 4 is that transportation plays a fundamental role in a sustainable society by providing for mobility and the distribution of goods and services. The value of transportation derives from the net value of these services, as measured by the TBL.



PHOTO: DAVID FALCONE, NATIONAL ARCHIVES AND RECORDS ADMINISTRATION

Interstate 5 cuts through a neighborhood in Portland, Oregon, circa 1973. Environmental concerns were not a high priority at the time many Interstates were originally constructed.

¹ www.trb.org/NCHRP750/ForesightReport750Series.aspx.

² http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_750v4.pdf.

Sustainability becomes not “another thing” but “the thing.”

Agencies can reframe many of the questions in transportation with TBL service to society as the overarching objective and can make a business case for alternative investments in day-to-day decision making. In this context, trade-offs and investment decisions expand beyond life-cycle costs to consider user benefits and environmental and social concerns.

For example, modal investment decisions involve the consideration of regional economic vitality, carbon emissions, access, and safety, along with the traditional concerns of cost and usage. Under a TBL approach, transportation services aim to maximize—and to optimize—societal welfare within practical confines creatively on a larger scale in a businesslike manner.

As business guru Edward Deming wrote in *The New Economics*, “The obligation of any component is to contribute its best to the system, not to maximize its own production, profit, or sales....” In other words, the measure of a transportation agency’s performance should be the net benefit contributed across society’s TBL instead of life-cycle costs or asset conditions. Transportation can contribute disproportionately to the economy, as long as society has other, more efficient mechanisms to improve social and environmental conditions; nonetheless, trans-

portation should maximize cost-effective contributions to these elements as part of its public mission.

Commitment to Sustainability

The conceptual maturity model in NCHRP Report 750, Volume 4, frames an agency’s progression from an internal focus on transportation infrastructure and mobility to an external focus on the sustainability of the larger community (Table 1, below). The distinctions between the levels are illustrative. The premise is that transportation agencies can progress from a narrow focus to a broader perspective necessary for effective support of a sustainable society. Although artificial, the construct can help an agency address sustainability in holistic terms and can provide a standard for assessing processes and performance from a more comprehensive vantage.

The organizational sustainability maturity model parallels the organizational history of transportation agencies:

- ◆ Level 0, Mobility, represents the post–World War II Interstate era and the focus on mobility and vehicular throughput.
- ◆ Level 1, Compliance, represents the era after the National Environmental Protection Act and the growing appreciation for the costs and impacts of

TABLE 1 Transportation Agency Sustainability Maturity Levels

Maturity Level	Objective	Metrics	Year	Characteristics
0. Safe mobility	Build Interstate Reduce fatalities	Miles built Number of crashes	1954–1970	Supports societal mobility Government ownership and control of infrastructure Transportation agency as owner–manager and regulator
1. Compliant transportation	Achieve letting goal Reduce fatalities Reduce congestion	Dollars spent Number of crashes	1970–2000	Supports societal mobility Compliance with environmental, economic, and social legislation Transportation agency as owner–manager and regulator Top-down planning
2. Green transportation	Reduce congestion Reduce fatalities Achieve letting goal Be green	Dollars spent Number of crashes Wetlands preservation CO ₂ emissions	1985–2015	Supports societal mobility, safety, and environmental, economic, and social needs; emphasis on environment Transportation agency as owner–manager and regulator
3. Sustainable transportation	Improve mobility Reduce congestion Reduce fatalities Achieve letting goal Be green and sustainable	Passenger miles Delay hours Number of crashes CO ₂ emissions Rating score	2010–2030	Supports sustainable transportation Favors partnerships between public and private sectors Transportation agency as infrastructure integrator (some owner–operator and some private) Transportation agency as regulator
4. Triple bottom line (TBL) sustainability	Improve mobility Reduce congestion Reduce fatalities Be green and sustainable Improve society	Passenger miles Delay hours Number of crashes CO ₂ emissions Rating score Public support TBL in dollar equivalents	2025–	Supports societal sustainability Broad agency decision-making partnerships Risk sharing between public and private sectors Transportation agency as infrastructure integrator (some owner, some owner–operator, and some private) Transportation agency as system’s steward and regulator

Washington State DOT installed a larger culvert as part of its SR-520 improvement project. The new culvert will allow fish migration and is among several other environmental improvements in the project.



PHOTO: WASHINGTON STATE DOT

transportation projects.

- ◆ Level 2, Green Transportation, includes environmental stewardship and a proactive, positive approach to externalities.

- ◆ Level 3, Sustainable Transportation, addresses TBL concerns, including social and economic benefits, yet without the tools and institutional arrangements for effective delivery.

- ◆ Level 4, TBL Sustainability, represents a full commitment to transportation services in support of a more sustainable society.

Operationalizing Sustainability

Tools for assessing projects and programs are important for agency decision making and are helpful in assessing organizational capacities and methods. For example, at Level 0, Mobility, an agency needs only basic tools to plan and deliver highway capacity. At Level 1, Compliance, environmental assessments are helpful in avoiding, minimizing, and mitigating adverse environmental impacts.

At the midpoint of maturity, Level 2, Green Transportation, proactive environmental stewardship calls

TABLE 2 National and State Level Sustainability Rating Systems

System	Sponsor	Scope	Criteria	Review	Link
Envision	Institute for Sustainable Infrastructure	Infrastructure	Checklist includes 60 credits in five categories: quality of life, leadership, resource allocation, natural world, and climate and risk	Fee-based	www.sustainableinfrastructure.org/rating/
GreenLITES	New York State DOT	Highways	Checklist includes 180 project development criteria and additional tools for planning, operations, and maintenance	Self-assessment	https://www.dot.ny.gov/programs/greenlites
INVEST	Federal Highway Administration	Highways	Checklist includes 64 criteria, planning through operations and maintenance	Self-assessment	https://www.sustainablehighways.org/
Greenroads	Greenroads Foundation	Highways	Checklist includes 48 criteria focused on design and construction	Fee based	https://www.greenroads.org/
STARS	North American Sustainable Transportation Council	Multimodal transportation	Checklist includes 29 credits, planning through operations	Fee-based	www.transportationcouncil.org/
TIGER	U.S. DOT	Transportation, all modes	Benefit-cost, dollar-based valuation across many aspects of the triple bottom line	Grant program	www.dot.gov/policy-initiatives/tiger/tiger-bca-resource-guide-2014
INSTEP	U.S. National Park Service	Transportation, all modes, within park setting	Checklist includes 37 criteria focused on design and construction	Self-assessment	https://www.nps.gov/articles/transinstep.htm



Slauson Avenue in Los Angeles, California. L.A. Metro received a \$15 million federal TIGER grant to replace an underused rail corridor with 6.4 miles of pedestrian and bike path.

for more than avoiding negative impacts, applying a systematic method for assessing the sustainability features of projects and programs. A checklist of best practices for increasing TBL benefits can be helpful in awarding points for achievement and can render a score for a project or decision—much like the Leadership in Energy and Environmental Design, or LEED, certification awarded by the U.S. Green Building Council.

Some of the more popular Level 2 sustainability tools are shown in Table 2 (page 34), which provides links to more detailed information about the means and methods. These tools are evolving, becoming more sensitive to a project's context, but still tend to award points on the basis of utilization, without regard to the cost, value, or quantity of the TBL results.

At Level 3, Sustainable Transportation, the focus is on the TBL results—including the social and economic—and requires sustainability tools that recognize context and opportunity. Checklist tools continue to be useful, although TBL valuation tools are gaining acceptance, such as those used in the U.S. Department of Transportation (DOT) grants program TIGER—or Transportation Investment Generating Economic Recovery. The TIGER program valuation tools translate a range of project benefits and costs into dollar equivalents, allowing for informed trade-offs between competing factors such as safety, mobility, emissions, and access.

Nevertheless, accepted values are lacking for intangibles such as wildlife habitat, aesthetics, community cohesion, and more. The calculations therefore tend to leave these out, and the analyses must address the considerations separately through weighting factors and other means.

Collaborative decision making assumes critical importance at Level 4, TBL Sustainability. At this point, the agency has a full appreciation of—and commit-

ment to—transportation service in support of a more sustainable society and is working with a range of stakeholders to achieve shared objectives. Outreach tools to define and achieve consensus on outcomes and values become essential.

Consensus Building

The TBL valuation approach is essential for agencies focusing on service to a more sustainable society. For example, the benefits of paratransit service to the general traveling public may seem small because of the number of passengers involved, and the benefits to the agency in terms of net revenue may be negative; but from the societal perspective, if paratransit can help an aging population remain in their homes and avoid the institutional costs of assisted living, the service can benefit residential care, individuals, and families, as well as reduce the cost of publicly provided care.

A TBL approach helps agencies more effectively provide essential services such as paratransit.



Improvements to the southern section of the Robert Moses Parkway in New York State were part of a state-selected GreenLITES project.



Photo: Adam Moss

A TBL dollar-equivalent approach to the business case for paratransit can illuminate the net benefits and costs for decision makers. Moreover, funding transfers between transportation and the agencies responsible for elder care can be considered on a “level playing field” to optimize society’s services for the mobility challenged.

Similarly, at Level 4, the streamlining of discussions and decision making for project-level environmental permitting becomes more tractable. If all of a state’s agencies are seeking to contribute to a more sustainable society as a common, unifying objective, the state DOT would be advancing projects that have been publicly vetted and that exhibit a significant long-term, net positive TBL value. Environmental resource agencies accepting this premise would focus the permitting process on determinations of public interest and would participate as partners in the consensus valuation process.

For example, some would argue that resources such as wetlands are irreplaceable and inappropriate for valuation, but from the Level 4 perspective, the larger society is spending public money or forgoing common, long-term TBL net benefits through avoidance; this imputes a value to the wetlands. With a larger purview, the analytics and transparency of the consensus valuation approach would engage all agencies and stakeholders in serving a more sustainable society and would provide a mechanism for more effective environmental permitting.

Transportation agencies can advance this Level 4 consensus building by transparently engaging those who are willing to discuss the issues and by documenting the reasoning in dollar equivalents. The Internet can aid this type of discussion and analysis and

may provide precedents and defensibility in any litigation. Starting with approaches and tools like those of the TIGER projects and embracing the method of successive approximations—familiar to field practitioners—agencies can convey the true value of transportation services to the larger society, as outlined in NCHRP Report 750, Volume 4.

Applying the Model

New York State DOT and California DOT (Caltrans) have field-tested the maturity model. New York State DOT surveyed staff with such questions as “What can be done to further advance sustainability within the agency?” and “What’s holding us back?”³ Caltrans applied the maturity model to inform the next steps in developing a strategic management plan⁴ and published a one-page synopsis for internal instruction.⁵

The first meeting of state DOT sustainability directors, hosted by Caltrans and the State Smart Transportation Initiative in June 2015, keynoted both of these tools and the conceptual frameworks.⁶ As a result, additional collaboration is under way using the NCHRP Report 750 sustainability precepts.

Additional material on this topic is available in a presentation from the May 2015 TRB International Conference on Transportation for Sustainability⁷ and on the NCHRP Foresight Series website.⁸

³ <https://www.surveymonkey.com/r/Z79993R>.

⁴ www.dot.ca.gov/perf/library/pdf/Caltrans_Strategic_Mgmt_Plan_033015.pdf.

⁵ <http://1drv.ms/1GjKsJb>.

⁶ www.ssti.us/Events/dot-sustainability-directors-meeting/.

⁷ http://events.webcastingconferences.com/600_trb_sustainability/lobby_br2/.

⁸ www.trb.org/NCHRP750/ForesightReport750Series.aspx.

Incorporating Transportation Security Awareness into a State Agency's Routine Operations and Training

A Shared Responsibility

PAT BYE AND JEFFREY WESTERN

Bye is Consultant, and Western is Principal, Western Management and Consulting, LLC, Madison, Wisconsin. Western is an emeritus member of the TRB Standing Committee on Critical Transportation Infrastructure Protection.

