SEPTEMBER–OCTOBER 2012
NUMBER 282

TRANSPORTATION RESEARCH BOARD
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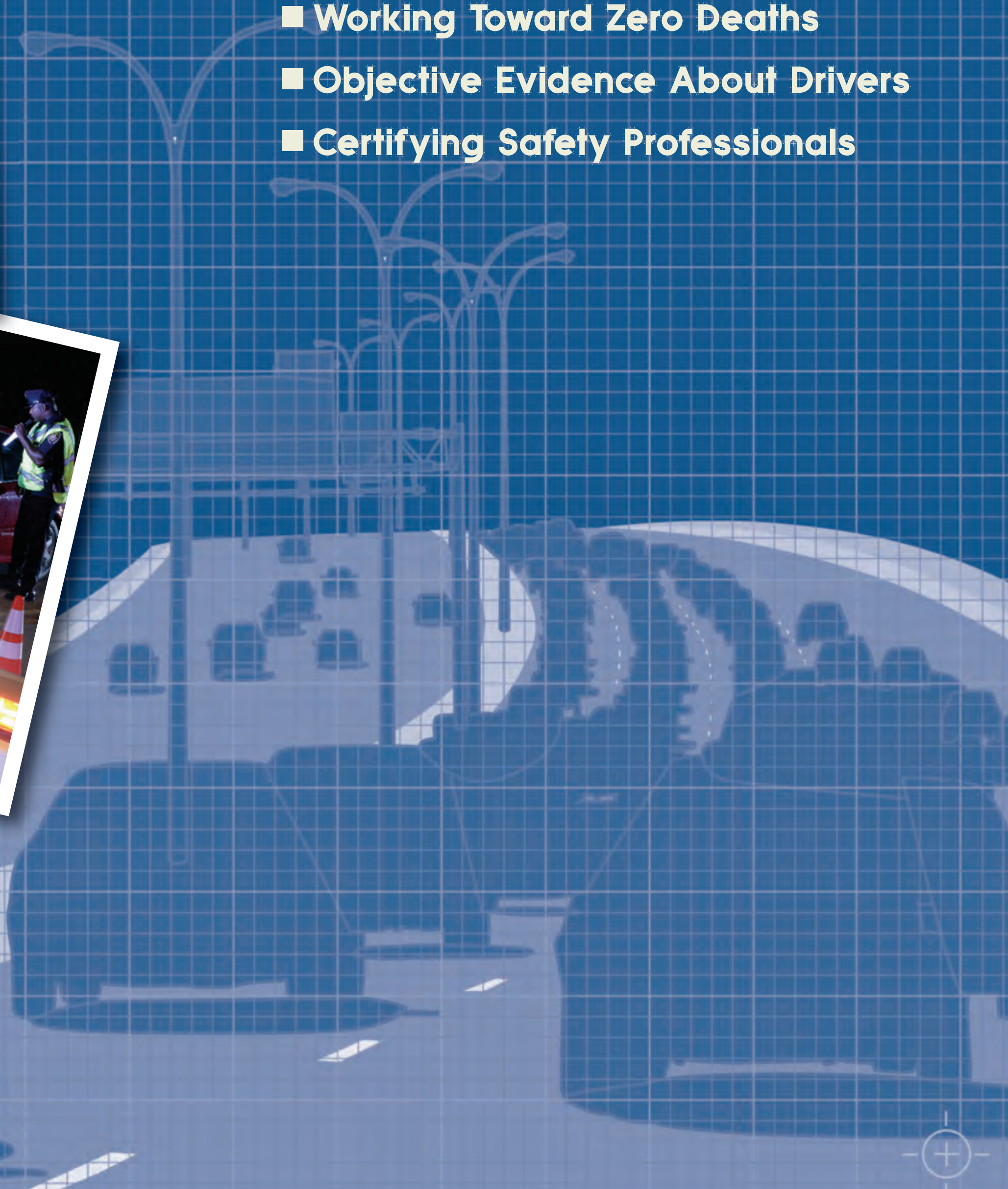
TR NEWS

Blueprints to Improve Highway Safety

- New Manual Drives Advances
- State Plans Deliver Results
- Working Toward Zero Deaths
- Objective Evidence About Drivers
- Certifying Safety Professionals



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TR NEWS

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BLUEPRINTS TO IMPROVE HIGHWAY SAFETY

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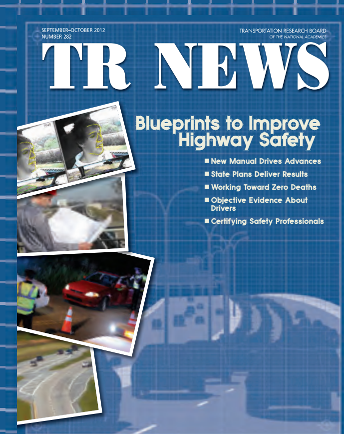

COVER: Promising new research-based blueprints are in place to improve highway safety throughout the nation.

TR NEWS

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

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ALSO IN THIS ISSUE:

COMING NEXT ISSUE

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM
NCHRP
1962 50 Years 2012

The National Cooperative Highway Research Program is celebrating its 50th anniversary and the Transit Cooperative Research Program its 20th in 2012; in addition, the Innovations Deserving Exploratory Analysis (IDEA) Program is completing its 20th year. This year also marks the 50th anniversary of the Federal-Aid Highway Act of 1962, which established the practice of urban transportation planning. Articles in the November–December *TR News* commemorate these significant milestones—including history, highlights, legacy, accomplishments, and ongoing prospects and endeavors.

Blueprints to Improve
HIGHWAY SAFETY

INTRODUCTION

Creating Our Safety Future

EZRA HAUER

The author is Professor Emeritus, Department of Civil Engineering, University of Toronto; an emeritus member of the TRB Safety Data Analysis and Evaluation Committee; and the 1999 recipient of TRB's Roy W. Crum Distinguished Service Award. He resides in Toronto, Ontario, Canada.

We want our road safety future to be created with deliberation; we want our decisions to be guided by evidence. The tools and the initiatives described in this issue are important strides in the right direction. For the first time, with the publication of the *Highway Safety Manual*, we have a way to link road design to safety consequences; for the first time, we can put on our bookshelf a document that tells us how to express safety in numbers and that explains which countermeasure will have what effect.

These are important tools. But the arrow needs an archer and the pen a poet. Tools do not create the road safety future—trained professionals do. Can you imagine health care being delivered by departments of health through guidelines and canned software, without doctors and nurses? Imagining the delivery of road safety without engineers and planners trained in road safety should be equally difficult. Alas, imagination is not needed; one only has to look around.

The talk nowadays is about embracing the Toward Zero Deaths (TZD) vision, also described in this issue. To show their commitment, institutions are being asked to obtain TZD accreditation. This is important, because institutions determine budgets and programs. Committed institutions, however, will not create our safety future—professionals will, through the decisions they make daily. Therefore shouldn't professional organizations also be asked to make a commitment to TZD? Couldn't professional organizations ensure that only accredited professionals can sign a plan or submit a report affecting road safety? Shouldn't professional organizations define what a professional must know about road safety before being allowed to approve a highway design, a signal timing sheet, a subdivision layout, or an urban transport plan?

Having the professional organizations participating in this way would ensure that the safety tools are used appropriately and that evidence is translated into practice. Moreover, the requirement for accreditation in road safety will lead to courses, textbooks, and systematic training. As doctors and nurses trained in medicine are essential for the delivery of health care, so engineers and planners trained in road safety are essential for the delivery of evidence-based road safety. All aboard!

Appreciation is expressed to TRB Senior Program Officers Mark S. Bush, Richard F. Pain, Charles Niessner, and Christopher Hedges for their work in developing this issue of *TR News*.

Blueprints to Improve HIGHWAY SAFETY

The Highway Safety Manual

Improving Methods and Results

JOHN C. MILTON

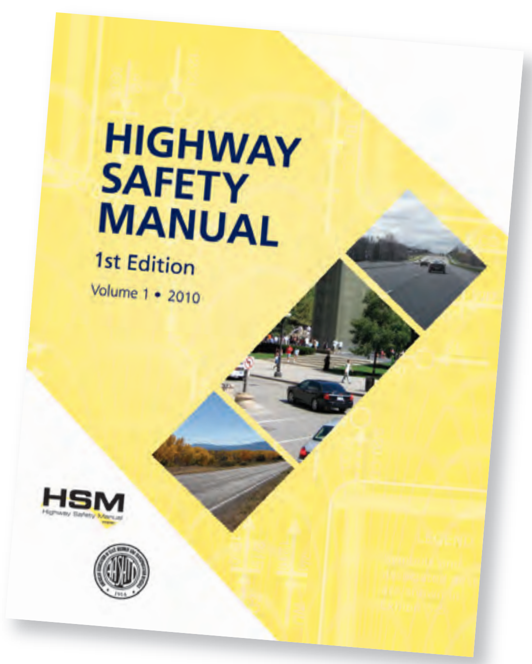
The author is Director of Enterprise Risk and Safety Management, Washington State Department of Transportation, Olympia, and serves as Chair of the TRB Highway Safety Performance Committee and of the National Cooperative Highway Research Program Project Panel on Development of a Comprehensive Approach for Serious Traffic Crash Injury Measurement and Reporting Systems and of the Project Panel on Interchange Safety Analysis Tool Enhancement.

In December 1999 a group of highway safety academics, practitioners, and agency representatives convened in Irvine, California, to discuss the creation of a comprehensive and authoritative manual that would serve the field of highway safety in the same way that the *Highway Capacity Manual* had served the field of operations. This group became the core of a larger team that has focused substantial amounts of professional and volunteer time on this vision.

The vision became reality 11 years later, with the publication of the *Highway Safety Manual* (HSM). The HSM represents a dedicated effort to create and drive the science of safety into practical use and to integrate safety as a key consideration in any highway project, program, or activity. The development of the HSM focused on the quantification of safety performance, beyond the traditional safety paradigm.

To succeed, the HSM had to become a tool for professionals in planning, design, operations, maintenance, and system management. The planner and designer would be able to consider reconstruction and upgrades to facilities and to compare the anticipated safety performance with that of the current facility. Summarizing crash history and relying on nominal assessments of what would improve safety performance no longer sufficed. The HSM had to improve the reliability of information, enabling substantive assessments that would reduce fatal and serious injuries. In addition, the HSM had to offer approaches to assess a facility's safety performance.

The HSM represents the cooperative efforts of the American Association of State Highway and Transportation Officials (AASHTO), the Federal Highway Administration (FHWA), and the Transportation Research Board (TRB). Technical content was developed through a major research effort funded and managed through the National Cooperative Highway Research Program (NCHRP). The TRB Highway Safety Performance Committee, the AASHTO HSM Task Force, and the FHWA Office of Safety continue the collaboration as new partners become involved in implementation and in the development of the second edition of the HSM.



The *Highway Safety Manual*, published in 2010, was developed as a comprehensive tool for the integration of safety into highway planning, design, operations, maintenance, and system management.

Scientific Basis

Before the HSM, safety program and project decision making relied on a variety of sources and methods to assess steps and actions to reduce the potential for crashes. The assessments varied in effectiveness and did not maximize reductions in total crashes. Finding science-based, state-of-the-practice methods, approaches, and knowledge was difficult.

When safety decisions are not quantified, tradeoff decisions among traffic operations, environmental stewardship, or cost are difficult and often have been based on perception. A scientific basis was needed for decision making. Highway and roadway safety is a priority for most state DOTs, but budgets are shrinking for all programs. Decision making must be reliable and optimal.

Photo: National Highway Traffic Safety Administration

A first responder records information at the scene of a crash. From emergency response services to roadway design, highway safety decision making must be reliable.

The HSM was designed for use throughout a project's development. The intended users are professionals in planning, design, construction, operations, and maintenance of the roadway and highway systems at the state, county, and local levels.

Absolute safety does not exist; the primary objective of highway safety is to lower the risk for crash frequency and crash severity. The safety professional relies on three primary components to reduce risk: the human, the vehicle, and the roadway. The HSM focuses on the roadway but recognizes the importance of the vehicle, of human factors, and of the interventions of education, enforcement, and emergency medical services.