All transportation employees contribute to security—security is everyone's responsibility. Although the state emergency management or homeland security organizations hold primary accountability for security, state departments of transportation (DOTs) control access to critical components of the transportation network, coordinate with law enforcement to ensure quick response to incidents, conduct risk and vulnerability assessments, and work to mitigate the effects of risks and vulnerabilities.

Because of their varied responsibilities and work locations, transportation agency employees are often the first to notice or learn about suspicious activity and are best positioned to recognize threats or security concerns. The greatest obstacle to effective security is a decrease in employees' vigilance because of infrequent incidents.

Security Mindset

As with safety, establishing a security mindset in all transportation agency endeavors is critical. Talking about security is as important as taking physical actions for security.

Security is a responsibility and concern of all transportation agency employees.



PHOTO: WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY

A Metro Transit K-9 team inspects fare vending machines in a Washington, D.C., Metro station.

Agency leadership must support and reinforce a security awareness program. When all employees understand the importance of security in their daily work, and each takes responsibility to know the security risks and the appropriate measures to address potential and actual security issues, the agency has established a security culture—security has become integral to the daily routine.

National Cooperative Highway Research Program (NCHRP) Report 793, *Incorporating Transportation Security Awareness into Routine State DOT Operations and Training*, highlights the importance of security awareness for all agency employees and contractors and describes techniques to integrate all-hazards security awareness into routine operations, maintenance, and training. The guide is designed to improve the security of transportation systems within resource and budget constraints. The research



PHOTO: OREGON DOT

Security Awareness Dos and Don'ts: Keeping Safe

DO report unusual or suspicious people or items right away.

DO record as many details as possible.

DO NOT take risks that could harm yourself or others.

DO NOT try to “handle it” yourself.

DO NOT confront a suspicious individual.

DO NOT touch, move, or cover a suspicious substance or object.

DO NOT allow an unauthorized person access to restricted areas.

findings draw on a review of training practices in the field, a comprehensive scan of the transportation community, and interviews with industry practitioners.

Training Programs

Almost 60 percent of the survey respondents indicated that their organization required or encouraged training in transportation security. Nevertheless, other types of training were more prominent—for example, 88 percent required or encouraged training in emergency preparedness; 79 percent in transportation safety; and 71 percent in continuity of operations.

Security training has changed and matured in the past 10 years. Comprehensive sustainable security training calls for updated and improved approaches that emphasize relevance and repeatability and maintain employees' interest. Federal requirements for the security training of transportation employees have focused on transit and on hazardous materials and food transport.

The American Public Transportation Association issued its Recommended Practice: Security Awareness Training for Transit Employees in 2012. NCHRP Report 525, Volume 14, *Security 101: A Physical Security Primer for Transportation Agencies*, outlined the elements of training for a security awareness program.

Security courses and curricula geared to agencies include the First Observer training from the Department of Homeland Security–Transportation Security Administration (TSA), TSA brochures on security



PHOTO: METRO TRANSIT

A bicycle rapid response training session for Metro Transit Police in Minneapolis–St. Paul, Minnesota. Metro Transit received a Gold Award in bus safety from the American Public Transportation Association for their operations and communications safety measures.

awareness, resources from the Federal Highway Administration, training from the Federal Emergency Management Agency and the State Emergency Management Agency, and NCHRP resources, such as NCHRP Report 525, Volume 7, *System Security Awareness for Transportation Employees*.

Organizational Readiness

Five key questions can determine a transportation agency's readiness to support an effective security awareness program:

1. Does the management support security awareness?

Successful security awareness programs have top-level support. As with safety, security in a transportation agency is a top-down organizational activity. Management must understand and accept the responsibility to demonstrate the importance of security awareness and its integration into daily operations and maintenance.

2. Has the agency identified and articulated a reporting structure, making clear what gets reported and to whom?

Establishing a reporting structure—who to inform and how to describe something suspicious—is critical. Employees need to know who to contact—an internal supervisor or security staffer or an external law enforcement agency; how to contact—for example, by emergency hotline or calling 911; and what information to report—namely, the who, what, where, and when and the details about the persons, objects, or vehicles involved (see Figure 1, page 39).

The Federal Emergency Management Agency (FEMA) hosts a disaster survivor assistance team training exercise for FEMA Corps members.



PHOTO: K.C. WILSON/FEMA

3. What awareness behaviors should an agency recommend and reinforce—what should employees look out for?

Security awareness should focus on supporting business needs and processes. What are the agency's priorities? What are the agency's areas of concern? What should employees look out for and how? Establishing security behaviors as a part of everyone's routine relies on common knowledge to exercise common sense.

4. Are the security procedures documented and are reporting mechanisms in place?

Integrating the reporting structure into internal security procedures can increase the effectiveness of a security awareness program. Are the security procedures documented? Can internal procedures be used in the employee security awareness program?

5. Does the agency have organizational relationships with law enforcement—can employees call an established external contact number?

Security awareness programs commonly recommend that employees contact external law enforcement. An agency that already has established organizational relationships with local law enforcement has a starting point to explore reporting options.

Core Components

Effective security awareness messages are relevant, appropriate, realistic, and consistent and present examples from agency experience. A security awareness program includes the following elements:

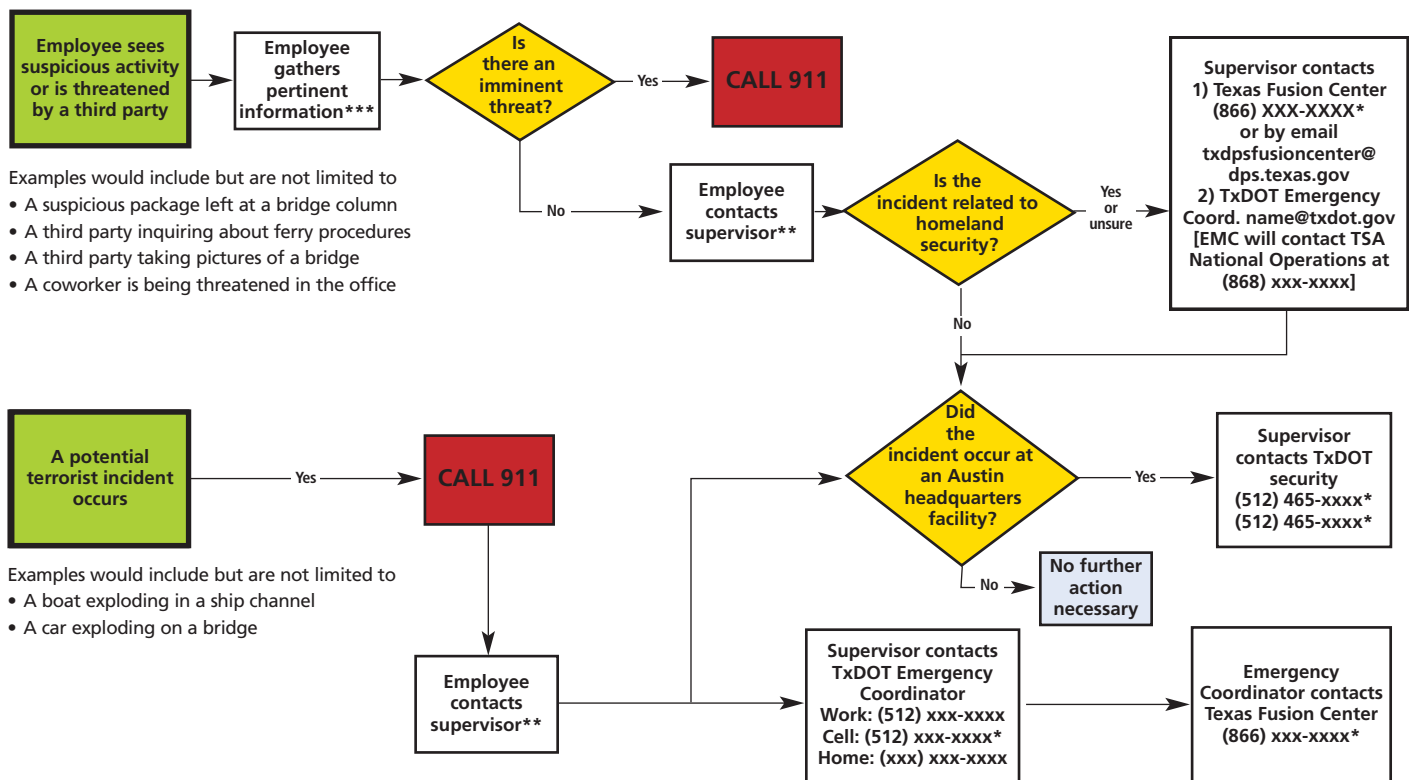
- ◆ **Communicating general messages**—promoting security awareness with such messages as “Security begins with you!” and “Be alert and be aware—you are the eyes, ears, and mouths of the DOT.”

- ◆ **Knowing the risks**—informing employees about the risks within the agency and the potential consequences. Messages can include a general overview of the risks to transportation agency systems, as well as specific, job-related messages—for example, alerting maintenance employees about the risks involving vehicles, equipment, and facilities.

- ◆ **Recognizing and observing security risks**—providing practical tips on how to detect and identify potential security risks—for example, “Note suspicious activities and objects and report things that do not seem right” and “Know your coworkers, your community, and your work environment. Be aware of unusual changes in your surroundings.”

- ◆ **Reporting a security threat**—clarify ways to

FIGURE 1 Texas DOT flowchart for security reporting procedures.



* Phone numbers are available 24/7.

** Supervisor will contact district or division office and may take any additional actions as necessary.

*** Employees should not endanger themselves by picking up suspicious packages, confronting suspects, etc.

The “if you see something, say something” security awareness campaign from the U.S. Department of Homeland Security is utilized by transit agencies across the country.



PHOTO: ZENON/FLICKR

respond to and report a security threat. Specify the contact, how to contact, and what information to provide. Posters, employee handouts, and wallet cards are effective ways to communicate the reporting guidelines throughout the agency.

Mainstreaming Awareness

Mainstreaming all-hazards security awareness in transportation agencies presents a challenge. Following are techniques that have proved effective and relatively inexpensive to implement, along with methods for promoting security awareness within a state DOT:

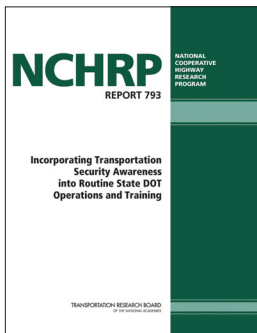
1. **Suggest that senior leaders and management include security awareness messages in all communications to employees.** Senior leadership can discuss security at every opportunity. At regular meetings, for example, management and supervisors can discuss how to integrate security into daily work routines, perhaps by including security sweeps in pretrip and posttrip vehicle inspections and by checking depots for suspicious activity, packages, or devices.

2. **Discuss security at the small unit level.** Managers and supervisors can establish a routine for discussing things out of the ordinary and the importance of security awareness. The ideal is to highlight security along with safety as an essential part of the workplace routine.

3. **Incorporate security awareness into employee training.** Security awareness is an appropriate topic in training new employees and can be included in position-specific training. For example, Texas DOT incorporates awareness information into bridge inspector training, highlighting vigilance and communication. The module includes what to look for during an inspection, such as suspicious graffiti or unusual damage. The fracture-critical module of the training emphasizes vigilance about unusual or suspicious objects on the vulnerable points of a bridge.

4. **Include security awareness messages in regular internal communications and at special events.** Agency newsletters and e-mails can include awareness reminders and security tips. Posters, in-box reminders, and employee wallet cards can convey security messages and can disseminate information throughout the agency. At special events, spotlighting employees who maintain secure work areas and practices is a way to keep everyone motivated and aware.

NCHRP Report 793 offers an introduction to transportation security and the role of state DOTs. The research identifies the core components of a security awareness campaign, with examples from transportation agencies. Appendixes include an overview of available training, with links to courses and resources; a list of contacts at training organizations; and a directory of resources on transportation security.