Core Principles

Throughout the development of the HSM, particular attention was given to the reliability of the analysis as key to reducing fatalities. As a result, the HSM is a fundamentally unique document, presenting the evolution of approaches, methods, and knowledge in highway safety. At its core are two principles:

- ◆ Allow the user to base decisions on actual anticipated changes in crash frequency and severity; and
- ◆ Address the statistical issues that have a direct impact on reliability.

Nominal and Substantive Safety

Most highway programs have addressed safety through the application of standards. Standards often generically refer to design policies, guidelines, and critieria that are part of an agency's design and traffic operations manuals; to the AASHTO *Policy on Geometric Design of Highways and Streets*; to the AASHTO *Roadside Design Guide*; and to the *Manual on Uniform Traffic Control Devices*. Each of these documents, however, differs in purpose, use, and interpretation.

The assumption was that the application of a design standard provided safety. Ezra Hauer aptly termed this "nominal safety" in the 1990s. Many of these standards were not developed to address crash frequency and severity but operational, environmental, economical, and other considerations.

Hauer advocated that "substantive safety" was more appropriate for addressing crashes. Substantive safety provides a statistically reliable assessment of safety performance to inform an agency's planning, project development, and traffic operations.

In applying design standards, the designer assumes that the resulting design will be safe—that meeting the design manual requirements equals safety. Within this context, however, the designed facility is only nominally safe. For example, 12-ft lanes are the design standard for a particular facility type; a design for 11-ft lane widths, which would require a design exception, represents an absolute change in safety—the nominal crash risk would be significantly higher.

Substantive safety, in contrast, relies on scientific findings for determining the anticipated safety performance, measured in crash frequency and severity. With the substantive safety approach, the designer

Photo: iStock

Efforts to reduce crash risk focus on the human, the vehicle, and the roadway.

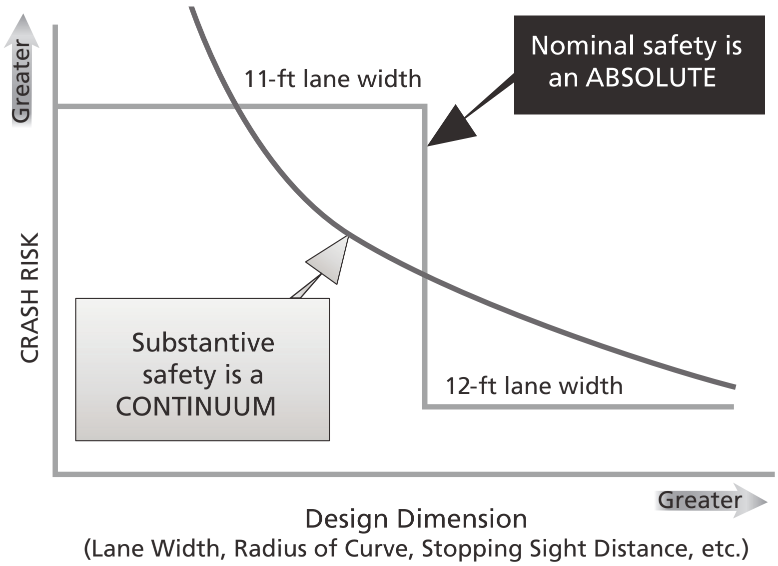


FIGURE 1 Nominal versus substantive safety. (Source: CH2M Hill, 2011.)

uses the HSM to determine the effect of a change in lane width on crash frequency and severity; for a given facility type and volume, the difference in the anticipated crash outcomes may be neglible. In the substantive safety approach to design and system management, crash frequency and severity are critical in decision making.

Figure 1 (above) illustrates the difference between nominal and substantive safety with the 12-ft versus 11-ft lane width example. The line labeled as nominal safety indicates that the crash risk associated with the 11-ft lane is substantially higher than that for the 12-ft lane. Under the nominal safety approach, the 11-ft lane would be deemed unsafe, and the 12-ft lane safe. The curve labeled substantive safety shows the actual anticipated crash performance as a continuum—as lane width increases, the crash risk decreases.

Regression to the Mean

Historically, potential projects underwent a ranking of crash frequency or rate, followed by a "black spot" analysis that used short periods of observed crash history—typically two to five years—to identify locations that might benefit from changes to the road or roadside environment that would reduce crash frequency or severity. This method has been moderately successful, but using limited data can lead to large fluctuations in crash rates, as shown in Figure 2 (below, left).

Determining locations for safety intervention from small sets of data can lead to unreliable assumptions about safety performance if the analysis does not account for regression to the mean. An agency cannot know with certainty that the site will respond, or that any changes are directly caused by the treatment.

Crashes are random events; therefore crash frequency at a given site will vary from year to year; a project selected on the high side of this variance will show an average number of crashes that exceeds expectation. As shown in Figure 3 (below, right), accounting for regression to the mean produces a different expected average crash frequency, but one that is more indicative of the true safety performance at the site. Therefore the project is more likely to show a crash reduction with the appropriate countermeasure.

Accounting for regression to the mean and incorporating the substantive safety philosophy improves decision making. The result is fewer crashes on the highway system and a reduction in fatal and serious injuries. Improving an agency's ability to incorporate safety into decision making translates into increased effectiveness in expenditures, increased awareness of trade-offs, and the ability to inform the public—including stakeholders and elected officials—about the benefits and impacts of programs and projects.

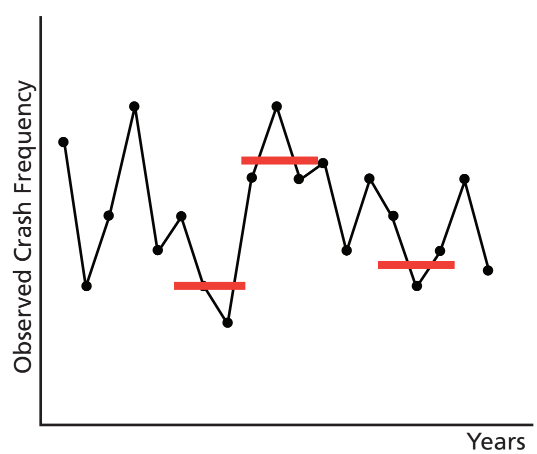


FIGURE 2 Average short-term crash frequency (red horizontal rules).

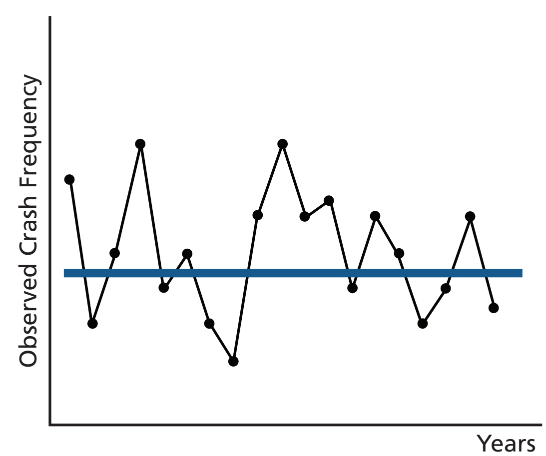


FIGURE 3 Expected average crash frequency (blue horizontal rule).

Highway Safety Manual Contents

New Thought Process

The HSM presents a new thought process for many organizations that will require some changes to policy, procedures, and methods. The document's structure follows the project development process for most transportation organizations. The three-volume HSM comprises 17 chapters sorted into four parts (see box, above).

Basic Concepts

Part A introduces the basic concepts of highway safety, with chapters on human factors and safety fundamentals. Improving safety performance requires an awareness throughout the project development process of user capabilities, limitations, and interactions with the roadway.

Chapter 1—Introduction and Overview defines the purpose and intended audience of the HSM. The HSM is a technical document that requires a level of understanding for its use. The chapter highlights types of applications, the scope of the document, and its relationship to project development.

Chapter 2—Human Factors introduces the basic principles, indicating the effect of human factors and of the ways that designs and operations can account and compensate for limitations. The goal is to reduce the potential for errors—and consequently reduce crashes—related to human factors. The NCHRP Report 600 series, *Human Factors Guidelines for Road Systems*, supplements this chapter.[1]

Chapter 3 introduces the concepts that support the application of the methods, approaches, and knowledge presented in the HSM.

Road Safety Management

Chapters 4 through 9 address road safety management, following the steps commonly taken in system and project planning, program management, preliminary engineering, and operations.

The first step generally involves screening for the projects most likely to respond to design modifications. Chapter 4—Network Screening outlines the process, which includes establishing the reason, determining the reference population, selecting performance measures, and selecting the screening methods. The chapter summarizes the state of the practice and shows how to incorporate safety into the ranking process, to focus resources where the return is highest.

After the projects are ranked, the next step is to understand the factors contributing to crashes across the location, corridor, or system. Chapter 5—Diagnosis describes how to analyze historic safety performance to gain insight into the circumstances contributing to observed crashes. Properly identifying the patterns, target crash types, and the contributing circumstances increases the probability that

[1]http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_600A.pdf.

A multilane, divided highway in a rural area. Understanding the specific factors that contribute to crashes in a highway system is an essential step in the project planning process.

PHOTO: AAA FOUNDATION FOR TRAFFIC SAFETY

Photo: Oregon Department of Transportation

Developed for training purposes as part of a National Cooperative Highway Research Program (NCHRP) project, spreadsheets incorporating locally derived values for Oregon can be used as a companion tool to Part C—Predictive Methods of the HSM. Part C assists practitioners in assessing the safety performance of rural, two-lane roads, as well as rural highways and urban and suburban arterials.

the factors contributing to crashes can be addressed in the best way possible.

Selection of a potential countermeasure is the third step, discussed in Chapter 6. Countermeasures aim to reduce the frequency and severity of crashes for a specific site, or they may represent a trade-off between crash severity and frequency. Selecting the appropriate countermeasures maximizes the potential for reducing crashes and their severity.

The economic analysis methods in the HSM allow comparisons of a countermeasure's anticipated benefits and costs. Chapter 7—Economic Appraisal presents cost-effectiveness and benefit–cost analysis methods. Although costs are typically valued in monetary terms, agencies often incorporate nonmonetary considerations. Project comparisons can use common performance metrics and analysis techniques.

Chapter 8 outlines project prioritization, necessary when several candidate sites have been identified on the network, the economic evaluations have been performed, and the economically feasible candidate sites have been selected and are consistent with organizational policies. The process allows an agency to identify the projects with the greatest potential benefit across the system.

Evaluating the change to the system in terms of crash or injury reduction helps an organization to understand safety performance and to account for safety in decision making. This approach is more likely to succeed in improving system performance. Chapter 9 presents different evaluation methods and approaches, reviews the strengths and limitations of each, and supports the development of crash modification factors (CMFs). Evaluating safety effectiveness provides agencies with feedback for policies and decision making.

Assessing Safety Performance

Part C—Predictive Methods applies to rural two-lane, two-way roads (Chapter 10), rural multilane highways (Chapter 11), and urban and suburban arterials (Chapter 12). The predictive method assesses anticipated safety performance—that is, the predicted average crash frequency—and the expected average crash frequency, where applicable.

The estimates can be used to assess a network, corridor, or site, for existing and future conditions, with or without proposed countermeasures, as well as the effectiveness of potential countermeasures under current and future conditions. Part C allows the assessment of the safety performance of new facilities under various traffic volumes.

Safety Treatments

Part D—Crash Modification Factors presents the potential effects of safety treatments and of operational and other site-specific changes on crashes for roadway segments (Chapter 13), intersections (Chapter 14), interchanges (Chapter 15), special facilities and geometric situations (Chapter 16), and road networks (Chapter 17). Each chapter explores the potential safety impacts in terms of the quality and the statistical reliability of the research.

Part D presents a subset of the CMFs available in practice. All information in the HSM underwent thorough screening and expert review to assure reliability of the information and guidance. Part D is supplemented with information from the FHWA Crash Modification Clearinghouse[2] and the NCHRP Report 600 series.

The HSM is scalable; some organizations or

[2]www.cmfclearinghouse.org.

Photo: Wayan Vota

Raised medians were installed along New Hampshire Avenue in Washington, D.C., in 2009; safety treatments are examined in the HSM Part D—Crash Modification Factors.

agencies may choose to implement only a portion of the tools. For instance, an organization may decide to focus on the planning and scoping of projects covered in Part B and on the reliable approaches incorporated in Part C; others may focus on design and apply Part C and Chapter 2—Human Factors. AASHTO developed Figure 4 (right) to show potential links to the project development process.

Software Tools

Several software tools were developed to ease application of the HSM and are an integral part of the package. Following are some of the noncommercial software applications.

Safety Analyst is a highway safety management software tool that performs functions outlined in Part B, Chapters 4 through 9, of the HSM. Safety Analyst was developed through a pooled-fund effort by states and is offered as part of AASHTOWare, AASHTO's suite of software for designing and managing transportation infrastructure projects.[3]

The Interactive Highway Safety Design Model (IHSDM), a software tool developed and made available at no cost by FHWA, is used to evaluate the safety and operational effects of design decisions and includes modules on crash prediction, design consistency, intersection review, policy review, traffic analysis, and driver–vehicle issues. The IHSDM–HSM Predictive Method 2011 (Version 7.0.0) is available online.[4] The crash prediction module incorporates Part C, Chapters 10 through 12, of the HSM.

Under NCHRP Project 17-38, *Highway Safety Manual* Implementation and Training Materials, Karen Dixon of Texas A&M Transportation Institute developed spreadsheets to assist in performing the Part C predictive methods. Alabama, Virginia, Illinois, and Washington State DOTs have applied and expanded the spreadsheets.

The FHWA Crash Modification Factors Clearinghouse is a web-based database that allows searches for CMFs and assists in selecting the most appropriate measure.[2] The site employs a five-star rating system and includes supporting research.

Supporting Documents

To assist in the implementation of the HSM, documents have been created for a variety of levels within a state DOT, focusing on the HSM as part of the project development process. The documents are available on FHWA's HSM website[5] or AASHTO's Highway Safety Manual website.[6]

[3]www.aashtoware.org/Pages/default.aspx.

[4]www.ihsdm.org.

[5]http://safety.fhwa.dot.gov/hsm.

[6]www.highwaysafetymanual.org/Pages/default.aspx.

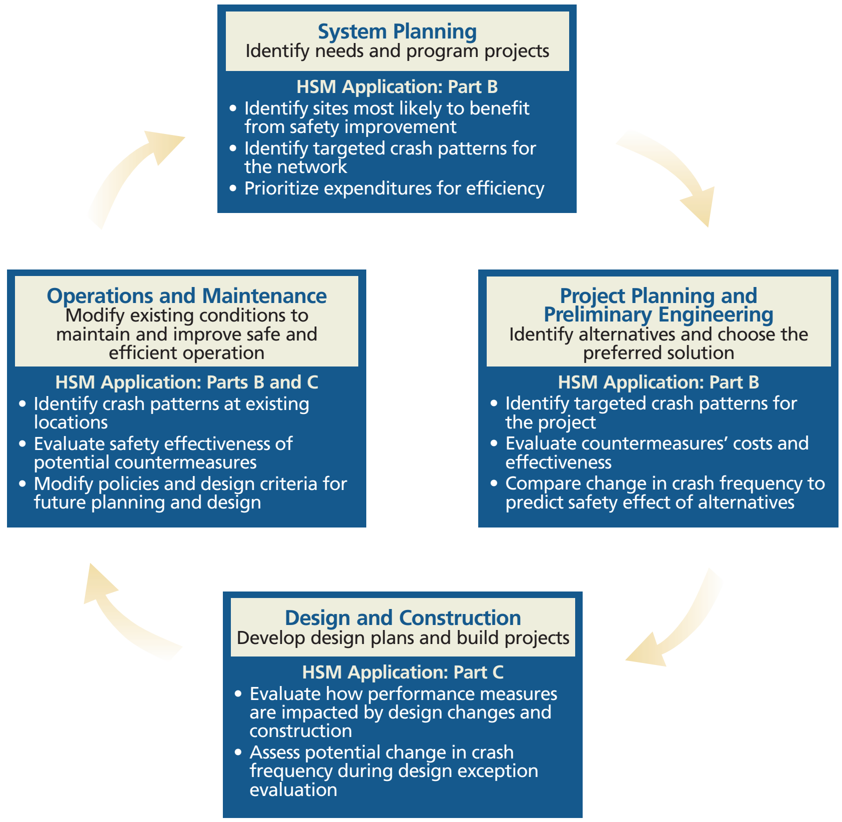


FIGURE 4 HSM and the project development process. (Source: AASHTO.)

The HSM outreach materials provide a quick point of reference and summary information to ease adoption of the HSM, including the *HSM Overview Brochure*, *HSM Overview Fact Sheet*, and *An Introduction to the Highway Safety Manual*.

FHWA has developed three HSM guides. The *HSM Managers Guide* (2011) provides information to state DOT managers charged with incorporating the HSM into the project development process. *Integrating the HSM into the Highway Project Development Process* (2012) helps transportation professionals apply the HSM in planning and scoping, environmental studies, predesign, final design, and day-to-day maintenance and operations activities. The *HSM Training Guide* (2011) was developed for state and local agencies considering implementation of the HSM; it documents training needs, sequences of training, delivery methods, and courses offered by FHWA's National Highway Institute and the Institute of Transportation Engineers.

Case studies complement the guides, demonstrating applications of the HSM, including the roadway safety management process, predictive methods, and the development of safety performance functions and implementation plans. FHWA also sponsors a user discussion forum on the AASHTO HSM website.[7]

[7]www.hsmforum.org.

Safety Analyst

Software Tools for Safety Analysis of Specific Highway Sites

DOUGLAS W. HARWOOD AND DARREN J. TORBIC

Safety Analyst consists of a set of software tools available from the American Association of State Highway and Transportation Officials (AASHTO) to help highway agencies analyze the safety effects of infrastructure improvements at specific sites on a highway and street network.[a] The tools were developed through a Federal Highway Administration (FHWA) pooled-fund study that ran from 2001 to 2009 with the participation of 27 state highway agencies and other stakeholders.

The software includes four modules that together address the six steps of the safety management process described in Part B of the *Highway Safety Manual* (HSM):

- **Module 1: Network Screening** reviews the entire highway network and identifies sites with the greatest potential for safety improvement.
- **Module 2: Diagnosis and Countermeasure Selection** diagnoses the safety concerns at particular sites and assists in selecting effective countermeasures to reduce the frequency and the severity of crashes.
- **Module 3: Economic Appraisal and Priority Ranking** performs cost-effectiveness and benefit–cost analyses for a specific countermeasure or for several alternative countermeasures at specific sites and ranks countermeasures and sites to assist highway agencies in setting investment priorities.
- **Module 4: Countermeasure Evaluation** performs before-and-after evaluations to document the effectiveness of implemented safety improvements.

The modular package allows for flexibility—users can apply Safety Analyst at any stage of the safety management process.

The Safety Analyst database consists of the highway agency's records of roadway segment, intersection, and ramp characteristics; traffic volumes; and crashes for its entire system. The software includes tools to import and manage data from the highway agency's databases. When Safety Analyst identifies a need, the project can be designed with supporting analyses from FHWA's Interactive Highway Safety Design Model (IHSDM; see article, page 11).

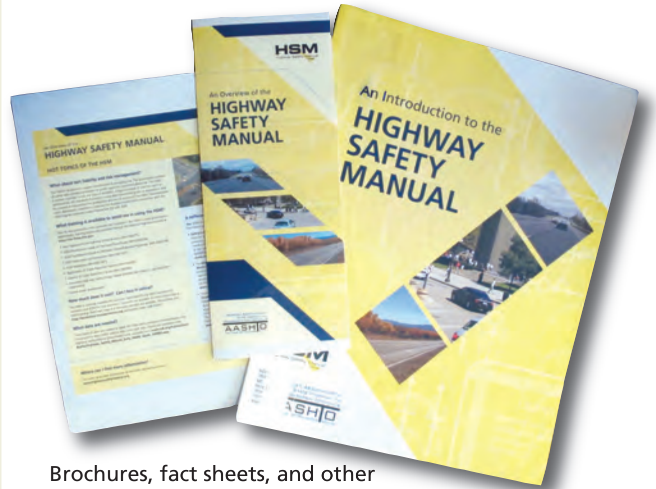
The data requirements for Safety Analyst are less extensive than for the predictive models in Part C of the HSM and in the IHSDM; project design requires more extensive data. Agencies that lack the detailed crash data to support Safety Analyst can apply the usRAP Tools software, available from the U.S. Road Assessment Program (see article, page 15), to perform the steps of network screening, countermeasure selection, and economic appraisal.

The Safety Analyst software can be licensed for use by highway agencies through the AASHTOWare program.[b] In addition to permitting use of the software, the license provides access to technical support, including engineering support from MRIGlobal and computer software and data management support from ITT Excelis.

The authors are with MRIGlobal. Harwood is Transportation Research Center Director, Kansas City, Missouri; and Torbic is Principal Traffic Engineer, State College, Pennsylvania.

[a]www.safetyanalyst.org.

[b]For licensing information, contact Vicki Schofield at AASHTOWare, VSchofield@aashto.org.



Brochures, fact sheets, and other outreach materials help states and localities assist in adopting the HSM.

Research Supporting the HSM

TRB's Transportation Research Circular E-C142, *Methodology for the Development and Inclusion of Crash Modification Factors in the First Edition of the Highway Safety Manual* (2010), provides background on the development of Part D of the HSM and describes the CMF literature review and inclusion process.[8] This document offers a framework for the review of future safety publications, to determine statistical reliability, the characteristics of reliable CMF results, higher-quality methods to advance the science of safety, and improvements for later editions of the HSM.

During the development of the first edition, several professionals expressed concern about employing the monetary costs of crashes to justify programs and initiatives. In moving from a qualitative to a quantitative approach, however, economic appraisal is a key in decision making. Societal cost figures are often used to show the benefits of crash reduction and to prioritize projects. In 2011, NCHRP Project 20-24(068) developed a simple calculator to assist state DOTs in estimating the crash costs by state, using site and safety attributes such as posted speed limit, geometry, traffic control, signalization, crash type, and maximum severity of injury.[9]

CMFs are critical in quantifying the impacts on safety and directly affect the reliability of analyses. FHWA published *A Guide to Developing Quality Crash Modification Factors* (2010) to explain the process and the issues to consider in selecting evaluation methods; the document covers the background, definitions, purpose, use, and concerns in developing CMFs.[10]

In addition, FHWA sponsored research in support

[8]http://onlinepubs.trb.org/onlinepubs/circulars/ec142.pdf.

[9]http://usroadsafety.com/crash-cost-calculator.

[10]www.cmfclearinghouse.org/collateral/CMF_Guide.pdf.

Blueprints to Improve HIGHWAY SAFETY

The Interactive Highway Safety Design Model

CLAYTON CHEN

The Interactive Highway Safety Design Model (IHSDM) is a suite of software tools that support project-level decisions about the geometric design of roadways. The model provides quantitative information on the expected safety and operational performance of a design. Produced by the Federal Highway Administration's Safety Research and Development Program, the IHSDM is a resource for the predictive method described in Part C of the American Association of State Highway and Transportation Officials' *Highway Safety Manual* (HSM).

IHSDM assists project developers in making decisions that improve the safety performance of designs. The software tools also help project planners, designers, and reviewers justify and defend decisions about geometric design.

The 2011 IHSDM comprises six evaluation modules: Crash Prediction, Policy Review, Design Consistency, Intersection Review, Traffic Analysis, and Driver–Vehicle. The Crash Prediction Module (CPM) is a software implementation of HSM Part C, which includes crash prediction methodologies for rural two-lane and multilane highways and for urban and suburban arterials.

PHOTO: WASHINGTON STATE DOT

The Interactive Highway Safety Design Model's Crash Prediction Module presents methodologies for highways and arterials; efforts are under way to incorporate crash prediction capabilities for ramps, freeways, and interchanges as well.