NCHRP Report 793, *Incorporating Transportation Security Awareness into Routine State DOT Operations and Training*, is available from the TRB online bookstore, <https://www.mytrb.org/Store/Product.aspx?ID=7416>; to view the book online, go to www.trb.org/Main/Blurbs/171543.aspx.

Design Management for Transportation Construction Projects

Design-Build and Construction Manager-General Contractor Methods

R. EDWARD MINCHIN, JR., AND GIOVANNI C. MIGLIACCIO

Minchin is Rinker Professor and Director of Master's Programs, M. E. Rinker, Sr., School of Construction Management, University of Florida, Gainesville. Migliaccio holds the P. D. Koon Endowed Professorship in Construction Management, Department of Construction Management, and a Fellowship with the Runstad Center for Real Estate Studies, University of Washington, Seattle.

In the past two decades, new methods have emerged to speed up the delivery of transportation projects. These advanced and innovative construction project delivery systems, however, present agencies with an array of challenges. Many of these challenges involve design management—the fast-track systems require more speed in the design process, which must lay a solid foundation at the early stages and then must stay ahead of the construction's progress.

Flexibility is essential, because changes to the design are inevitable as the contractor learns more about the construction process at the project site. The contractor's participation in the design should bring many benefits, including innovation, constructability, and proper assignment of risk. Moreover, relationships between parties to the contract are likely to be less adversarial.

A research team from the University of Florida and the University of Washington investigated the dynamics of design management through National Cooperative Highway Research Program (NCHRP) Project 15-46, Guide for Design Management on Design-Build and Construction Manager-General Contractor Projects. The project findings were published as NCHRP Report 787.

Construction Manager-General Contractor

Users of the construction manager-general contractor (CM-GC) delivery system must understand and adapt to a distinctive culture. In addition, they must recruit a team of experienced leaders, capitalize on the early involvement of the contractor, and properly allocate project risk.

A Washington State DOT inspector surveys new girders on the 92nd Avenue Northeast lidded overpass in Bellevue, part of the Eastside Transit and HOV project that was completed using the design-build delivery method.



PHOTO: WASHINGTON STATE DOT

The Utah Transit Authority used construction manager–general contractor delivery to complete an extension of its Front Runner rail service from downtown Salt Lake City to Provo.



Photo: Paul Kimo McGeehan, Flickr

Understanding the Process

Under the CM-GC system, regular project meetings develop the design—not a design office. This changes the emphasis from developing traditional sets of plans for bids to developing sets of plans for construction. The parties involved should share a workspace to facilitate communication and impromptu meetings.

In many cases, CM-GC requires significant changes in the culture and philosophies for all project stakeholders. The approach places additional requirements on the design professionals, such as increased work hours to maintain the accelerated pace and to address the changes and innovations proposed by the CM—that is, the contractor.

The whole team should handle the design duties from the beginning—including permitting, project management, utility coordination, and project schedules—as well as the duties of the owner's representative. The CM should take over the project administration as early as possible in the design phase and should continue through construction. Not requiring quantity take-offs, computation books, and bid summary sheets can decrease some of the risk and effort traditionally assigned to the design professionals.

Team of Innovators

The project team should consist of proven, experienced leaders and innovators, with transparency in every facet of the award and hiring processes. The fundamental question in evaluating a potential team member is “Will this individual advance or impede the CM-GC process?”

With CM-GC, the owner has the opportunity to select the entire project team based on qualifications and past performance. Low bids should not be the

primary criterion for choosing contractors and subcontractors.

The Utah Transit Authority has stated that it can manage a project with substantially fewer staff if the right contractors and subcontractors are selected. Osceola County in Florida found that an experienced project team can thin down the set of plans substantially. The City of Phoenix, Arizona, has determined that the quality of the contractors and subcontractors is paramount, and therefore the city does not consider cost in selecting the CM. Finally, educating all stakeholders before the start of the program is essential, because total buy-in by the participants is critical.

Early Contractor Involvement

Retaining the CM early in the process allows more time to develop a synergy with the design professionals and the rest of the team and to pursue innovation. Innovation at every step of planning, design, and construction is essential to the success of a CM-GC project.

The CM is the key team member for innovation, guiding the team to reduce changes and delays and to resolve constructability issues and schedule challenges. The CM also facilitates contracting and procurement—permitting agencies and utility companies respond more favorably to a project team's requests after the contractor is on board.

Cultivating Innovation

CM-GC has higher design costs, on average, than the other two major project delivery systems; innovation in design and construction is the best way to offset these costs. CM-GC incentivizes and encourages innovation. The owner must ask if the agency is prepared to accept innovative ideas even if the proposed concepts have never been used on its projects before.

Innovation should be an item on the agenda at every CM-GC meeting on design progress. Avoiding agency bias against ideas that “were not invented here” is an important step in achieving CM-GC success. Contractual requirements should allow the team to target a certain amount of cost savings.

Assigning Project Risk

In addition to the opportunity for innovation, a CM-GC project offers flexibility in allocating and reallocating risk. For example, if a CM submits a cost that appears high for a certain work item in a certain phase of the project, the owner can inquire about the cause. Often the answer is related to risk—another party may be better suited to cover the risk, and the CM then can lower the cost.

The entire project team should agree to a policy of zero change orders; once the change orders start, the process begins to lose effectiveness. Osceola

County made an arrangement with all team members that when the budget and contingencies were exhausted, the team's work would continue pro bono. This motivated everyone to monitor and control spending effectively.

Case Study: Utah

Mountain View Corridor is a 15-mile planned freeway in Utah. Utah DOT retained the contractor for preconstruction services when the design was roughly 30 percent complete. Approximately one year was spent in producing the plans, adding innovations, completing constructability reviews, and pricing the job. Project personnel noted that the contractor should have participated earlier.

The project had four pricing milestones—the 30 percent, 50 percent, 75 percent, and 90 percent stages of the plans. At each milestone, the team conducted a risk workshop, at which the contractor reviewed the plans and the team discussed every possible incident that could change the pricing. A percentage was derived, based on the probability that each incident might actually occur and the impact on the cost and schedule. A risk register recorded the possible occurrences, and Monte Carlo simulations identified the probability of finishing the job at certain costs. Each stage required a 90 percent probability of covering the project cost.

As shown in Figure 1 (below), the progress of four consecutive quarterly risk workshops started with a 50 percent probability of the project finishing at a cost of \$307 million and a 90 percent probability of finishing at \$350 million (Milestone 1). The curve flattened and moved to the right as the contractor identified risks not considered, and the cost estimate climbed



Photo: Utah DOT

accordingly (Milestone 2). As the team eliminated those risks, the price fell (Milestones 3 and 4).

At the time of Milestone 1, the team carried \$50 million in contingency. As the contractor gained confidence, the contingency fund went from \$50 million to \$30 million, and the \$20 million savings was reinvested in more right-of-ways (ROWs) and construction.

The design professionals' responsibilities for cost containment focused on ensuring that the design budget was not overrun and on delivering a design that could be built within the budget. The team used a software program to determine the potential costs or savings for each change in terms of design, construction schedule, and construction.

According to the CM-GC contract, if something was deemed 75 percent likely to happen, a provisional sum would be assigned. When a scenario tied to a provisional sum did not occur, the money saved would be applied to the purchase of additional ROWs and construction.

The opening of the Mountain View Overpass in Utah featured a 5K race.

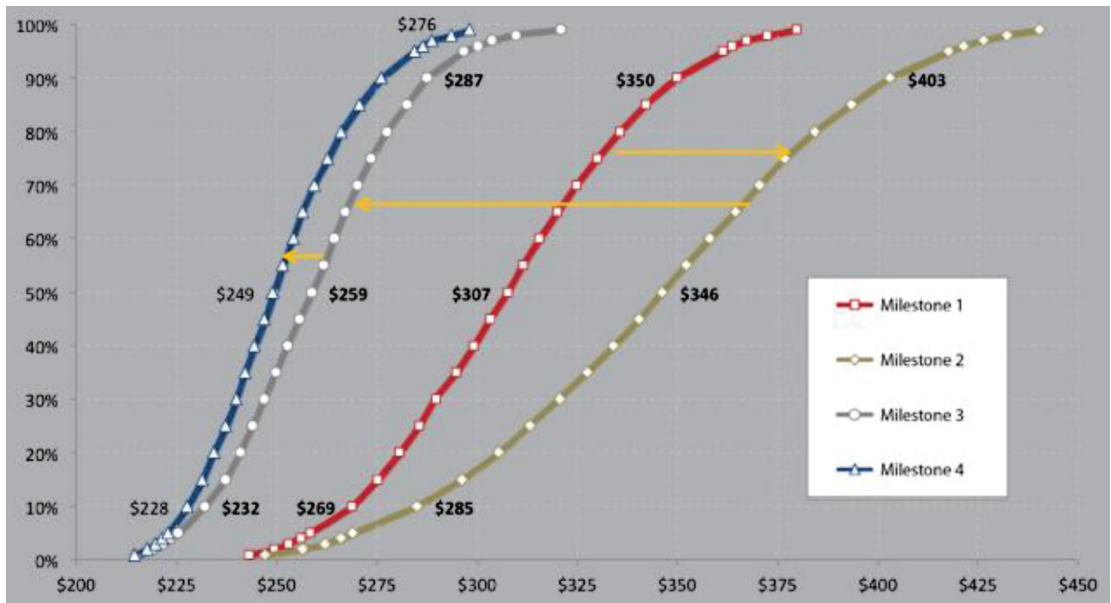


FIGURE 1 Risk curves after four risk workshops. (Source: Utah DOT.)

TABLE 1 Reinvestments of Savings from Mountain View Corridor Project Construction

Reinvestment	Reinvestment Amount (\$ millions)
Golf course reconstruction	18
Kern River gas relocation	18
Residential relocation (150)	40
Kennecott Rail Line relocation	11
Rocky Mountain Power relocation	20
Water tank relocation	4
Additional earthwork	6

Source: Utah DOT.

One challenge related to a 300-foot-wide utility transmission corridor. Having the contractor meet with the utility company led to a solution that allowed the team to postpone indefinitely an \$8 million relocation. The \$8 million was part of \$117 million saved; the savings enabled the 15-mile project to become a 17.5-mile project. Table 1 (above) identifies specific reinvestments of Mountain View Corridor funds.

Design-Build

After almost two decades of use, design-build is a tested delivery system and is preferred when delivery time is critical. A recent survey found that about 80 percent of state agencies have used design-build. Approximately half of these have used the method sporadically, however, and on fewer than 10 projects. Moreover, design-build is still new to the majority of local transportation agencies.

Design Management

At the extreme, three units can manage the design under the system: the first during the preaward or procurement phase; the second during the postaward or pure design phase; and finally during the postaward construction phase.

Two approaches are common, depending on the type of project and the level of the agency's experience with design-build. When projects are unique or when an agency is not expert with design-build delivery, the same group manages the process from procurement throughout postaward delivery. This creates a continuity of design information.

When the project lacks uniqueness and the agency is highly versed in design-build, agency staff and units that specialize in design-build procurement commonly receive the assignment of preaward design administration. Often, an individual involved in the procurement is later assigned to manage postaward design activities jointly with a construction project manager. The design manager's role decreases as the project moves from release for construction to completion, as shown in Figure 2 (below). This industry practice attempts to bridge project responsibility from preaward to postaward.

Sometimes the procurement process allows for alternative technical concepts—value engineering proposals that provide necessary project functions at the lowest cost—submitted individually by competing teams. The final design can incorporate proposals after a team is selected, before a contract is awarded, or after the award; the design may incorporate ideas from a team not selected.

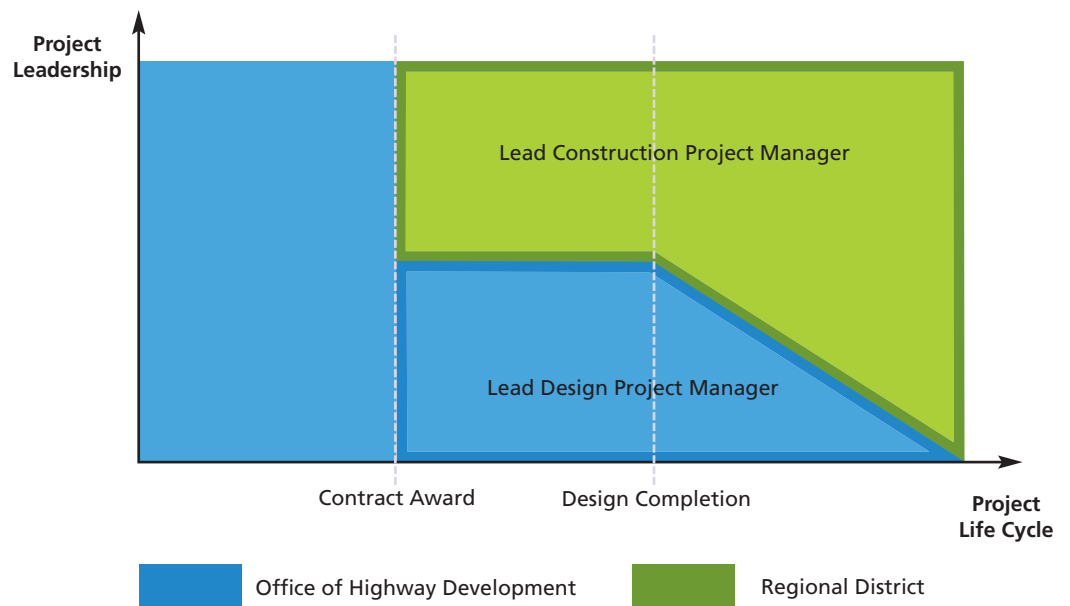


FIGURE 2 Schematic of project leadership throughout the project life cycle.



A design-build scoping meeting reviews a North Carolina DOT project to upgrade and streamline a 1-mile section of U.S. 421 in Winston-Salem.

Some agencies require approvals before allowing the inclusion of alternative technical concepts in the final proposal. How the agency handles the selection, approval, and incorporation of these alternative design ideas significantly affects design management. The case studies in NCHRP Report 787 provide a comprehensive description of approaches to preaward design management, with and without alternative technical concepts. When alternative technical concepts are not allowed, agencies rely on postaward value engineering.

Case Study: North Carolina

North Carolina DOT has let contracts for almost 90 highway and bridge projects using design-build since 1999. The Design-Build Group is part of the agency's Transportation Program Management section.

Figure 2 shows how the responsibilities of a design manager and a construction project manager change during the project life cycle. Between the award and the completion of design, the regional district construction office shares responsibility but takes the lead after completion of the design. This arrangement creates two project managers who share responsibilities throughout the contract administration process after the contract award.

North Carolina DOT has become adept at turning plans around quickly and at encouraging the design-build team to innovate. The arrangement benefits from the contractor's practical knowledge of the best way to build something and whether it could be built as designed. Each contractor has a unique set of equipment, implements, and materials, as well as personnel with unique knowledge, skills,

and capabilities, who can generate a design that best utilizes the unique capabilities of the contractor.

Value Engineering

The agency allows value engineering in the postaward phase. Bidders must state the innovations incorporated into their proposals, as well as the innovations considered but not incorporated. The agency also asks bidders to price a few alternative items—such as different aesthetic rails on a bridge—that may or may not be included in the project.

After the bidder selection, the agency evaluates the innovations that were not incorporated and the alternative items that were priced, and decides whether or not to incorporate any of these into the project. Any savings from the value engineering process are split evenly between the agency and the design-build team.

Permits and Rights

If North Carolina DOT obtains all the environmental permits before the contract award, the design-build team is responsible for obtaining any additional permits required by changes in the design. If the agency has obtained only a few permits before the contract award, the design-build team is responsible for obtaining all the other necessary permits.

Similarly, if North Carolina DOT acquires the properties before the contract award, the design-build team is responsible for purchasing any additional ROW necessitated by design changes. If the agency does not acquire any property before the contract award, the design-build team is responsible for the ROW process—usually hiring an ROW firm

Crews work on mechanically stabilized earth walls during construction of the I-485 Interchange, a design-build project in Mecklenberg County, North Carolina.



PHOTO: NORTH CAROLINA DOT

for the appraisal, negotiation, and other tasks. In both cases, the agency pays the purchase price.

Benefits of Innovation

One of the selection criteria for design-build projects is the opportunity for innovation. Complex projects that offer opportunities for innovation typically have a maximum quality credit percentage of 25 percent to 30 percent, and projects that offer little opportunity for innovation or flexibility typically have a maximum quality credit of 15 percent. Design-build projects with limited opportunity for innovation and a narrow scope of work are procured as express projects that do not require a technical proposal.

The design-build project team working on the I-485 Interchange in Mecklenburg County took full advantage of the opportunity to innovate. The project entailed the construction of a new interchange between I-85 and I-485. The selected design-build team submitted a price of \$92,162,250—approximately 26 percent less than the engineer's estimate—and committed to completion approximately four months early.

The design-build team received the highest technical score for converting a four-level stacked interchange into a two-level turbine interchange. The change eliminated approximately 2 million cubic yards of borrow and a detour of I-85 that would have been necessary to hang steel for the four-level interchange. The turbine interchange design lowered the roadway embankment heights by approximately 40 feet, minimizing the potential for closures during icy conditions.

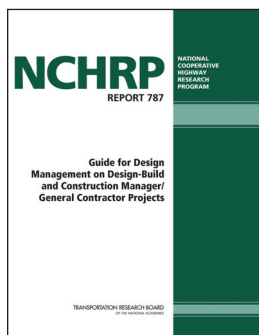
The cost savings totaled approximately \$30 million. In addition, although the turbine interchange increased the number of bridges approximately threefold, the smaller, simpler bridges substantially reduced the costs of maintenance and of widening.

Fast-Track Advantages

Under the design-build system, design management is a function of the design-build team. Under CM-GC, design management involves teamwork between the owner, the design professionals, and the CM—the primary contractor. Both systems aim for speed—but quality improves in most cases because of the contractor's contributions to the design process. The owner's leadership in the design management process is important in CM-GC, but owner participation is also key in design-build.

Innovation is an advantage in both of these fast-track delivery methods, which help agencies add highway mileage and bridges at less expense to taxpayers. The Utah and North Carolina case studies—plus the many others described in NCHRP Report 787—demonstrate savings of millions of dollars on highway construction projects through innovation.

Although design-build offers the advantage of a single point of contact, CM-GC offers the construction owner two additional advantages: the flexibility to assign and reassign risk throughout the project and more control over the design through a direct contractual relationship with the design professionals. Both systems encourage all of the parties to the contract to develop and maintain harmonious working relationships.



NCHRP Report 787, *Guide for Design Management on Design-Build and Construction Manager-General Contractor Projects*, is available from the TRB online bookstore, <https://www.mytrb.org/Store/Product.aspx?ID=7399>; to view the book online, go to <http://www.trb.org/Main/Blurbs/171479.aspx>.



Composting Roadkill

Research and Implementation by the Virginia Department of Transportation

BRIDGET DONALDSON AND DAVID WILSON

Donaldson is Senior Research Scientist, Virginia Transportation Research Council, Charlottesville. Wilson is Environmental Program Manager, Virginia Department of Transportation, Richmond.

More than 1.2 million deer–vehicle collisions occurred in the United States in 2014. Removing and disposing of the deer carcasses and those of the millions of other animals killed in collisions with vehicles are essential services that transportation agencies provide.

According to a national survey in 2005, the 23 responding states predominantly managed roadkill with a combination of landfills and burial. Common shortcomings cited included the long travel distances to landfills, landfill restrictions, and a lack of viable burial areas (1).

Problem

Each year, vehicles in Virginia hit more than 56,000 deer. The Virginia Department of Transportation (DOT) spends more than \$4 million to remove and dispose of the carcasses of deer and other wildlife. Road maintenance teams need roadkill management strategies that are viable, environmentally compliant, and cost-effective.

Composting roadkill is not common in the United States, although composting livestock carcasses is a frequent practice not only in the United States but worldwide. Under Virginia law, composting benign roadkill is subject to the same siting, construction, and testing requirements that apply to the disposal of sewage sludge and household waste. The actions necessary to adhere to the broader compost-

ing regulations are beyond the typical budgets and duties of a state DOT maintenance staff; as a result, the regulations could limit the adoption of a composting program in many states.

Solution

In 2009, the Virginia Transportation Research Council (VTRC) began a series of research projects to evaluate the environmental implications of composting roadkill and the utility of the practice as an option for managing the carcasses in a way that protects the environment and passes regulatory review. VTRC evaluated three methods (Figure 1, below); the criteria and results are shown in Table 1 (page 48).

Compost Windrows

Researchers constructed windrows with deer carcasses placed side by side between layers of wood chips, a source of carbon. The absorbent, bulky quality of the wood chips helped to maintain the proper moisture levels and oxygen flow for composting, and the high carbon content balanced the high nitrogen content of the animal carcasses.

Virginia's solid-waste management regulations aim to control the amount of leachate entering water sources from composting operations. Leachate is the product of precipitation that percolates through the compost and contains extracted or dissolved compost material. The VTRC researchers found that the

FIGURE 1 Compost methods evaluated: (a) static compost windrows, (b) forced aeration system, and (c) rotary drum.



(a)



(b)



(c)

TABLE 1 Evaluations of Compost Windrows and Vessels: Criteria and Research Findings

Criterion	Windrows	Vessels: Rotary Drum and Forced Air System
Compost temperatures	150°F and higher; met EPA criteria for pathogen destruction	150°F and higher; met EPA criteria for pathogen destruction
Pathogens ^a	Confirmed destruction	Confirmed destruction
Leachate volume	2 percent of the precipitation that fell on the windrow plots left the piles as leachate. ^b	Not applicable: leachate was contained.
Leachate contaminants	Filtration through soil reduced contaminants to nominal concentrations.	Not applicable: leachate was contained and recycled within the forced air system.
Operational performance	Not applicable: no operation required	Performed well with oversight and management
Plant germination and growth	Not tested	Plants grown with compost grew significantly larger by weight than those grown with soil.
Maturation time	11 to 12 months	2.5 to 4.5 months
Cost	Nominal—wood chips are free for some DOTs.	Ranges from \$43,000 to \$139,000, depending on vessel capacity; the forced-air system is the most expensive option evaluated but is cost-effective with sufficient carcass volume.

^a *E. coli*, *Salmonella*, and ascarid ova (roundworm eggs).

^b Low volumes of leachate are partly the result of the high absorption capacity of wood chips.

natural filtration through the soil reduced the leachate constituents to nominal concentrations (2). In addition, the windrows achieved high temperatures that quickly destroyed pathogens (Figure 2, below).

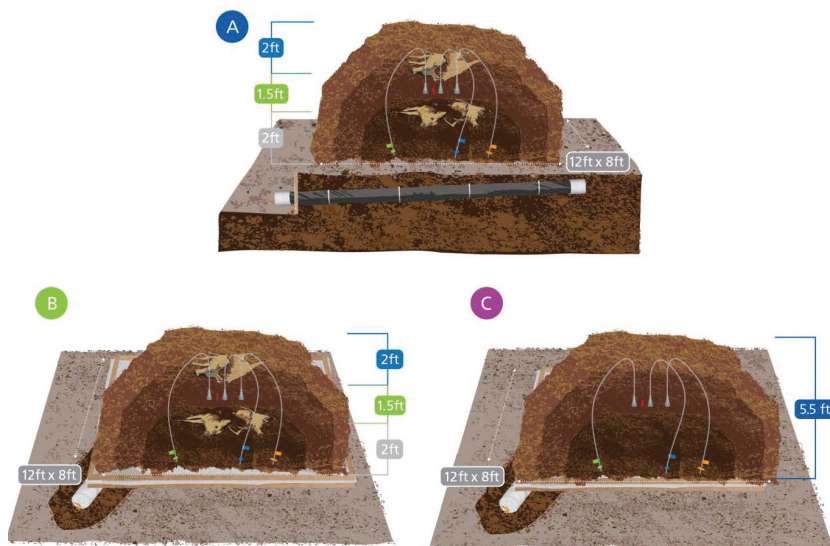


FIGURE 2 Illustrations of plot design, windrow construction, and placement of flasks containing pathogens: Windrow A, with leachate filtered through soil and collected in a buried lysimeter; Windrow B, with leachate not filtered through soil; and Control Pile C, containing no deer and with leachate not filtered through soil. A temperature data logger was placed between the pathogen flasks in all three piles.