The IHSDM includes a recently developed calibration utility to assist agencies in implementing the procedures described in the Part C Appendix. Agencies can enter their own safety performance functions and modify the default crash distributions. Efforts are under way to extend the CPM to include freeway, ramp, and interchange crash prediction capabilities from new HSM chapters developed under National Cooperative Highway Research Program Project 17-45, Enhanced Safety Prediction Methodology and Analysis Tool for Freeways and Interchanges.

Two recent case studies highlight the use of IHSDM to implement HSM Part C methods:

◆ The Louisiana Department of Transportation and Development (DOTD) conducted a safety analysis to quantify the benefits of constructing an alternative route from Interstate 12 to Bush. The CPM produced estimates of the crashes expected in 2035 for the study area network, for the no-build condition, and for four alternative scenarios. The total network crash performance was evaluated and compared for each scenario. An estimated cost per crash by severity was applied to the predicted number of crashes, and the alternatives were ranked by cost savings. Louisiana DOTD was able to identify the safest and most cost-effective solution.

◆ The Idaho Department of Transportation (DOT) conducted a comprehensive review of conditions on the State Highway 8 corridor to identify and prioritize operational improvements over a 10-year period. The IHSDM crash predictions were based on the existing traffic, roadway geometry, and recent crash history. The output indicated that for more than half of the 11-mile corridor, the calculated crash rate was higher than the statewide average. Potential locations were identified for improvement. "The advantage of employing IHSDM was the opportunity to perform a detailed and simultaneous review within the corridor on a variety of critical elements—for example, traffic operations, geometry, and safety—to isolate potential problem areas and allow the development of strategic mitigation strategies," the project manager noted.

IHSDM training consists of a two-day course onsite or a web-based version led by experienced instructors. Participants learn about key IHSDM capabilities and limitations, evaluate highways using IHSDM, and recognize when and how the module can be used during the project development process.

Resources

- For more information about the Idaho DOT case study, visit http://safety.fhwa.dot.gov/hsm/casestudies/id_cstd.cfm.
- For more information about training courses, see FHWA-NHI-380071 and -380100 in the National Highway Institute catalog, http://nhi.fhwa.dot.gov.
- Additional resources are available at http://www.fhwa.dot.gov/research/tfhrc/projects/safety/comprehensive/ihsdm/index.cfm and http://www.ihsdm.org.
- Contact: Clayton Chen, 202-493-3054; clayton.chen@dot.gov.

The author is Highway Research Engineer, Federal Highway Administration, McLean, Virginia.

Wikimedia Commons

A pedestrian refuge island in a roadway. Safety for nonmotorists also is part of the NCHRP research portfolio.

of the Highway Safety Improvement Program. *Investigation of Existing and Alternative Methods for Combining Multiple CMFs* (2010) presents issues in the application of multiple CMFs and offers guidance for estimating the effects of combined treatments.[11]

NCHRP Project 20-7(314), Recommended Protocol for Developing Crash Modification Factors, has outlined a process for developing CMFs. The findings describe the necessary documentation and how to address potential biases.

The NCHRP Report 600 series focuses on road user capabilities and on limitations in road design and operations.[12] The guidelines are useful for diagnosing the contributing factors in collisions and for the selection of countermeasures.

Training and Implementation

Training is a critical component of the HSM. NCHRP Project 20-7(290), Highway Safety Training Synthesis, surveyed the safety training available and developed a roadmap and central database of the information. NCHRP Project 17-38, Development of Overview Training for the HSM, assisted FHWA and others in preparing to implement the HSM.

The first of many research publications supporting HSM implementation was NCHRP Research Results Digest 329, *Highway Safety Manual Data Needs Guide*.[13] The guide assists users in understanding the data needed for the Part C methodologies and explains the difference between available data and the data needed in the future.

NCHRP Project 17-50, Lead States Initiative for Implementing the HSM, started after the successful Safety Performance Function Summit hosted by Illinois DOT through the efforts of State Safety Engineer Priscilla Tobias; the summit focused on the use of quantitative tools in highway safety. The project has established a dialogue among states that have experience in quantifying safety, to inform other states,

[11]www.cmfclearinghouse.org/collateral/Combining_Multiple_CMFs_Final.pdf.

[12]http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_600A.pdf; http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_600B.pdf; and http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_600C.pdf.

[13]http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rrd_329.pdf.

Roadside Safety Analysis Program, Version 3

Upgrading a Tool for Roadside Safety Design

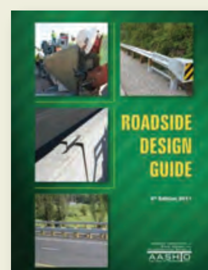
MALCOLM H. RAY, CHRISTINE E. CARRIGAN, AND CHUCK PLAXICO

The Roadside Safety Analysis Program (RSAP) was developed to update and enhance the cost-effectiveness analysis algorithms and procedures of the ROADSIDE software package included in the *Roadside Design Guide*, published by the American Association of State Highway and Transportation Officials (AASHTO). The program and its interface recently have undergone an extensive upgrade, incorporating new research results and enhancing the computing capabilities and ease of use.

Version 3 of the Roadside Safety Analysis Program (RSAPv3) was developed as a tool for the 2011 Roadside Design

Version 3 of RSAP (RSAPv3) soon will be available electronically at no charge from AASHTO to purchasers of the *Roadside Design Guide*. The National Cooperative Highway Research Program is preparing to publish a final report that contains a user's manual with detailed, how-to explanations and an engineer's manual tracing the technical background behind the code, as well as the methodologies for the analyses. The software, manuals, and example problems are available on the website of the AASHTO Technical Committee for Roadside Safety.[a]

As the benefit–cost tool for the 2011 edition of the *Roadside Design Guide,* RSAPv3 assists in performing roadside safety economic analyses and serves as an alternative to the warranting approach also included in the guide. RSAPv3 incorporates substantive advances in roadside safety in the decade since the previous version; this required rewriting the code and developing new methods and techniques.



An encroachment-based approach, RSAPv3 divides collisions into three independent events:

1. The encroachment, when the vehicle first leaves the road;
2. The traversal of the roadside, where hazards may be located; and
3. The severity of the crash when a vehicle intersects a roadside hazard.

RSAP performs this series of calculations many times, simulating tens of thousands of encroachments for a typical roadway segment and estimating the crash costs of each possible encroachment. After generating all the encroachments and the estimated crash costs, the program produces an estimate of the total crash cost for the segment.

RSAPv3 can evaluate up to five design alternatives on up to

[a]http://design.transportation.org/Pages/RoadsideSafety.aspx.

and is developing a user guide for the HSM. The FHWA Pooled Fund Study for HSM Implementation is under way to advance the lead states initiative and to expand implementation to all states.[14]

Toward Future Editions

NCHRP Project 20-7(279), Work Plan for the 2nd Edition of the HSM, is a comprehensive effort to assess future research needs for the manual. Surveys of safety professionals have helped the AASHTO Task Force on the HSM and the TRB Highway Safety Performance Committee prioritize research efforts.

The first edition of the HSM included only a few roadside countermeasures. NCHRP Project 17-54, Consideration of Roadside Features in the *Highway Safety Manual*, recognizes the role of roadside features in crashes and is exploring the differences between the HSM and the NCHRP-developed Roadside Safety Analysis Program (RSAP), including the comparative strengths and weaknesses of each and ways to address the differences. The project also is identifying ongoing roadside research, CMFs research, and needed CMFs and aims to develop CMFs.[15]

[14]Transportation Pooled Fund 255; www.pooledfund.org/Details/Study/484.

NCHRP Project 17-56, Development of Crash Reduction Factors for Uncontrolled Pedestrian Crossing Treatments, looks to quantify the relationship between pedestrian crashes and crossing treatments. The research will evaluate various crossing treatments and will develop CMFs for crash type and severity.[16]

The ability to assess crash injuries accurately is critical in the selection of appropriate countermeasures; however, police reports of crash injuries often lack accuracy. NCHRP Project 17-57, Development of a Comprehensive Approach for Serious Traffic Crash Injury Measurement and Reporting Systems, is developing a framework for moving to International Statistical Classification of Diseases and Related Health Problems codes and to provide a process for linking crash data with hospital discharge data. The findings may provide a new injury scale for the HSM.[17]

[15]http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=2979.

[16]http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=3178.

[17]http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=3179.

20 highway segments and can compare the benefit–cost ratio of each alternative. The program identifies the alternative that makes best use of the funds.

The encroachment module in RSAPv3 takes into account the frequency of roadside encroachments by highway type and traffic volume. Adjustment factors are included for the effects of horizontal curvature, grade, number of lanes, lane width, access density, and posted speed limit.

RSAPv3 incorporates data on vehicle trajectories during an encroachment. The trajectories are superimposed on the user-entered data for roadside terrain, and the program assesses all possible interactions of trajectories with user-entered hazards.

RSAPv3 replaces the subjective severity index with an objective fatal crash cost ratio based on observed, police-reported crash data. RSAPv3 also accounts for unreported crashes—which can be considered roadside safety successes. The program includes a preloaded selection of crash severity models for many common roadside hazards, such as trees, utility poles, guardrails, and bridge piers.

The final report and its appendices document the methods and procedures in developing RSAPv3 and include a selection of case studies to illustrate use of the program. RSAPv3 provides roadside designers with an effective tool for making decisions about roadside safety designs.

Photo: Mike Lee

A median cable barrier on I-470 in Ohio prevented this tractor-trailer from reaching the opposite lanes of the highway in a crash. Roadside traversals are among the collision events analyzed by RSAPv3.

Resources

Mak, K. K., D. L. Sicking, and B. A. Coon. *NCHRP Report 665: Identification of Vehicular Impact Conditions Associated with Serious Ran-off-Road Crashes*. Transportation Research Board of the National Academies, Washington, D.C., 2010. http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_665.pdf.

NCHRP Project 17-43: Long-Term Roadside Crash Data Collection Program. http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=1637.

Roadside Design Guide, 3rd Edition. American Association of State Highway and Transportation Officials, Washington, D.C., 2006.

The authors are with RoadSafe LLC, Canton, Maine.

Several NCHRP projects are under way to inform future editions of the HSM; one is examining the relationship between pedestrian crashes and crossing treatments.

Photo: Washington State DOT

NCHRP Project 17-59, Safety Impacts of Intersection Sight Distance, is reviewing the relationship between safety and available intersection sight distance. Products include guidelines for various intersections and other factors and conditions, plus CMFs or other appropriate functions.[18]

[18]http://apps.trb.org/cmsfeed/trbnetprojectdisplay.asp?projectid=3181.

Training Materials for Applying the *Highway Safety Manual*

Released by the American Association for State Highway and Transportation Officials in 2010, the *Highway Safety Manual* (HSM) presents tools to facilitate decisions on roadway planning, design, operations, and maintenance that focus on their safety consequences. Because a key component to the manual's success is wide dissemination and comprehensive understanding of its techniques, the National Cooperative Highway Research Program (NCHRP) initiated an outreach and training project, summarized in NCHRP Report 715, *Highway Safety Manual Training Materials*.

Training materials include basic introductory information, as well as specific content for advanced procedures. The report features 12 informational modules addressing the development of the HSM, safety fundamentals, network screening, predictive methods, human factors, economic appraisal and prioritization, specialized procedures, diagnosis and countermeasure selection, safety effectiveness evaluation methods, crash prediction procedures, candidate crash modification factors, and introductory information on safety assessment procedures. Training materials include presentation slides with speaker notes, participant handouts, interactive sample problems, and smart spreadsheets.

The report emphasizes the importance of clear, concise, and objective language in safety instruction and documentation. Phrases and terms used to describe transportation scenarios often have connotations beyond their intended meaning—the report also highlights phrases that can be perceived incorrectly.

For more information on NCHRP Report 715 or to download the included CD-ROM, visit www.trb.org/Publications/Blurbs/167185.aspx.