Compost Vessels

Static compost windrows are economical and need little maintenance but require a large amount of space; if left unturned, the windrows produce mature compost in 10 to 11 months. The researchers therefore investigated rotary drum and forced-air systems, vessels that have smaller footprints and are designed to contain leachate; moreover, the compost matures relatively quickly.

Rotary drums operate with an electric motor that automatically rotates to aerate and mix the material. The drums also include an aeration system and wire-less sensors for the temperature.

The forced-air system has two or more adjoining concrete containers—depending on the roadkill volume requirements for the area—and a three-walled, covered area for storage and curing. A mounted air pump forces air into the composting material through tubes in the container floor.

VTRC evaluated rotary drums and a forced-air system with the criteria listed in Table 1. The compost generated from both systems met all criteria, and with consistent management and oversight, the systems performed well from an operational perspective (3).

Application

The VTRC research established that the composting methods evaluated are effective and do not contaminate groundwater or surface water and do not spread pathogens. Virginia DOT and the state’s Department of Environmental Quality executed a joint memoran-

dum of understanding (MOU) for composting animal remains from roadway maintenance operations (4).

The MOU outlines operational requirements for carcass composting—for example, the siting, construction, leachate capture, and compost testing. By increasing the prospects for Virginia DOT to implement composting, the agreement promotes the reuse of material that otherwise would be placed in a landfill.

VTRC recently completed guidelines for composting, including detailed descriptions of materials, the steps, and the time and the temperatures needed to achieve compost maturity. The guidelines also include beneficial applications for the finished compost.

Virginia DOT currently has five compost vessels that serve 15 maintenance areas. The agency plans to increase windrow composting throughout the state and to locate several additional composting vessels strategically.

The compost method chosen for an area depends on the volume of roadkill and the availability of space. Forced-air composting is the most prevalent method in Virginia, because the technique can handle a large volume of roadkill within a relatively small footprint.

Benefits

Research found that the compost methods that were evaluated provide Virginia DOT with a much-needed and more efficient alternative to the current practices for managing roadkill. Composting provides a viable option in maintenance areas that have long travel distances to disposal facilities or that no longer have landfills accepting animal remains. Composting also offers environmental benefits, potential savings, and a practical end product.

In contrast with disposal at a landfill, composting animal carcasses saves valuable landfill space and decreases the volume of organic byproducts, which are known sources of methane, a greenhouse gas.

VTRC researchers expect to find substantial cost savings from windrow composting, which requires no investment for areas that have a free source of wood chips. The initial investment for a compost vessel ranges from \$43,000 to \$139,000, but researchers found that a vessel can pay for itself if it replaces a lengthy drive to a landfill (5). Efforts to enhance the potential for greater savings from vessel composting are ongoing. Initiatives under way include the following:

- ◆ Ensuring that the size of the vessel matches the area's volume of carcasses,
- ◆ Pooling carcasses with other maintenance areas, and

- ◆ Applying finished compost in road projects.

Applications include compost blankets—a layer of composted material spread on the soil—and compost berms, which reduce erosion and stormwater runoff. Virginia DOT will use compost to establish vegetation for site restoration, aesthetics, or general landscaping.

For more information, contact Bridget Donaldson, Senior Research Scientist, Virginia Transportation Research Council, 434-293-1922; bridget.donaldson@vdot.virginia.gov.

Acknowledgments

The authors acknowledge Jimmy White, Audrey Moruza, Ed Wallingford, Robert Perry, and Ann Overton for their work on Virginia DOT's roadkill composting program.

References

1. Maryland State Highway Administration. *Summary of Responses to Maryland Survey on Animal Carcass Disposal*. American Association of State Highway and Transportation Officials, Washington, D.C., 2005. <http://research.transportation.org/Pages/RACSurveyResultsOrganizedbyYear.aspx>.
2. Donaldson, B. M., G. P. Smith, Y. J. Kweon, N. Sriranganathan, and D. L. Wilson. *Composting Animal Carcasses Removed from Roads: An Analysis of Pathogen Destruction and Leachate Constituents in Deer Mortality Static Windrow Composting*. Publication VCTIR 12-R12. Virginia Center for Transportation Innovation and Research, Charlottesville, 2012.
3. Donaldson, B. M., and J. W. White, Jr. *Composting Animal Mortality Removed from Roads: A Pilot Study of Rotary Drum and Forced Aeration Compost Vessels*. Publication VCTIR 13-R8. Virginia Center for Transportation Innovation and Research, Charlottesville, 2013.
4. Virginia Department of Environmental Quality and Virginia Department of Transportation. *Memorandum of Understanding Between the Virginia Department of Environmental Quality and the Virginia Department of Transportation: Composting Animal Road Mortality from VDOT Maintenance Roadway Operations*. Virginia Department of Environmental Quality, Richmond, 2015.
5. Moruza, A. K., and B. M. Donaldson. *An Evaluation of the Economics and Logistics of Animal Mortality Composting for the Virginia Department of Transportation*. Publication VCTIR 15-R18. Virginia Center for Transportation Innovation and Research, Charlottesville, 2015.

EDITOR'S NOTE: Appreciation is expressed to G. P. Jayaprakash, Transportation Research Board, for his 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).



PHOTO: ADAM FOSTER, FLICKR

Sue Chrysler

Texas A&M Transportation Institute

As a human factors psychologist and senior research scientist at Texas A&M Transportation Institute, Susan Chrysler incorporates all perspectives: “Trying to imagine what traffic-control devices might look like from a heavy truck or a bicycle, or how a driver with not-so-perfect vision might see things.” Research makes this possible, she notes, by allowing engineers and operations professionals to work through all possible consequences of new technologies.

“Since everyone is unique, it is important to conduct human factors research to capture all of this variation in experience and ability,” Chrysler adds. “Testing across a broad range of people identifies any unintended hazards in new devices, designs, and operational strategies.”



“Since everyone is unique, it is important to conduct human factors research to capture all of this variation in experience and ability.”

As a graduate student in the Center for Cognitive Sciences, an interdisciplinary cognitive psychology program at the University of Minnesota, Chrysler became accustomed to working with researchers in other disciplines. She then joined the human factors lab in the Department of Kinesiology as a technical editor, working with a driving simulator and early virtual-reality equipment. Her first project with the simulator investigated mobile phone use—in 1992, when not many people had them. “I quickly began to see how my training in human memory, learning, attention, experimental methods, and statistics could be applied to real-world problems,” she recalls.

3M sponsored another project that evaluated driver responses to its new delineation system. In 1993, after receiving her Ph.D., Chrysler joined 3M as a transportation human factors researcher. One of her most significant projects at 3M involved the development and testing of fluorescent retroreflective materials, as on yellow-green school crossing signs. “This work gave me my first taste of driving down the road and seeing ‘my’ sign,” Chrysler recalls. “I still enjoy that today.” She is listed as an inventor on two U.S. patents for retroreflective materials.

Chrysler credits professional mentors at 3M with demonstrating that few things in research are as effective as getting out in the field and looking at what is being tested—and with introducing her to TRB. She joined the Standing Committee on

Vehicle User Characteristics in 2001. She served as its chair, and as chair of the Subcommittee on Human Factors Road Design Guides, from 2008 to 2014. Chrysler also was a member of committees on Traffic Control Devices, User Information Systems, and the Simulation and Measurement of Vehicle and Operator Performance and is a current member of the Standing Committee on Highway Safety Performance.

Chrysler’s work with TRB and other groups sharpened her interest in transportation, and in 2001 she joined Texas A&M Transportation Institute (TTI) to work in the transportation operations group. She then joined the Center for Transportation Safety to manage its human factors program. At that time, Texas was starting to build managed lanes to improve travel time reliability and to relieve congestion. “There were no traffic sign and pavement marking standards for these types of operations,” Chrysler comments. She conducted surveys, comprehension testing, and focus groups to discover roadway user information needs, as well as studies on nighttime visibility of retroreflective signs and pavement markings and on the Clearview typeface for roadway signs.

A notable project at TTI investigated the use of horizontal signs—symbols, arrows, and route markers applied to the pavement. In Texas, most frontage roads are one-way; Chrysler applied directional arrows at the bottom of an on-ramp to indicate a two-way frontage road to exiting drivers, and the \$300 countermeasure reduced wrong-way driving in that section from 11 to zero percent.

In 2010, Chrysler began working in the area of connected vehicles, with funding from the National Highway Traffic Safety Administration, exploring the potential for driver distraction caused by connected-vehicle messages and developing ways to assess this distraction. She continued this line of inquiry in 2011, when she became director of research at the University of Iowa’s National Advanced Driving Simulator (NADS). There she worked on forward collision warning systems and on drowsiness detection systems, studied driver responses to near-crashes with pedestrians, and received a grant to establish the university transportation center Safer-Sim.

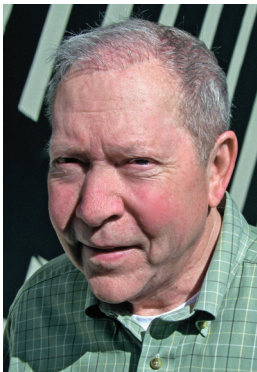
In 2014, Chrysler returned to TTI and focused once again on understanding driver response to infrastructure and traffic operations. She currently serves on the National Cooperative Highway Research Program project panel on Guidelines for Implementing Managed Lanes, and is managing a Texas Department of Transportation project that involves new changeable message sign technology.

“I tell my students and younger colleagues that their research needs to tell a story to anyone, from any background, in a way that enables them to appreciate the importance of the work,” Chrysler observes.

Charles A. Fuhs Consultant

For more than 40 years, Charles A. (Chuck) Fuhs has planned and implemented congestion management applications on urban freeways, focusing especially on managed lanes. He started with bus and high-occupancy vehicle (HOV) lanes and more recently expanded his scope to include active traffic management, congestion pricing, and express lanes. In his career overseeing more than 150 projects across the United States, Canada, and overseas, Fuhs has served in roles from conceptual designer to project manager to performance monitor and operator.

“The nexus of urban road transportation and technology adaptation has never been greater—nor has the need to apply the latest tools to address urban mobility,” Fuhs observes.



“The nexus of urban road transportation and technology adaptation has never been greater—nor has the need to apply the latest tools to address urban mobility.”

Fuhs received master’s and bachelor’s degrees from Texas A&M University, and in 1976 joined the Texas A&M Transportation Institute as a research assistant. He then managed transitway development at the Metropolitan Transit Authority of Harris County, Texas, from 1979 to 1985, leading the plans, design, construction, and operation of reversible freeway lanes for express buses, vanpools, and carpools. These projects now are operated as express lanes that also serve solo commuters; the lanes are used by more than 70,000 commuters daily, saving an average of 10 minutes per commuting trip. The system was the first in the United States to integrate transitways, bus terminals, and park-and-ride lots throughout the region; Fuhs helped forge a strong relationship between the transit authority and the state highway department.

The nature of managed lanes have changed, along with the country’s transportation needs, Fuhs maintains: “What were busways and transitways in the 1960s and 1970s became HOV and carpool lanes in the 1980s and 1990s. Today, an ever-widening application of tools is needed to manage one or more lanes on congested urban freeways.”

“Emerging technologies—coupled with a new generation of practitioners who embrace change—will again show us what is possible over the next few years, as autonomous and connected vehicles and intelligent active traffic management nudge

us to achieve greater transportation safety and efficiency,” Fuhs comments. Federal programs such as the Urban Partnership Agreements and Congestion Reduction Demonstrations have helped further the adoption of technology and multimodal strategies, he adds.

In 1987, Fuhs joined the consulting firm Parsons Brinckerhoff. A company-funded fellowship allowed him to create the first national guide for HOV facilities and helped him plan and develop HOV and express lanes across the country: the I-10 Katy Freeway managed lanes in Houston, Texas; the Los Angeles and Orange County, California, HOV lane systems; the I-93 HOV “zipper” lanes in Boston, Massachusetts; the I-25 HOV lanes in Denver, Colorado; and various HOV lanes and direct-access ramps in Seattle, Washington. He also helped plan managed lane systems in Charlotte, North Carolina; Atlanta, Georgia; Seattle, Washington; and San Diego and San Francisco–Oakland, California.

Currently a consultant, Fuhs helps prepare guidance for managed lane development and serves as peer reviewer for corridors in Phoenix, Arizona; Los Angeles; Austin, Texas; Houston; and Oklahoma City, Oklahoma. He is part of the research team for National Cooperative Highway Research Program (NCHRP) Project 15-49, Guidelines for Implementing Managed Lanes, to be completed this year.

Fuhs’ resources for managed lanes and HOV projects now are used by organizations and agencies, including the Federal Highway Administration, Institute of Transportation Engineers, and state departments of transportation. Among these resources are NCHRP Report 414, *HOV Systems Manual*; a chapter of the *Freeway Management Operation Handbook* on managed lanes; NCHRP Synthesis 185, *Preferential Lane Treatments for High-Occupancy Vehicles*; the American Association of State Highway and Transportation Officials’ *Guide for High-Occupancy Vehicle Facilities*; and more. Fuhs has led seminars and training courses on HOV and managed lanes in the United States, Canada, Asia, and Europe.

“Pilot projects that applied research led us in new directions in managing congestion four decades ago; and we are at another inflection point where the latest innovations will need to be championed into adoption,” Fuhs notes.

A participant in TRB meetings and events since 1974, Fuhs joined the High-Occupancy Vehicle Systems Committee in 1989. The group was renamed the Standing Committee on Managed Lanes in 2012, and Fuhs supported many of its activities, including an annual HOV project inventory, national and international conferences, training seminars and workshops, and TRB Annual Meeting sessions. He has served as the committee’s chair or cochair since 2013 and is a member of the Operations Section executive board.

International Trade and Transportation

Annual Meeting Session Looks into Future Trends

KATHERINE F. TURNBULL

Turnbull is Executive Associate Director, Texas A&M Transportation Institute, and a member of the TRB Executive Committee.

Guided by Patricia Hu, Director of the Bureau of Transportation Statistics (BTS), U. S. Department of Transportation, TRB Executive Committee members discussed international trade driving the future economy at the 2016 TRB Annual Meeting.

U.S. international merchandise trade increased from \$1.2 trillion in 1990 to slightly more than \$5 trillion in 2014, according to Hu. She also noted that the shift in U.S. trading partners has affected international trade and transportation: in 1990, the top three countries for exports and imports were Canada, Japan, and Mexico; in 2015, Canada and Mexico were still top export partners, but China jumped from 18th to 3rd place. China was the eighth largest exporter to the United States in 1990; in 2015, it was the top exporter, followed by Canada and Mexico.

Sea and Air

Geraldine Knatz, Professor of Practice of Policy and Engineering at the University of Southern California—and former director of the Port of Los Angeles—discussed ocean carrier consolidations and alliances, increasing vessel size, shifting trade lanes, and new models of cooperation among U.S. ports. She suggested that ocean carrier alliances are having a greater impact on port competition than the expansion of the Panama Canal.



PHOTO: PORT OF LONG BEACH

Containers are transferred at the Port of Long Beach in California.

With four major alliances, 10 companies have approximately 65 percent of the world liner fleet, as measured in 20-foot equivalent units (TEUs). The container-carrying capacity of ships has increased from 1,530 TEUs in 1968 to 19,000 TEUs in 2015.

According to a Boston Consulting Group report, East Coast ports stand to gain a 10 percent share of container traffic from East Asia with the canal expansion. As an example of new approaches to cooperation, Knatz cited the agreement to merge cargo operations signed in 2014 by the Port of Seattle and the Port of Tacoma in Washington State.

Jim Crites, TRB Executive Committee chair and Executive Vice President of Operations at Dallas–Fort Worth International Airport, described the influence of technology on air freight. New wide-body aircraft has improved fuel efficiency and range, while increasing belly cargo space, he noted. Moreover, the Next-Generation Air Transportation System, commonly known as NextGen, is expected to benefit global logistic chains by increasing reliability, improving operational and cost efficiency, and providing greater fuel efficiency. Unmanned aircraft systems may allow for customized last-mile delivery of international goods but may have disruptive impacts on airspace safety and security, Crites added.

Infrastructure

Roger Huff, President of HGLC, LLC, provided a private-sector perspective. Noting that transportation enabled global trade, he pointed to industry esti-



PHOTO: RISSON PHOTOGRAPHY

(Left to right:) Panelists Katherine Turnbull, Jim Crites, Patricia Hu, Roger Huff, Dan Turner, and Geraldine Knatz at the 2016 Annual Meeting session on International Trade Driving the Future Economy.

mates that a 10 percent reduction in transportation costs can drive a 20 percent growth in international and domestic trade. International trade is influenced by the transportation infrastructure, the availability of a variety of transportation services, and the transaction environment, which includes exchange rates, insurance, tariffs, and other elements, he noted.

Katherine Turnbull, Executive Associate Director, Texas A&M Transportation Institute, discussed the challenges of moving freight at U.S.–Mexico land border crossings. With the BTS reporting that surface trade between the United States and Mexico has increased from approximately \$97 billion in 1995 to \$430 billion in 2014, reducing bottlenecks for commercial vehicles at ports of entry (POEs) has become even more important.

Turnbull described the development and operation of a real-time border crossing information system through a collaborative partnership of federal, state, and local governments. The system, which uses radio-frequency identification technology, provides



Photo: North Dakota DOT

real-time data to shippers, carriers, and agency personnel, as well as archived data for trend analyses. The system has been deployed at the major POEs in Texas and Arizona, and implementation is expected in the next few years at California POEs.

Infrastructure serving freight—truck route diverts heavy oil-related traffic around New Town, North Dakota.



SAFETY IN ENERGY MOVEMENT— Jeff Wiese, Pipeline and Hazardous Materials Safety Administration, participates in a panel discussion with other federal representatives at a meeting of the Domestic Transportation of Petroleum, Natural Gas, and Ethanol Study Committee in February at the National Academies of Sciences, Engineering, and Medicine's Keck Center in Washington, D.C. The project explores the transportation safety issues associated with changes in the long-distance movement of crude oil, natural gas, and ethanol—hazardous materials that have seen a sharp rise in production in recent years.

COOPERATIVE RESEARCH PROGRAMS NEWS

Implementing a National Highway Safety Strategy

The American Association of State Highway and Transportation Officials' Standing Committee on Highway Traffic Safety will lead the development and implementation of a national strategic safety plan, Toward Zero Deaths. A National Cooperative Highway Research Program (NCHRP) project is under way to develop the plan framework. The Uni-

versity of Minnesota has received a \$500,000, 36-month contract (NCHRP Project 17-64, FY 2013) to advance the implementation of Toward Zero Deaths.

The project also will present a communications strategy and guidance on such implementation needs as knowledge management, performance measures, leadership, and overcoming challenges.

For more information, contact Mark S. Bush, TRB, 202-334-1646 or mbush@nas.edu.

Master Plan Integrates Buffalo Bike Facilities

First adopted in 1977, the bicycling master plan of Buffalo, New York, adapts the city's radial grid street pattern into a connected network of on-street bike-ways that complement greenway trails. In January, the New York State Department of Transportation and the New York State Energy Research and Development Authority released an update to the master plan.

Authors of the update developed a typology for bicycle facilities recognizing four research-derived categories of system users: the “strong and fearless”; the “enthused and confident”; the “interested but concerned”; and the “no way, no how” nonusers. Outreach efforts included a public survey and a text-message survey, public meetings, stakeholder meetings, online comments and e-mails, and input from regional and local government agencies. Authors then identified routes that catered to the largest group of riders—the interested but concerned.

Eleven projects in various locations across Buffalo were designated as vital to the bicycle network. Each project connects bike facilities and key destinations and is accessible and supported by the community. Researchers integrated field investigations, traffic and GIS research, and bicycle facility design methodologies to develop design guidelines as the projects are implemented in the next decade.



PHOTO: JUSTIN BOOTH, GOBIKE BUFFALO

Buffalo residents provide input on the draft bike master plan at a public meeting in December 2014.

To download a PDF of the report, visit www.nyserda.ny.gov/-/media/Files/Publications/Research/Transportation/Buffalo-bike-Master-Plan.pdf.

Falls and Crash Risk in Older Drivers

Falls tend to be associated with subsequent motor vehicle crashes for older drivers, according to a report from the AAA Foundation for Traffic Safety.

Researchers reviewed studies that examined crash risk as well as driving behavior related to falls. The studies focused on adult drivers age 55 and older, with a mean age of at least 65, and with sample sizes ranging from 27 to more than 17,000. The literature review and meta-analysis were supplemented with pooled risk estimates from random-effects models.

Researchers found little or no association between falls and subsequent driving behavior—for example, a person avoiding certain driving situations or ceasing to drive after a fall—that could not also be attributed to study design, conduct, or reporting bias.

Five of the studies, however, revealed that a history of falls had a consistently positive association with increased motor vehicle crashes and crash-related injuries. The correlation should be studied further, the researchers concluded.

To view the report, visit www.aaafoundation.org/sites/default/files/SeniorsAndFalls.pdf.



PHOTO: AAA FOUNDATION FOR TRAFFIC SAFETY

INTERNATIONAL NEWS

Canadians Support Efforts Against Drinking and Driving

A majority of Canadians—69.5 percent—regard efforts to prevent drinking and driving as a major public priority, according to an annual national opinion poll conducted by the Traffic Injury Research Foundation in Canada. In comparison, 69.8 percent of respondents indicated that the state of the health-care system should be at the top of the nation's public agenda.

With some fluctuation, responses to the poll also showed a decrease in the number of Canadians who reported driving after consuming alcohol past the legal limit—from 8.2 percent in 2007 to 4.2 percent in 2015. Most respondents who reported driving after drinking said that they had consumed alcohol at the home of a friend or relative (32.3 percent) or at a bar (29.3 percent).

Traffic records show a sustained decrease in the number of Canadians killed in crashes involving a driver under the influence of alcohol, from 763 in 2006 to 563 in 2012, the most recent year data were collected. This is approximately half the rate in 1995, when nearly 1,100 people died in crashes related to drinking and driving.

A total of 1,204 Canadians completed the online

poll in October and November of 2015.

To read the full report, visit www.tirf.ca/publications/PDF_publications/RSM_2015_Drinking_Driving_Eng_7.pdf.

Statistical Pulse of Travel in Australia

Measured in tonne kilometers, Australian domestic freight transportation has increased steadily for the past 40 years, driven by rail movement of iron ore in the Pilbara region in western Australia, according to the *Australian Infrastructure Statistics Yearbook* released by the Bureau of Infrastructure, Transport and Regional Economics. Road and rail dominate domestic freight activity, with approximately 200 billion and 300 billion tonne kilometers moved in 2014, respectively; coastal freight peaked in 2006 and 2007 and since then has decreased steadily.

According to the report, most nonfreight travelers in Australia use passenger cars—with more than 250 billion passenger kilometers traveled in 2014; nevertheless, travel in other modes has increased since 2001. Air travel in particular has risen sharply, from more than 30 billion passenger kilometers in 2001 to more than 70 billion passenger kilometers in 2014.

To read the full report, visit https://bitre.gov.au/publications/2015/files/BITRE_yearbook_2015_full_report.pdf.