NCHRP Project 17-62, Improved Prediction Models for Crash Types and Crash Severities, is developing models to supplement or to replace those listed in the HSM. The research will produce new SPFs or distributions for predicting crash severity on a facility.[19]

NCHRP Project 17-63, Guidance for the Development and Application of Crash Modification Factors, is exploring procedures for formulating, calibrating, and using new CMFs for multiple-treatment applications.[20]

Potential New Chapters

NCHRP Project 17-45, Enhanced Safety Prediction Methodology and Analysis Tool for Freeways and Interchanges, has produced two new chapters for the TRB Safety Performance Committee and AASHTO to consider for the HSM. The chapters will likely become part of the IHSDM predictive methods module. In addition, the research has enhanced the Interchange Safety Analysis Tool.[21]

NCHRP Project 17-58, Safety Prediction Models for Six-Lane and One-Way Urban and Suburban Arterials, is pursuing the continued development of the predictive methods chapters. The research will develop crash frequency and severity models for segments and intersections, as well as new chapters for the HSM.[22]

An Evolving Science

The HSM was created to reduce fatal and serious crashes on the nation's highways. The manual has changed the field of highway safety by introducing the means to quantify the impacts of safety in common practice and to use this information throughout the program and project development process. The HSM cannot be a static document; changes will occur as new information develops and the science of safety evolves.

The development and implementation of the HSM has spurred many research efforts and partnerships. The dedication of AASHTO, FHWA, and TRB in the publication of the first edition is evident. Volunteers and staff have devoted and contributed countless hours to the development of the HSM and to the effort to improve the science of highway safety. The TRB Highway Safety Performance Committee encourages participation in HSM activities and in the nation's Toward Zero Deaths vision.[23]

[19]http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=3420.

[20]http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=3421.

[21]http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=2512.

[22]http://apps.trb.org/cmsfeed/trbnetprojectdisplay.asp?projectid=2759.

[23]www.safetyperformance.org.

Road Safety Management Tool Assists State and Local Engineers

PETER KISSINGER

The new highway bill signed in July increases funding for highway safety and emphasizes the value of state strategic highway safety plans for all public roads. This will generate demand for new and innovative safety management tools, such as usRAP—the U.S. Road Assessment Program.[a]

The AAA Foundation for Traffic Safety completed an eight-state pilot test in 2010 to explore the benefits of usRAP. Modeled on programs in Europe and Australia and in effect in more than 70 countries, usRAP uses crash history data or roadway inventory data to assess and benchmark the relative safety of roads. State and county engineers and other key stakeholders are represented on the technical advisory panel that has guided the program.

Implementation of usRAP is under way across the country. In Michigan and Illinois, the usRAP team is building on a successful project in Kane County, Illinois, and is working with the states' departments of transportation and several counties to assist in the development of county-level strategic highway safety plans. These efforts will demonstrate the utility and applicability of usRAP to county and local jurisdictions, which often do not have adequate crash data to deploy more traditional analytical tools, such as the American Association of State Highway and Transportation Officials' Safety Analyst.

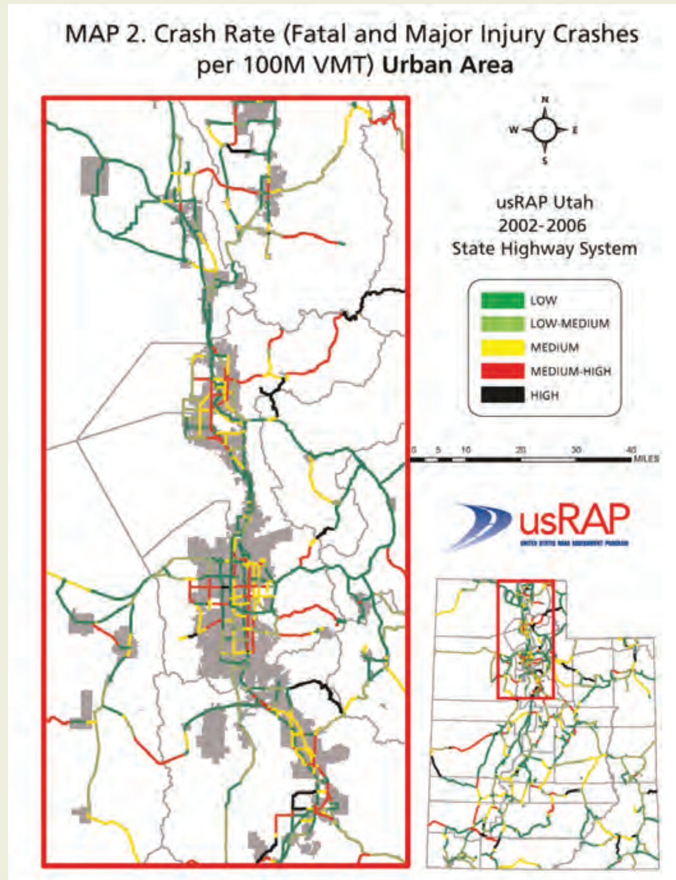
Through the Road Protection Score, usRAP identifies road segments with higher crash potential, analyzing road inventory data for the absence or presence of design features that correlate strongly with the risk of serious crashes. By generating a safety investment plan, usRAP offers cost-effective options—that is, road safety improvements—for engineers to consider for lowering the identified risks.

In Utah, the usRAP team has trained state safety engineers to perform analyses and produce color-coded risk maps from historical crash data. The team plans additional training sessions for state and county engineers, as well as for consultants interested in integrating the usRAP tools into their procedures.[b]

These efforts complement and supplement other highway safety management practices and help state and local jurisdictions respond to the new emphases on performance metrics and transparency, with the move nationwide to enhance traffic safety culture and to pursue the Toward Zero Deaths agenda.

The author is President and CEO, AAA Foundation for Traffic Safety, Washington, D.C.

IMAGE: USRAP



The usRAP risk map for Utah shows historical crash data in the state.

IMAGE: USRAP

An introductory video on the U.S. Road Assessment Program (usRAP) website provides an overview of the program. usRAP was pilot-tested in eight states and currently is being implemented across the country.

[a] www.usrap.us.

[b] To collaborate with usRAP or to participate in the training, contact the AAA Foundation at usRAP@aaafoundation.org or 202-638-5944.

Blueprints to Improve
HIGHWAY
SAFETY

In an interconnected highway network, even a minor car crash has the potential for major delays and damage. A comprehensive approach to traffic safety is required.

PHOTO: AAA FOUNDATION FOR TRAFFIC SAFETY

The Strategic Approach to Traffic Safety

Evolution and Synergies

PAMELA BEER, LORRIE LAING, AND JENNIFER WARREN

Beer and Laing are Senior Associates at Cambridge Systematics, Inc. Beer works from the Bethesda, Maryland, office, and Laing from the Chicago, Illinois, office. Warren is Program Manager, State Highway Safety Plans, Federal Highway Administration Office of Safety, Washington, D.C.

The safe operation of the U.S. surface transportation system depends on a careful choreography involving the attitudes and behavior of the road user, the number and capabilities of the vehicles, and the condition of the roadways and surrounding environment. A breakdown in any area can result in death, injury, property damage, and delay. Preventing a breakdown is not easy. Multiple factors contribute to the occurrence and severity of any crash; therefore an equally multifaceted response is necessary to address traffic safety.

Although considered a component of highway development projects, traffic safety did not come to the forefront of national transportation system concerns until 1966, with the passage of the Highway Safety Act. Subsequent transportation laws addressed safety. In 1991, for example, the Intermodal Surface Transportation Efficiency Act required states to develop a safety management system, and in 1998, the Transportation Equity Act for the 21st Century required that safety and security be incorporated as priorities in planning.

The Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) of 2005 went further by requiring a multidisciplinary, synergistic approach to traffic safety, and the new transportation authorization, Moving Ahead for Progress in the 21st Century, has strengthened the requirement. By requiring states to develop a strategic highway safety plan (SHSP), the law provided a jump start to improve U.S. traffic safety efforts from a statistical plateau that had lasted more than a decade. According to *Traffic Safety Facts 2005*, compiled for the National Highway Traffic Safety Administration (NHTSA), fatalities had been near the 40,000 level for more than 10 years (*1*). The motor vehicle fatality and injury rates per 100 million vehicle miles traveled (VMT) also remained level, with small decreases between 1995 and 2005.

Safety Systems Approach

The concept of a strategic plan to address safety was not new. In 1997, the Board of Directors of the American Association of State Highway and Transportation Officials (AASHTO) approved the AASHTO Strategic Highway Safety Plan, a comprehensive plan to reduce vehicle-related fatalities and injuries on the nation's highways. AASHTO encouraged states to adopt a similar plan, and a few took up the challenge.

Programs implemented in the United Kingdom, Canada, Australia, and several European countries provided compelling evidence. Applying data-driven, systemwide, multimodal, collaborative, and comprehensive plans developed in consultation with all traffic safety stakeholders, these countries realized substantial reductions in the numbers of deaths and serious injuries. In the United Kingdom, fatalities decreased 53 percent over 30 years, even as VMT increased an average of 2.7 percent per year. In 1974, the fatality rate in the United Kingdom was 34 percent higher than that in the United States; in 2004, however, the UK fatality rate was 29 percent lower.

The multidisciplinary safety systems approach required attention to road users, the roadway, and the vehicle. The underlying philosophy recognized that human beings make mistakes but should not die or suffer serious injuries as a result.

The SHSP requirement in SAFETEA-LU applied the safety systems approach, moving traffic safety from a reactive to a proactive practice. Traffic safety stakeholders—engineers, planners, law enforcement officers, educators, emergency medical services professionals, community advocates, and others—had to step out of their accustomed boundaries and collaborate, abandoning the scattershot approach to traffic safety. An SHSP requires a targeted and focused approach to prevent crashes or to mitigate the serious impacts of crashes.

SHSP Framework

Strategic planning was new to many states, particularly for improving traffic safety. Charged with overseeing the SHSP process, the Federal Highway Administration (FHWA) has provided tools, technical assistance, and information to help states develop and implement the plans.

The document that provided the framework and guidance for SHSP development was *A Champion's Guide to Saving Lives*. The guide noted,

> An important benefit of an SHSP is better coordination of statewide goals and safety programs to effectively reduce highway fatalities and serious injuries on all public roads through a comprehensive approach. The collaborative process of developing and implementing a state SHSP brings together and draws on the strengths and resources of all safety partners. The SHSP will allow the scheduling and implementation of safety improvement programs, comprehensive initiatives, and projects to be coordinated throughout the state. (2, p. 1)

Most strategic plans require some basic steps. The *Champions Guide* recommended that states gain support from their leadership for the plan, identify a person who would champion the cause, gather and analyze data, identify key emphasis areas and performance-based goals, develop strategies and countermeasures, and determine priorities for implementation (2). A second edition of the guide is nearing publication.

Stakeholder Involvement

Stakeholder input was a key ingredient in the development process. The SHSP is a multidisciplinary document—stakeholders should have a sense of ownership in the plan and a shared sense of responsibility for reducing traffic fatalities and serious injuries. The process requires time and patience as participants move out of their comfort zones and take on another responsibility.

Key stakeholders such as the state governor's highway safety representative, regional and metro-

Photo courtesy Stephen Read, Virginia DOT

Regional outreach meetings in Virginia convened stakeholders to assist in the development of a strategic highway safety plan (SHSP).

Blueprints to Improve HIGHWAY SAFETY

Reaching Greater Heights

Improving Roadway Data Practices for Enhanced Safety Decisions

MICHAEL S. GRIFFITH

The terms data, information, and knowledge are often used interchangeably. The difference between the terms is the level of detail or abstraction. Data are the lowest level of abstraction, information is the next level, and finally, knowledge is the highest level. On their own, data convey no meaning. To become information, data must be interpreted and take on meaning. To illustrate, the height of Mt. Everest is data; a book on the geological characteristics of Mt. Everest may be considered information; and a research report relating the success rate of mountain climbers to such factors as the weather, the experience and fitness of the climbers, and the support provided to the climbers may be considered knowledge.

Like climbers on Mt. Everest, the highway safety community has reached greater heights by conducting research with data and creating new knowledge. State-of-the-art resources such as the *Highway Safety Manual* (HSM) and the Crash Modification Factors Clearinghouse[a] have assembled this knowledge. But for many applications, state and local highway agencies must rely on their own data to put the knowledge into practice. For example, an agency wants to evaluate the expected safety performance of each of the design alternatives for reconstructing a two-lane rural highway; if using the HSM for the evaluation, the agency will need the cross-section and alignment data for the project. Many states, however, do not have these detailed data available.