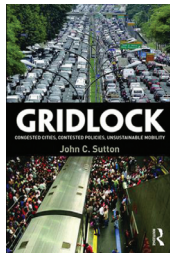


PHOTO: MICK STANIC, FLICKR

Eastern Freeway in Melbourne, Victoria, Australia.

Gridlock: Congested Cities, Contested Policies, Unsustainable Mobility

John C. Sutton. Routledge, 2016; 182 pp.; \$49.95; 978-1-13885-201-3.



Using case studies from the United States and Europe, this book explores competing discourses in transportation policy and planning and how these have led to congestion on the roads and in the halls of government. Also presented is the concept of mobility management, facilitated by mobile communication and information technology.

International Space Station: Architecture Beyond Earth

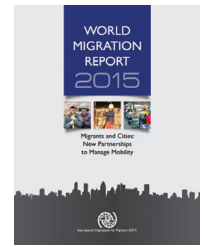
David Nixon. Circa Press, 2016; 416 pp.; £65; 978-0-99307-213-0.



The author of this volume—a member of the team that designed the International Space Station (ISS)—provides a comprehensive account of the station's conception, development, and assembly in space. Also included is a memoir from astronaut Nicole Stott, a veteran of two ISS expeditions and several space shuttle missions.

World Migration Report 2015

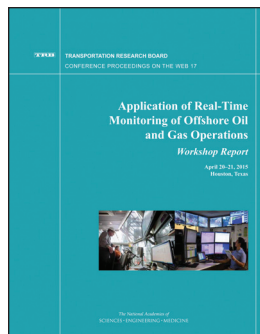
International Organization for Migration, 2015; 228 pp.; \$60; 978-92-9068-709-2.



This volume explores how migration influences cities and how cities, in turn, shape the migrant experience, with a focus on migration in the cities of the global south as well as internal movement. Also examined are the ways in which cities manage increasingly mobile, diverse populations.

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

TRB PUBLICATIONS



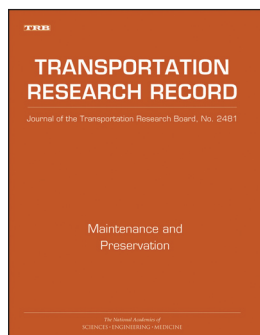
Application of Real-Time Monitoring of Offshore Oil and Gas Operations: Workshop Report
Conference Proceedings on the Web 17

This report summarizes an April 2015 conference, sponsored by the Bureau of Safety and Environmental Enforcement of the U.S. Department of the Interior, that explored real-time monitoring of offshore oil and gas operations.

For more information, visit www.trb.org/Publications/Blurbs/173606.aspx.

ities for roadway snow and ice control, a multiple-step traffic speed forecasting strategy for winter free-way operations, and other topics.

2015; 140 pp.; TRB affiliates, \$53.25; nonaffiliates, \$71. Subscriber categories: maintenance and preservation, operations and traffic management, vehicles and equipment.



Maintenance and Preservation

Transportation Research Record 2481

Authors present research on maintenance and preservation issues, including an efficiency measurement of bridge management with data envelopment analysis, a laboratory evaluation of partial-depth patching materials for use in winter climates, and Virginia's experience with high-friction surface treatments.

2015; 139 pp.; TRB affiliates, \$53.25; nonaffiliates, \$71. Subscriber categories: maintenance and preservation, bridges and other structures, pavements.

Highway Capacity and Quality of Service

Transportation Research Record 2483

Highway capacity and quality of service topics are explored in this volume, from the generalized effects of on-street parking maneuvers on intersection performance to a planning-level methodology for freeway facilities.

2015; 159 pp.; TRB affiliates, \$53.25; nonaffiliates, \$71. Subscriber categories: operations and traffic management, planning and forecasting.

Maintenance Services, Transportation Weather, and Winter Maintenance

Transportation Research Record 2482

The papers in this volume address the prediction of pavement marking service life with transverse test deck data, the strategic location of satellite salt facil-

Freeway Operations; Regional Systems Management and Operations; Managed Lanes 2015

Transportation Research Record 2484

Acceleration characteristics at metered on-ramps, incident-induced delays on freeways, wrong-way driving prevention, a reliable method for collecting average vehicle occupancy data for multilane freeways, and other topics are explored in this volume.

2015; 192 pp.; TRB affiliates, \$59.25; nonaffiliates, \$79. Subscriber categories: operations and traffic management, safety and human factors.

TRB PUBLICATIONS *(continued)***Visibility and Work Zone Traffic Controls**

Transportation Research Record 2485

Authors present research on the relationship between roadway illuminance level and nighttime rural intersection safety, approaches to adaptive lighting on roadways, an evaluation of mobile work zone alarm systems, and more.

2015; 92 pp.; TRB affiliates, \$45.75; nonaffiliates, \$61. Subscriber categories: *operations and traffic management, safety and human factors, maintenance and preservation.*

Operational Effects of Geometrics and Access Management

Transportation Research Record 2486

The papers in this volume explore such topics as the design criteria for minimum passing zone lengths, pedestrian and bicyclist accommodations and crossings on superstreets, and the effect of stopping sight distance on crashes at crest vertical curves on rural two-lane highways.

2015; 92 pp.; TRB affiliates, \$45.75; nonaffiliates, \$61. Subscriber categories: *operations and traffic management, design, safety and human factors.*

Traffic Signal Systems, Volumes 1–2

Transportation Research Record 2487 and 2488

An emission-based signal timing optimization for isolated intersections, performance measures for optimizing diverging interchanges, and online implementation and evaluation of weather-responsive coordinated signal timing operations are among the topics presented in these volumes.

2015; Vol. 1, 132 pp.; TRB affiliates, \$50.25; nonaffiliates, \$67. Vol. 2, 116 pp.; TRB affiliates, \$48; nonaffiliates, \$64. 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 2015

Transportation Research Record 2489

Topics examined in this volume include in-car advice to reduce the negative effects of phantom traffic jams, a platoon-based speed control algorithm for ecodriving at signalized intersections, and online and offline prediction of time-varying parking occupancy.

2015; 152 pp.; TRB affiliates, \$53.25; nonaffiliates, \$71. Subscriber categories: *operations and traffic management, safety and human factors, research.*

Traffic Flow Theory and Characteristics, Volumes 1–2

Transportation Research Record 2490 and 2491

Authors present research on the impacts of different angles and speeds on behavior of pedestrian crowd merging, left-lane changes in laterally unbalanced traffic, a comparative analysis of traffic state estimation, the spatiotemporal clustering of urban networks, and more.

2015; Vol. 1, 148 pp.; TRB affiliates, \$53.25; nonaffiliates, \$71. Vol. 2, 136 pp.; TRB affiliates, \$50.25; nonaffiliates, \$67. Subscriber categories: *operations and traffic management, planning and forecasting.*

Traffic Control Devices

Transportation Research Record 2492

The effects of traffic control devices on rural curve driving behavior, criteria for determining the number of intersections at divided highway junctions, and designing traffic signal clearance intervals to consider buses are some of the subjects examined in this volume.

2015; 92 pp.; TRB affiliates, \$45.75; nonaffiliates, \$61. Subscriber categories: *operations and traffic management, safety and human factors, pedestrians and bicyclists.*

Travel Demand Forecasting, Volumes 1–2

Transportation Research Record 2493 and 2494

The papers in this volume examine such topics as the effects of autonomous vehicle ownership on trip, mode, and route choice; activity pattern models with well-being indicators; and the activity space of older and working-age adults in the Puget Sound region, Washington.

2015; Vol. 1, 144 pp.; TRB affiliates, \$45.75; nonaffiliates, \$61. Vol. 2, 96 pp.; TRB affiliates, \$45.75; nonaffiliates, \$61. Subscriber category: *planning and forecasting.*

Travel Behavior, Volumes 1–2

Transportation Research Record 2495 and 2496

Factors associated with high school students' delayed acquisition of a driver's license, reliability in the German value-of-time study, awareness and utilization of advanced traveler information by active seekers, and other topics are explored in these volumes.

2015; Vol. 1, 152 pp.; TRB affiliates, \$53.25; nonaffiliates, \$71; Vol. 2, 72 pp.; TRB affiliates, \$41.25; nonaffiliates, \$55. Subscriber category: *planning and forecasting.*

**TRANSPORTATION
RESEARCH RECORD**

Journal of the Transportation Research Board, No. 2485

Visibility and Work Zone
Traffic ControlsThe Research Institute of
SCIENCE, ENGINEERING, MEDICINE

The TRR Journal Online website provides electronic access to the full text of approximately 15,000 peer-reviewed papers that have been published as part of the Transportation Research Record: Journal of the Transportation Research Board (TRR Journal) series since 1996. The site includes the latest in search technologies and is updated as new TRR Journal papers become available. To explore the TRR Online service, visit www.TRB.org/TRROnline.

TRB PUBLICATIONS (continued)

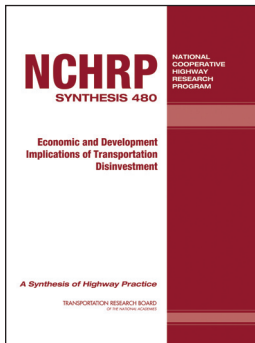


Pedestrian and Bicycle Transportation Along Existing Roads: ActiveTrans Priority Tool Guidebook

NCHRP Report 803

This report presents a tool and guidance to help prioritize improvements to pedestrian and bicycle facilities, either separately or together as part of a complete streets evaluation approach. A supplemental CD contains a spreadsheet on the ActiveTrans methodology.

2015; 87 pp.; TRB affiliates, \$53.25; nonaffiliates, \$71. Subscriber categories: pedestrians and bicyclists, administration and management, planning and forecasting.

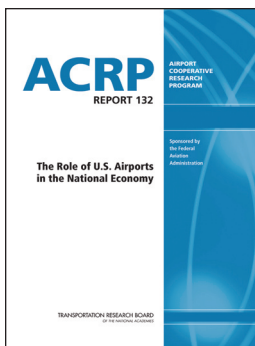


Guidebook for Designing and Managing Rights-of-Way for Carbon Sequestration and Biomass Generation

NCHRP Report 804

This report explores the operational concerns, programmatic issues, and market conditions associated with utilizing highway rights-of-way to develop carbon sequestration projects. A feasibility toolkit on CD-ROM is included with the print version of the report.

2015; 46 pp.; TRB affiliates, \$43.50; nonaffiliates, \$58. Subscriber categories: energy, environment.



Improved Test Methods for Specific Gravity and Absorption of Coarse and Fine Aggregate

NCHRP Report 805

Presented are test methods for determining the specific gravity and absorption of coarse and fine aggregates. The test is designed to improve the accuracy, precision, and ease of use—and reduce the time required for conditioning and testing—from the American Association of State Highway and Transportation Officials (AASHTO) T 84 and T 85 methods.

2015; 72 pp.; TRB affiliates, \$45.75; nonaffiliates, \$61. Subscriber category: materials.

Guide to Cross-Asset Resource Allocation and the Impact on Transportation System Performance

NCHRP Report 806

Authors provide guidance and a spreadsheet tool to help managers apply data-driven techniques to project prioritization, program development, scenario analysis, and target setting. The software is only available on www.TRB.org and can be downloaded as an ISO image.

2015; 113 pp.; TRB affiliates, \$48; nonaffiliates, \$64. Subscriber category: administration and management.

Properties of Foamed Asphalt for Warm-Mix Asphalt Applications

NCHRP Report 807

Authors present methods for measuring properties of foamed asphalts and designing foamed asphalt mixes with satisfactory aggregate coating and workability.

2015; 122 pp.; TRB affiliates, \$50.25; nonaffiliates, \$67. Subscriber categories: construction, materials, pavements.

Economic and Development Implications of Transportation Disinvestment

NCHRP Synthesis 480

This synthesis examines methods available to estimate disinvestment effects on transportation system integrity within and across modes in urban areas, regionally, and in nonmetropolitan areas, and includes information on models for economic forecasting and travel demand, risk or probability, benefit and impact, and needs.