[a]www.cmfclearinghouse.org.

PHOTO: RUPERT TAYLOR-PRICE

The differences between data, information, and knowledge can be illustrated by Mt. Everest: the mountain's height is data; a description of its characteristics, information; and research that interprets climbers' success rate to various factors, knowledge.

The Federal Highway Administration (FHWA) recently assessed the capabilities of each state for collecting, managing, and using roadway safety data. The project was conducted through the Roadway Safety Data Partnership, a collaborative effort by FHWA and the states to develop and deliver robust, data-driven safety capabilities. The assessment showed that states were at different levels of roadway data practice. FHWA is organizing four peer exchanges in 2012 and 2013 to highlight noteworthy practices from states relating to

- Roadway inventory data collection and technical standards,
- Data analysis tools and uses,
- Data management, and
- Data linkages.

As part of a focused effort to deliver technical assistance, tools, training, and other resources, FHWA is launching the Roadway Data Improvement Program at the end of 2012 to meet state and local highway agencies' needs identified in the assessment. The goal is for the states to develop action plans to address the data gaps. As state and local highway agencies optimize their data capabilities to generate new knowledge and improve the applications, successful safety investment decisions will result.

PHOTO: WASHINGTON STATE DOT

Washington State DOT works with Oregon DOT to rent an expensive, laser-equipped vehicle for collecting road stripe retroreflectivity data. According to the FHWA's Roadway Safety Data Partnership, levels of roadway data practice differ between states; collaborative programs can establish common approaches.

The author is Director, Office of Safety Technologies, Federal Highway Administration, Washington, D.C.

politan planning organizations, and state and local law enforcement officials were needed to offer their views and to make a commitment for continuing involvement after the plan was developed. At first, job responsibilities made this difficult for many stakeholders, particularly when collaboration across disciplines had not been common practice.

But stakeholders did get involved. For some, the support and active involvement of a leader or champion made the difference. Others were concerned about the lack of progress in decreasing the fatalities and serious injuries in their state or communities, and others were curious about the results from the new approach.

Defining Goals

SAFETEA-LU required approval of a state's SHSP by the governor or responsible state agency; the FHWA Division Office then reviewed and approved the development process. States realized many benefits during development, including the ability to leverage limited but available resources.

The SHSP process also helped establish common statewide safety goals and priorities. "It helped us collectively decide where we wanted Virginia to go in the future with respect to traffic safety," noted Stephen Read, Highway Safety Improvement Manager, Virginia Department of Transportation (DOT). "Rather than three or four different goals, we agreed on the same approach."

All 50 states and the District of Columbia completed their SHSPs by the deadline in SAFETEA-LU.

From Planning to Reality

Putting together the plan was just the beginning—the hard work was maintaining the momentum and keeping participants active and involved. One of the ways states addressed the issue was by assigning responsibility for parts of the plan to various stakeholder agencies and organizations. For instance, an agency would agree to take on a particular action step in an emphasis area and assume responsibility for the implementation.

The second tool developed by FHWA in collaboration with partners at the federal, state, and local levels therefore included emphasis-area action plans as a fundamental step to keep SHSPs at the forefront of efforts to improve traffic safety. The Implementation Process Model (IPM), a document based on research, the experiences of six model states, feedback from 10 pilot states, a panel review by related organizations, and the knowledge and experiences of subject matter experts, identifies the "essential eight"—four fundamental elements and four steps for successful SHSP implementation.

The fundamental elements include leadership, collaboration, communication, and data collection and analysis. The steps include emphasis area action plans, linkage to other plans, marketing, and monitoring, evaluation, and feedback. The IPM walks users through each element and step with a detailed description, key strategies to implement the element or step, and a checklist that allows states to see how they measure up to the model.

The IPM also presents noteworthy practices from states that have strengthened their implementation efforts. For example, one state appointed a full-time SHSP program manager to provide leadership and coordination for the development and implementation of the plan. Another state established a partnership between an agency's Bureau of Safety Engineering and law enforcement to improve understanding and coordination of safety roles.

Several states established a system for online access to transportation safety data, enabling safety partners to make data-driven decisions, and increased public awareness and support for the SHSP through branding. These noteworthy practices illustrated that new and potentially far-reaching changes were possible with a little creativity, hard work, and dedication.

Measuring Progress

Measuring progress requires evaluation. Evaluations contribute to the overarching goal of reducing the human and economic toll of crashes. The next evolution of the process, therefore, involves evaluating the SHSP. To complement the IPM, FHWA has developed an Evaluation Process Model (EPM), which provides a detailed description of the various parts of an SHSP evaluation—such as monitoring and tracking and measuring outcomes and inputs—as well as recommended actions and self-assessment questions.

Photo: Highways Agency, Department for Transport, UK

The M42 motorway in England. Multifaceted and data-driven safety programs in the United Kingdom and other countries produced dramatic decreases in highway fatalities and have served as models for SHSPs in the United States.

PHOTO COURTESY RHODE ISLAND DOT

In January, Rhode Island DOT hosted a kickoff meeting to update the state's SHSP. The state participated in the Federal Highway Administration's Evaluation Process Model pilot, and Governor Lincoln D. Chafee approved the plan in October.

An evaluation of the SHSP can provide direction for—and validation of—a state's traffic safety priorities. Through evaluation, states can determine their successes, uncover problems with meeting goals or implementing strategies, and identify opportunities for improvement. Evaluations can indicate whether the SHSP approach is working and contributing to a reduction in traffic-related fatalities and serious injuries.

Some states, such as Rhode Island, already are moving forward with evaluation. According to Robert Rocchio, Managing Engineer, Rhode Island DOT, "[the] evaluation plan…will help us continually improve our SHSP and safety. We view evaluation as a win–win opportunity."

Particularly now, when budgets are tight and expectations for success are high, evaluation can help a state target resources to areas that generate the greatest benefit. Evaluation can indicate whether the state is targeting traffic safety resources to priority areas and whether the plan is helping achieve the state's goals for reducing fatalities and serious injuries.

The EPM divides the evaluation process into several parts:

◆ **Preparing for evaluation** describes various planning methods and steps required to organize the evaluation.

◆ **Process evaluation** helps states evaluate SHSP management methods, including the strength of the leadership structure; whether the development process was sufficiently data driven, evidence based, multidisciplinary, multimodal, and collaborative; and the degree to which the process addressed all public roads.

◆ **Performance evaluation** provides methods for evaluating SHSP outputs and outcomes. Outputs measure the degree to which SHSP strategies and action plans are implemented, and outcomes measure the degree to which SHSP goals and targets are met.

◆ **Using evaluation** suggests effective ways to interpret, apply, and share evaluation results to document accomplishments, improve the SHSP process, and inform safety stakeholders, elected officials, and the public about SHSP initiatives and the importance of transportation safety.

States can use evaluation results for a variety of purposes:

◆ Validate the effectiveness of SHSP processes, strategies, and programs;

◆ Identify effective processes, strategies, and programs for replication;

◆ Identify weaknesses in the program strategies and actions, such as failure to implement strategies, as well as strategies that did not achieve the intended results;

◆ Improve program delivery;

◆ Direct resources to areas with the highest probability of improving safety; and

◆ Inform elected officials, the media, and the public about the impact of the SHSP.

Signs of Progress

According to NHTSA, 33,808 people died in motor vehicle traffic crashes in the United States in 2009—the lowest number of deaths since 1950 (*3*). Early estimates for 2010 showed the decline continuing, with fatalities 9.2 percent lower than in the first half of 2009 (*4*).

A news release from California DOT (Caltrans) reported that traffic fatalities in the state declined in 2010 to the lowest level since 1944. The April 4, 2012, release quoted Karen Brewster of Caltrans: "A focal point of California's highway safety efforts is the… SHSP, created in 2006 to address a broad range of important traffic safety issues. Continuing its commitment to SHSP goals, in 2011 Caltrans awarded 80 safety improvement projects worth about $140 million."

Other factors, however, also have contributed to the progress on traffic safety in the United States. With a troubled economy and rising fuel costs, people are driving less, which reduces exposure. Safer vehicles and improved emergency care also have contributed to the statistical declines in crashes, injuries, and fatalities. Nevertheless, these declines took place when states were focusing on the development and implementation of SHSPs.

Many states are seeing progress in the data; others are identifying additional data needs. In both cases, states expect more improvements as they implement and evaluate their SHSPs. Ongoing improvements in data allow for sophisticated analysis and improved evaluation results.

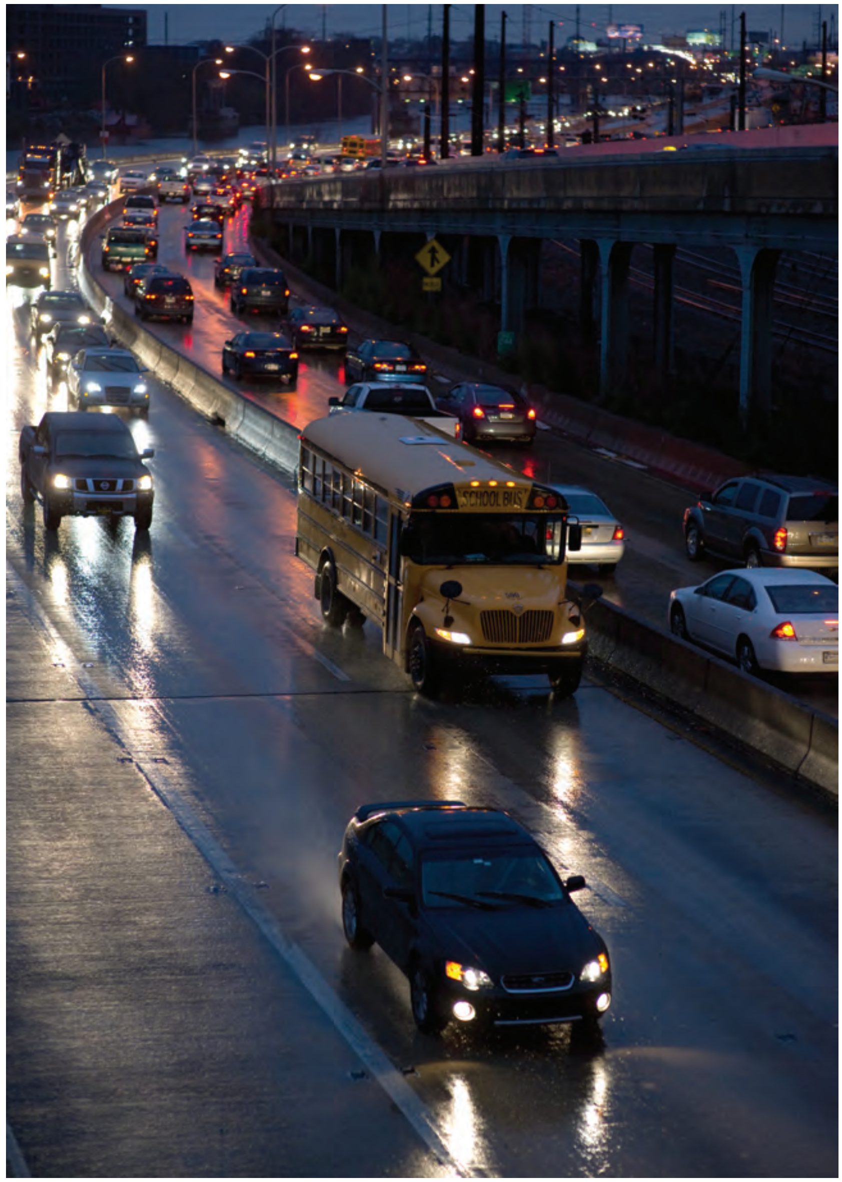
The development of predictive methods, such as the systemic analysis approach, will help states improve safety in all areas, particularly on rural roadways. Research is providing evidence about effective countermeasures. This ongoing progress will give states the tools and information to continue safety improvement efforts.

Synergistic Effects

The challenge for states, regions, and localities is to keep the goals in focus. The SHSP is often labor-intensive, but it works. An SHSP advances a decision-making process that builds on the strengths of all safety partners and that targets resources to the greatest opportunities for safety improvements. An active SHSP process creates a synergistic effect—states can realize gains beyond what individual agencies can accomplish on their own.

The SHSP has contributed to a cultural change, bringing together individuals and agencies in the U.S. traffic safety community to communicate and work across disciplines to achieve greater gains in traffic safety. Achieving the goal of fewer traffic-related deaths and serious injuries has motivated the effort.

PHOTO COURTESY MATT BLAZE



Road fatality rates are decreasing in the United States; along with safer vehicles, lower overall driving rates, and improved emergency care, SHSPs have contributed to progress in safety.

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Blueprints to Improve
HIGHWAY SAFETY

Toward Zero Deaths

A National Strategy for Highway Safety

THOMAS K. SOREL AND TROY E. COSTALES

PHOTO: NHTSA

Emergency medical technicians and firefighters attend to a car crash victim. Although highway fatalities are on the decline, the number of deaths and injuries every year has prompted development of a national safety strategy, Toward Zero Deaths (TZD).

Sorel is Commissioner, Minnesota Department of Transportation; Chair, AASHTO Standing Committee on Highway Traffic Safety; and a member of the TRB Executive Committee. Costales is Transportation Safety Division Administrator, Oregon Department of Transportation, and Immediate Past Chair, Governors Highway Safety Association.

Highway fatalities have decreased in the past few years, but each year—each day—an unacceptable number of people die on the nation's roads. Last year, 32,310 lives were lost, and in each of the past few years, more than 2.2 million people have been injured. These numbers should be considered a public health crisis.

Multidisciplinary safety efforts to reduce fatalities and serious injuries have greatly expanded, supported by safety professionals and advocates nationwide. Many agencies and organizations with roles in highway safety have their own strategic plans to guide their activities, but a strategy that unites these common efforts is lacking. The Toward Zero Deaths (TZD) National Strategy on Highway Safety aims to fill this need.

The TZD vision is for a highway system free of fatalities. The national strategy seeks to effect a sustained and accelerated decline in transportation-related deaths and injuries. With an intermediate goal, such as a 50 percent decrease in fatalities by 2030, safety organizations and professionals adopting the vision will work aggressively toward zero fatalities and minimal injuries as the annual norm.

Concerted Push

Highway safety stakeholders—including government agencies, associations, safety advocates, and individuals—are working diligently to reduce fatalities and serious injuries, and progress is being made. Without a concerted push to expand these efforts, however, achieving the vision will take much longer. Stakeholders need to build on programs that have proved effective in saving lives and to implement these strategies aggressively nationwide.

Stakeholders need to identify, develop, and promote promising new initiatives that can accelerate progress. Stakeholders need to leverage contributions from professionals in the fields of highway infrastructure, user behavior, public health, vehicle manufacturing, emergency medical services, law enforcement, and others to address the problems in a universal and collaborative manner.

A key element of the TZD effort involves changing the nation's highway safety culture. Road users need to make safety-driven decisions about how they drive, walk, cycle, and ride. A change in safety culture would give safety a priority in decisions about the surface transportation network and its operation. Organizational barriers need to be bridged to accommodate a larger, more comprehensive stakeholder group.

Safety culture is a complex challenge. Individual strategies or initiatives, such as public information campaigns on specific issues, contribute to changing the safety culture. Nonetheless, the goal is to develop a process for changing values and attitudes so that safety is part of every transportation decision, whether personal or organizational.

The consensus of safety stakeholders will guide the TZD national strategy. The purpose of the initiative is to unite the efforts of stakeholders across the country, to develop a roadmap for the future, and to identify and focus on the key areas in which the most progress can be made nationwide.

Comprehensive Approach

In 1998, the American Association of State Highway and Transportation Officials (AASHTO) published a strategic highway safety plan to help state transportation agencies address safety issues from a multidisciplinary perspective. The plan contains 22 highway safety challenges and encourages the states to address the challenges with driver, occupant, vehicle, and postcrash approaches, in addition to the traditional infrastructure approach.

Although developed with the input of highway safety partners from all disciplines, AASHTO's plan was for its members, not for the nation. In 2005, the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users required each state to develop a strategic highway safety plan with a similar comprehensive approach, using crash and other data to identify safety challenges.

Many transportation organizations have similar plans, programs, or policies addressing traffic safety. The organizations on the TZD Steering Committee represent the state and local governmental agencies that own, operate, and maintain roads; administer and enforce traffic laws; educate drivers and other road users; provide postcrash medical treatment and patient transportation; and supply technical assistance to local agency professionals (see box, below, left). Several agencies of the U.S. Department of Transportation (DOT) are represented in a nonvoting capacity, providing technical assistance on request; the agencies are not involved, however, in any TZD Steering Committee activities related to potential policies or legislation.

Developing a National Strategy

The national strategy will identify key initiatives for the next 25 years to achieve the TZD vision. Aiming safety partners' research, development, and national dissemination efforts toward a common vision is essential. The national strategy will include initiatives based on the potential to address roadway safety challenges and to offer the most dramatic reduction of fatalities and serious injuries. The list of effective countermeasures and programs will not be exhaustive but will contain many strategies for consideration by the implementing organizations.

A consensus document, the national strategy will focus on the core elements to achieve the TZD vision. Supporting materials are planned, including a comprehensive list of proven and promising strategies. Although the steering committee comprises state and local agency organizations, private and public organizations with an interest in making the nation's roadways safer are encouraged to participate. Each organization will choose the strategies most appropriate for its use.

Key Messages for Toward Zero Deaths

- Toward Zero Deaths (TZD) is a vision for the nation's highway safety—even one traffic fatality is unacceptable.
- The National Strategy on Highway Safety is the roadmap to reaching the TZD vision.
- Creating a culture of safety is a personal and professional responsibility.
- Traffic fatalities are a public health crisis.
- Every person can help prevent traffic fatalities and serious injuries by how he or she drives, rides, bikes, or walks today.

TZD Steering Committee Organizations

- American Association of Motor Vehicle Administrators
- American Association of State Highway and Transportation Officials
- Commercial Vehicle Safety Alliance
- Governors Highway Safety Association
- International Association of Chiefs of Police
- National Association of County Engineers
- National Local Technical Assistance Program Association
- National Association of State Emergency Medical Services Officials

Ex Officio Member Organizations

- Federal Highway Administration
- Federal Motor Carrier Safety Administration
- National Highway Traffic Safety Administration

PHOTO: iSTOCK

Changing the national highway safety culture—making safety a guiding principle for road users—is a complex challenge.

Photo: NHTSA

Initiatives such as implementing widespread sobriety checkpoints are part of the TZD strategy for safer drivers, passengers, and highways.

United Nations Avenue in Nairobi, Kenya, recently was remodeled to higher safety standards by the Kenyan Urban Roads Authority. Strategic highway safety efforts are under way across the globe; the United Nations' Decade of Action for Road Safety program aims to reduce the numbers of traffic fatalities and injuries worldwide by 2020.

Photo: Road Safety Fund

The national strategy will include elements unique to the core function of certain stakeholders, but the greatest benefits are expected from strategies that cross traditional disciplines. Safety practitioners, researchers, advocates, and others can use the national strategy to identify potential partners and opportunities for working collaboratively.

Through the efforts of steering committee organizations and through National Cooperative Highway Research Program (NCHRP) Project 17-51(4), Input to the Development of a National Highway Safety Strategy,[1] the TZD effort has gained input from safety stakeholders through webinars, a 2010 workshop, and reviews of materials under development. Stakeholders will review and comment on updated draft materials to ensure that the national strategy meets the needs of all stakeholders and unifies efforts.

Similar strategic highway safety efforts are under way worldwide. Almost 1.3 million people die each year on roads around the world, and as many as 50 million people are injured. The United Nations has launched the Decade of Action for Road Safety program to reduce the numbers of traffic fatalities and injuries worldwide between 2011 and 2020.[2] A global action plan serves as a resource for countries and local agencies to develop plans for their own safety activities. The TZD initiative can guide the U.S. contribution to this international effort.

[1]http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=2975.

Key Strategic Areas

The key areas of the national strategy framework are as follows:

- ◆ Safer drivers and passengers,
- ◆ Safer vulnerable users,
- ◆ Safer vehicles,
- ◆ Safer infrastructure,
- ◆ Enhanced emergency medical services (EMS),
- ◆ Improved safety management and data processes, and
- ◆ Safety culture.

The strategies addressing the first six areas will include state legislation, enforcement and adjudication, technology, state or local policy, and administrative approaches to address specific safety concerns; safety culture will be treated as a process for determining appropriate strategies.

The adoption of appropriate strategies necessitates a positive cultural shift toward traffic safety. To be considered high-impact, a countermeasure, program, or technology must be expected to have a profound impact on traffic fatalities and injuries when implemented nationwide or to address a large proportion of roadway safety problems. Many strategies will have challenges related to implementation, including costs, additional research or development needs, a lack of supporting legislation, or insufficient time for full implementation. Stakeholders will have to work aggressively to overcome the challenges and obstacles.

High-Impact Initiatives

Following are examples of high-impact strategies expected to be part of the TZD national strategy:

Safer drivers and passengers:

◆ Enact enabling legislation for—and implement—sobriety checkpoints.

◆ Implement automated enforcement to curb red light running and speeding.

[2]www.who.int/roadsafety/decade_of_action/plan/en/index.html.

◆ Implement uniform driver licensing standards—one driver, one record.

◆ Implement rigorous enforcement programs for aggressive driving and speeding.

Safer vulnerable users:

◆ Enact and enforce state pedestrian laws.

◆ Enact and enforce state motorcycle helmet legislation.

◆ Improve work zone design and operations.

Safer vehicles:

◆ Implement lane departure warning systems.

◆ Implement alcohol interlock systems.

◆ Implement vehicle safety technologies for passenger and commercial vehicles and drivers, such as speed feedback warning systems or vehicle-to-vehicle communications technologies.

Safer infrastructure:

◆ Implement roadway enhancements for older drivers.

◆ Install warning signs and rumble strips and enhance pavement markings, especially in and around curves.

◆ Incorporate science-based safety methodologies into project development.

Enhanced emergency medical services:

◆ Participate in the planning and implementation of Next Generation 9-1-1.

◆ Improve emergency medical response on roadways in rural areas, especially for incidents with mass casualties.

◆ Include EMS agencies in the planning and training for traffic incident management.

Improved safety management and data processes:

◆ Include the public health community and consider injury surveillance practices in the development, implementation, and evaluation of state, regional, and local safety plans.

◆ Improve the accuracy and completeness of crash location information for all public roads.

◆ Develop and promote core competencies for all positions within transportation agencies and ensure that staff is knowledgeable about the state of the practice.

The intent is to establish national priorities, along with the strategies and supplemental materials that safety stakeholders can use.

Transforming Safety Culture

To transform safety culture in the next 25 years, assessment of the current traffic safety culture is key. Many entities and people are involved in highway safety, from the national level to individual road users. Each group has its own values, beliefs, and behaviors; together these constitute the nation's traffic safety culture. Understanding the subculture for each organization or group of users will aid in identifying the most appropriate, effective, and efficient strategies for a specific roadway user group.

The following steps will be crucial in a program to improve safety culture:

PHOTO: DEREK JENSEN

Red light cameras and other automated enforcement technologies are expected to be part of the TZD strategy.

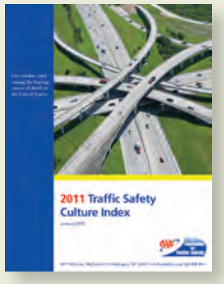
PHOTO: AAA FOUNDATION FOR TRAFFIC SAFETY

Vulnerable road users—such as motorcycle riders—can benefit from the enactment and enforcement of state helmet laws.

Changing the “Do As I Say, Not As I Do” Safety Culture

PETER KISSINGER

One death on America’s roadways is unacceptable; one death every 15 minutes is outrageous. Yet when the AAA Foundation for Traffic Safety convened a workshop in 2005 to discuss research priorities with a variety of traffic safety experts, the group reached a consensus that complacency, not outrage, has been the dominant sentiment when it comes to American attitudes about the enormous tolls that traffic crashes, injuries, and deaths take on our society.