2015; 59 pp.; TRB affiliates, \$38.25; nonaffiliates, \$51. Subscriber categories: economics, finance, highways.

Lessons Learned from Airport Sustainability Plans

ACRP Synthesis 66

Sustainability initiatives at smaller U.S. airports are examined in this volume, with an analysis of survey responses and telephone interviews.

2015; 88 pp.; TRB affiliates, \$45.75; nonaffiliates, \$61. Subscriber categories: aviation, environment.

The Role of U.S. Airports in the National Economy

ACRP Report 132

This report examines the economic role of U.S. airports and the national airport system to help communicate the national aggregate value of airports to communities and aviation stakeholders. A Power-Point presentation and brochure supplement the report, and appendixes are available online.

2015; 60 pp.; TRB affiliates, \$38.25; nonaffiliates, \$51. Subscriber categories: aviation, economics.

Best Practices Guidebook for Preparing Lead Emission Inventories from Piston-Powered Aircraft with the Emission Inventory Analysis Tool

ACRP Report 133

Presented in this volume is an emissions inventory analysis tool to quantify aircraft lead emissions

TRB PUBLICATIONS (continued)

at airports. The research contractor's report is included in ACRP Web-Only Document 21, *Quantifying Aircraft Lead Emissions at Airports*.

2015; 38 pp.; TRB affiliates, \$42; nonaffiliates, \$56. Subscriber categories: aviation, environment.

Applying Whole Effluent Toxicity Testing to Aircraft Deicing Runoff

ACRP Report 134

This report describes the unique characteristics of stormwater toxicity testing at airports and provides guidance for developing sound whole-effluent toxicity testing programs.

2015; 111 pp.; TRB affiliates, \$48; nonaffiliates, \$64. Subscriber categories: aviation, environment.

Understanding Airport Air Quality and Public Health Studies Related to Airports

ACRP Report 135

Authors present air quality-related research, from standards and regulations to health impacts, and the industry's current understanding of these impacts.

2015; 94 pp.; TRB affiliates, \$48; nonaffiliates, \$64. Subscriber categories: aviation, environment.

Implementing Integrated Self-Service at Airports

ACRP Report 136

Included in this volume are guidelines for implementing and optimizing a comprehensive passenger self-service experience for U.S. airports of all sizes. A CD-ROM with tools for developing an integrated passenger self-service program is included with the print version of the report.

2015; 106 pp.; TRB affiliates, \$55.50; nonaffiliates, \$74. Subscriber categories: aviation, data and information technology, terminals and facilities.

Guidebook for Advancing Collaborative Decision Making (CDM) at Airports

ACRP Report 137

This report provides a background and historical context for the use of CDM in the United States and Europe. The guidebook provides tools that can be used to help airports of all sizes integrate CDM into airport operations and work with stakeholders.

2015; 73 pp.; TRB affiliates, \$43.50; nonaffiliates, \$58. Subscriber category: aviation.

Preventive Maintenance at General Aviation Airports, Volume 1: Primer and Volume 2: Guidebook

ACRP Report 138

This report, which comprises a primer and a

guidebook, explores the value of airports to communities and the national airspace system, reviews the various infrastructure assets at airports, and outlines the value of planning and prioritizing preventive maintenance into the budgeting process. Included with the print version of the guidebook is a CD-ROM containing a PowerPoint presentation and customizable system checklists.

2015; 122 pp.; TRB affiliates, \$65.25; nonaffiliates, \$87. Subscriber categories: aviation, maintenance and preservation.

Optimizing Airport Building Operations and Maintenance Through Retrocommissioning: A Whole-Systems Approach

ACRP Report 139

This report explores ways to optimize operations and maintenance costs and improve overall building system performance through retrocommissioning. The report is accompanied by a CD that contains additional appendixes and a spreadsheet tool.

2015; 186 pp.; TRB affiliates, \$57.75; nonaffiliates, \$77. Subscriber category: aviation.

Policing and Security Practices for Small- and Medium-Sized Public Transit Systems

TCRP Report 180

This report explores the challenges and issues associated with the security of small- and medium-sized transit agencies, following the five stages of protection activity—prevention, mitigation, preparedness, response, and recovery—by providing baseline options and identifying potential security countermeasures.

2015; 96 pp.; TRB affiliates, \$26.25; nonaffiliates, \$35. Subscriber categories: public transportation, security and emergencies.

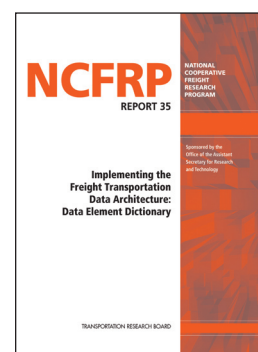
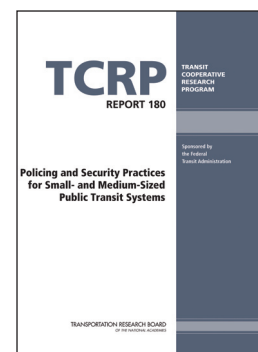
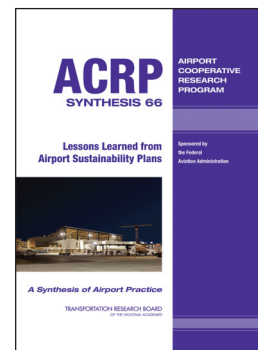
Implementing the Freight Transportation Data Architecture: Data Element Dictionary

NCFRP Report 35

This report provides findings from the research effort to develop a freight data dictionary for organizing the myriad freight data elements currently in use. Included is a web-based freight data element dictionary, hosted by the U.S. Department of Transportation's Bureau of Transportation Statistics.

2015; 149 pp.; TRB affiliates, \$53.25; nonaffiliates, \$71. Subscriber categories: data and information technology, freight transportation.

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



CALENDAR

TRB Meetings

June

- 2–3 Ferry Safety and Technology Conference
New York, New York
- 6–7 Exploring Data and Metrics of Value at the Intersection of Health Care and Transportation
Washington, D.C.
- 12–14 2nd International Symposium on Disaster Prevention and Mitigation of Highway Infrastructure
Xi'an, China
- 14–16 International Symposia on Enhancing Highway Performance: 7th International Symposium on Highway Capacity and Quality of Service and 3rd International Symposium on Freeway and Tollway Operations*
Berlin, Germany
- 21–23 From Sail to Satellite: Delivering Solutions for Tomorrow's Marine Transportation Systems
Washington, D.C.
- 26–29 American Society of Civil Engineers International Conference on Transportation and Development*
Houston, Texas
- 26–30 8th International Conference on Bridge Maintenance, Safety and Management*
Foz do Iguaçu, Brazil
- 27–30 National Equipment Fleet Management Conference*
Columbus, Ohio

July

- 6–7 3rd International Conference on Access Management*
Pretoria, South Africa
- 6–13 Chan Wui and Yunyin Rising Star Workshop for Early Career Professionals
(invitation only)
- 10–12 11th National Conference on Transportation Asset Management
Minneapolis, Minnesota
- 11 Geological Modeling: Methods and Methodologies
Colorado Springs, Colorado
- 16–18 International Conference on Transportation Infrastructure and Materials
Xi'an, China
- 17–20 55th Annual Workshop on Transportation Law
Washington, D.C.
- 17–20 Transportation-Related Environmental Analysis, Ecology and Historic and Archeological Preservation Summer Conference
Salt Lake City, Utah
- 19–21 Automated Vehicles Symposium 2016*
San Francisco, California
- 24–27 Transportation-Related Noise and Vibration Committee Summer Conference
Missoula, Montana
- 25–27 GeoChina 2016 International Conference*
Shandong, China

- 26–29 Resource Conservation and Recovery Summer Conference
Asheville, North Carolina

August

- 4–5 Transportation Planning and Air Quality Conference
Minneapolis, Minnesota
- 8–10 Istanbul Bridge Conference*
Istanbul, Turkey
- 9–11 2016 Summerail Conference*
Council Bluffs, Iowa; Omaha, Nebraska
- 14–17 Use of Scenario Planning in Transportation Planning
Portland, Oregon

September

- 4–7 3rd International Conference on Transportation Geotechnics*
Guimarães, Portugal
- 12–14 15th National Tools of the Trade Conference
Charleston, South Carolina
- 13–15 16th Biennial Harbor Safety Committee Conference: 21st-Century Waterways—The Changing Tide of Harbor Safety
Portland, Oregon
- 19–21 5th International Conference on Accelerated Pavement Testing*
San Jose, Costa Rica
- 25–29 8th World Congress on Joints, Bearings, and Seismic Systems for Concrete Structures*
Atlanta, Georgia

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.

INFORMATION FOR CONTRIBUTORS TO

TR NEWS

TR News welcomes the submission of manuscripts for possible publication in the categories listed below. All manuscripts submitted are subject to review by the Editorial Board and other reviewers to determine suitability for *TR News*; authors will be advised of acceptance of articles with or without revision. All manuscripts accepted for publication are subject to editing for conciseness and appropriate language and style. Authors receive a copy of the edited manuscript for review. Original artwork is returned only on request.

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

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

NEWS BRIEFS are short (100- to 750-word) items of interest and usually are not attributed to an author. They may be either text or photographs or a combination of both. Line drawings, charts, or tables may be used where appropriate. Articles may be related to construction, administration, planning, design, operations, maintenance, research, legal matters, or applications of special interest. Articles involving brand names or names of manufacturers may be determined to be inappropriate; however, no endorsement by TRB is implied

when such information appears. Foreign news articles should describe projects or methods that have universal instead of local application.

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

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

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

SUBMISSION REQUIREMENTS: Manuscripts submitted for possible publication in *TR News* and any correspondence on editorial matters should be sent to the Director, Publications Office, Transportation Research Board, 500 Fifth Street, NW, Washington, DC 20001, telephone 202-334-2972, or e-mail jawan@nas.edu.

- ◆ All manuscripts should be supplied in 12-point type, double-spaced, in Microsoft Word, on a CD or as an e-mail attachment.

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

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

NOTE: Authors are responsible for the authenticity of their articles and for obtaining written permissions from publishers or persons who own the copyright to any previously published or copyrighted material used in the articles.

Rockfall: Characterization and Control

*Timely Practical
Resource!*

On many major transportation routes, the degradation of rock exposures constructed 30 to 40 years ago has increased rockfall-induced traffic disruptions, accidents, and injuries.

Demands for improved rockfall evaluation and mitigation have encouraged adoption of new technologies to support new approaches to provide protections from rockfall hazards.

To make comprehensive information about these technologies and approaches widely available, the Transportation Research Board (TRB) has published *Rockfall: Characterization and Control* to address rockfall hazard identification and evaluation, investigation, mitigation, and maintenance and management.

The 658-page book comprises 18 chapters authored by internationally recognized rockfall experts. An accompanying DVD features instructive video clips—including historic footage—documenting rockfall field tests.

The text is written to appeal to a diverse audience, including transportation

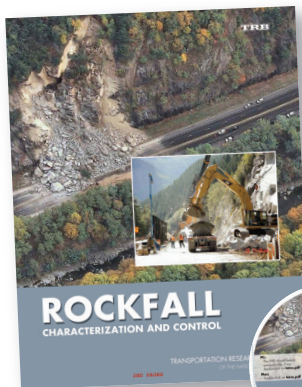


engineers responsible for rockfall investigations, students, and researchers who need a definitive resource on rockfall investigation and mitigation.

Order your copy today at www.TRB.org/Rockfall

- Hardcover, ISBN 978-0-309-22306-5, \$110
- Paperback, ISBN 978-0-309-22312-6, \$100

For more information, send an e-mail to TRBSales@nas.edu or visit TRB's online bookstore, <http://books.trbbookstore.org/>.



The National Academies of
SCIENCES • ENGINEERING • MEDICINE

The nation turns to the National Academies of Sciences, Engineering, and Medicine for independent, objective advice on issues that affect people's lives worldwide.

www.national-academies.org