The Traffic Safety Culture Index *provides a glimpse into behaviors and concerns of the driving public.*

Since then, the AAA Foundation has made understanding and strengthening the nation’s traffic safety culture a focus of research. The AAA Foundation’s vision is to foster a “social climate in which traffic safety is highly valued and rigorously pursued—both by individuals and organizations.” In essence, the aim is to raise the political priority of the issue and effect lasting behavioral changes by shifting beliefs and attitudes through new approaches, such as social norms messaging, which reinforces positive behaviors and attitudes through positive instead of negative statements.

The AAA Foundation’s first step was to publish a 2007 compendium of nearly two dozen papers addressing ways to define, measure, and strengthen a culture of safety. This seminal report remains a must-read for anyone interested in the subject. In 2008, the AAA Foundation published the *Traffic Safety Culture Index*, the first report in an annual series of nationally representative surveys benchmarking public attitudes and behaviors on the road. Subsequently, the AAA Foundation joined with the Western Transportation Institute to cohost three annual National Summits on Rural Traffic Safety Culture.

These efforts have revealed a great deal about safety culture in the United States and have identified a consistent pattern. When asked their thoughts about many of today’s leading traffic safety concerns, most people responded with what seemed an endorsement of safety-conscious behaviors. Yet substantial numbers of these respondents admitted to engaging in the same dangerous behaviors they criticized in others. The findings characterized safety culture in the United States as “do as I say, not as I do.”

The *Traffic Safety Culture Index* of 2011, for example, found that more than 94 percent of Americans believed that sending text messages or e-mails while driving was “somewhat” or “completely” unacceptable.[a] Nonetheless, more than one quarter (25.6 percent) of drivers admitted to typing a text or e-mail within the previous 30 days.

The AAA Foundation supports the traffic safety community’s recent focus on safety culture. The high visibility of safety culture in the development of the national strategic highway safety plan and in the efforts to achieve the Toward Zero Deaths vision is evidence of the progress under way.

Much more work is needed, however, and the AAA Foundation is committed to doing its share. Data collection for the 2012 *Index* is under way, and new analyses will look for cultural changes. The AAA Foundation also is interested in the work of the Transportation Research Board’s new Roadway Safety Culture Subcommittee and in potential collaborative research efforts. In summary, through the application of groundbreaking research results and in response to more effective messages, safety culture in the United States can change from “do as I say, not as I do,” to “leading by example.”

The author is President and CEO, AAA Foundation for Traffic Safety, Washington, D.C.

[a]www.aaafoundation.org/pdf/2011TSCIndex.pdf.

According to the Traffic Safety Culture Index *of 2011, nearly all drivers disapprove of sending or receiving text messages and e-mails while driving——but more than one quarter do it anyway.*

Photo: AAA Foundation for Traffic Safety

◆ Identify an entity to take the lead in planning the effort and bringing together stakeholders;

◆ Perform an assessment of current traffic safety culture and identify (*a*) common themes among the various groups and (*b*) gaps to address with safety culture strategies;

◆ Develop strategies for transforming safety culture; pilot-test and refine the strategies; and implement the strategies systemwide; and

◆ Evaluate the effectiveness of the strategies and identify additional needs.

This process is cyclical, repeated as progress is made and additional needs are identified.

Strategies that may be appropriate would challenge road users' beliefs or assumptions—for example, about how safely they can drive at high speeds; educating road users to resist the attitude that "everybody else is doing it"; or providing incentives for safe road use. Similarly, strategies are needed for addressing organizational safety culture, to transform the way that transportation decisions are made.

The strategies for the first six key areas contribute to improving traffic safety culture among road users and transportation professionals. Nonetheless, to transform traffic safety culture, a comprehensive program is needed that goes beyond the implementation of individual strategies.

Implementation Approach

The adoption and implementation of TZD by a significant number of safety partners will result in a focused national effort to achieve a roadway system with no fatalities. An organization that adopts the national strategy is likely to customize implementation to fit its role in transportation or highway safety, as well as its experience in strategic safety planning.

The TZD national strategy will encompass the next 25 years. Full implementation is not expected to result in zero fatalities in that period of time, but the span will allow for the planning, research, and development of new strategies, as well as for the implementation of high-impact strategies for the key areas. The implementation plan will set intermediate goals, so that safety professionals and other stakeholders can evaluate progress and identify additional needs.

Adoption of TZD

The TZD program involves a commitment to a comprehensive, multidisciplinary, aggressive, and proactive approach to improving highway safety. Traffic fatalities are a public health concern, and safety stakeholders should approach the problem with the same determination and resolve for prevention as other industries do, such as the air travel, food, and health care industries. Organizations may need to realign priorities and resources to support this vision, as well as to establish safe-driving policies on the use of occupant restraints and cell phones by their staff.

Photo: North Carolina DOT

Short-term strategies that are known to be effective and are easily implemented include installing warning signs and enhancing pavement markings around curves.

An organization adopting the TZD national strategy makes a commitment to support the unified effort to reduce fatalities and to identify ways that safety activities can contribute, or be enhanced to contribute. Each organization will not be able to contribute to all of the key focus areas but should consider participating in programs not typically within its jurisdiction or area of interest. Establishing or strengthening partnerships with nontraditional partners, joining strategic safety planning efforts, and participating in implementation and evaluation activities may identify ways to leverage limited resources for common goals.

Agencies and organizations can use the TZD national strategy to enhance their own strategic safety planning efforts. The strategy can serve as a starting point for entities that have not yet developed a strategic plan. An organization that already has adopted a zero-based approach may find new ideas worth considering.

Implementation Time Frames

The national strategy will indicate a time frame for fully implementing key initiatives, assuming that funding and human resources are available and that a concerted effort is made to implement individual strategies. The implementation time frames are defined as follows:

◆ *Short-term* strategies can be implemented nationwide within five years. These strategies are known to be effective—they do not require much additional research or development and will not require federal legislation or regulations. Installing warning signs and enhancing pavement markings in and around curves are examples.

◆ *Midterm* strategies can be implemented in the next 5 to 15 years and may require legislation at the state or national levels. Additional research may be needed to determine effectiveness in certain areas or on specific road types, or additional technological advances may be needed to allow for implementation. Incorporating vehicle-to-vehicle and vehicle-to-infrastructure communications into infrastructure planning, design, and management would be a midterm strategy.

◆ *Long-term* strategies will take 15 years or longer for full implementation. These initiatives may have a significant impact on safety but require the development of technologies, implementation throughout the entire roadway network, the enactment of legislation, a turnover of the vehicle fleet, or the overcoming of other challenges. Full implementation of vehicle-to-vehicle and vehicle-to-infrastructure technologies, for example, is a long-term strategy—although consideration in the roadway project development process could occur earlier. Moreover, strategies unforeseen today will emerge in the future.

Outreach and Communications

Consistent communication about TZD is a key to the implementation of the national strategy, as is outreach to potential safety partners and their members or staff. NCHRP Project 17-51(3) has developed a strategic communications plan for enlisting TZD partners; providing information to agency staff, association members, and other audiences; and evaluating the accomplishment of implementation objectives.

Florida and other states are conducting research on connected vehicle technology, a strategy for TZD that has the potential for long-term implementation.

Property and Courtesy of Florida DOT

The draft communications plan identifies target audiences and their roles in implementation. National associations, organizations, and advocacy groups, as well as private entities, can promote the TZD vision and national strategy through early adoption and implementation within their own organizations. In this way, state and local agencies, advocacy groups, communities, and private entities and companies would gain familiarity with the effort and consider participating. These new partners also would connect to elected officials and other policy makers who can advocate for additional resources to support the TZD vision. Media professionals are another target audience able to convey the TZD message to the public.

All TZD partners need to be able to discuss the national initiative and their roles in implementation with the same key messages. A brand and recommendations on methods for communicating with stakeholders have been developed to support key messages and implementation.

Research in the Works

Research is needed to determine the effectiveness of countermeasures and programs that are currently unproven, as well as the efficacy of new strategies. Gaps in the knowledge about the effectiveness of specific initiatives may be the most easily identified for research, but other needs will emerge as implementation progresses. Several ongoing or upcoming research activities support the TZD vision, and the steering committee and other stakeholders will identify additional research needs.

NCHRP Project 17-48 is identifying highway infrastructure and operations safety research to support the efforts of state and local highway agencies. Combined with research into driver behavior, emergency medical services, safety culture, public health, and other highway safety topics, the findings will help identify the research needed to support implementation of all aspects of the TZD national strategy.

The naturalistic driving study managed by the second Strategic Highway Research Program (SHRP 2) is collecting an unprecedented amount of data from which safety professionals will learn about driver interactions with the vehicle and roadway environment. Analyses of the SHRP 2 data will assist in evaluating, refining, and developing countermeasures.

NCHRP is sponsoring a domestic scan of states with zero-based fatality goals in 2013. The scan team will visit state DOTs and highway safety offices to identify best practices for adopting a zero-based goal or vision, implementing strategic highway safety plans with this approach, and strengthening partnerships with other organizations.

NCHRP Project 17-64, to begin in 2013, will focus on implementation of the TZD national strategy on highway safety and will look at the organizational and institutional needs of state highway agencies for implementation.

NCHRP Project 20-24, which manages smaller research projects on the administration of highway and transportation agencies, will initiate a project to assess state DOTs' administration of local road safety aid, to gain insights into the organizational challenges of addressing safety on roads not owned by states.

A key research project that awaits funding would examine the relative contributions of various safety programs—as well as of economic and other factors—to the recent, historic reductions in highway fatalities. Determining the impact of these programs will help safety partners enhance and continue the programs on a larger scale.

The TZD Challenge

The TZD Steering Committee recognizes that achieving the vision of a highway system free of fatalities will take time, commitment, and energy. The TZD national strategy offers a means to unify the efforts of the participating organizations and other highway safety stakeholders. The coordinated nationwide effort calls for all to develop and implement solutions that will reduce the numbers of traffic fatalities and serious injuries significantly.

The factors involved in crashes are familiar—the road environment, the road users, and the vehicles. At the national level, the strategies known to be effective should be aggressively promoted, and new strategies should be sought. Partnerships are necessary—for example, traffic fatalities and injuries are a focus area for public health professionals, child safety advocates, and others. Communicating to the traveling public, to transform the way the public thinks about safety and the roads, remains a priority. The TZD national strategy emphasizes communication with partners and the public and the coordination of messages.

Rigorously studied and proven strategies are needed to promote a positive traffic safety culture for all road users. Individual road users, whether driving or walking or riding, must make decisions based on safety. Professionals must approach all decisions from a traffic safety frame of reference, considering the safety impacts of any trade-offs. The TZD approach should originate at the leadership level, as well as at the individual and family levels. Expanding the individual goals to communities is a way to gain support and promote a positive traffic safety culture. With leadership moving organizations forward in the effort, the TZD vision and national strategy can gain adoption nationwide.

PHOTO: WASHINGTON STATE DOT

At a kickoff event in Chehalis, Washington State DOT Traffic Engineer (now retired) Ted Trepanier describes automated speed enforcement cameras installed along a work zone on I-5. Communicating safety initiatives to the public is key to implementing a national safety strategy.

Time and Diligence

With adequate resources, many of the strategies could begin widespread implementation now. Many of the strategies that will have a significant impact on national statistics, however, may take years to implement fully. Expanding use of the short-term strategies, with initial efforts on the longer-term strategies, must begin now.

A highway system free of fatalities is an epic challenge that will require time and diligence. The barriers are many, but every year more than 32,000 reasons should motivate working together tirelessly and enthusiastically Toward Zero Deaths.

Resources

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Blueprints to Improve HIGHWAY SAFETY

The SHRP 2 Naturalistic Driving Study

Addressing Driver Performance and Behavior in Traffic Safety

KENNETH L. CAMPBELL

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The central goal of the Naturalistic Driving Study (NDS) for the second Strategic Highway Research Program (SHRP 2) is to address the role of driver performance and behavior in traffic safety.[1] This involves understanding how the driver interacts with and adapts to the vehicle, the traffic environment, roadway characteristics, traffic control devices, and other environmental features. The NDS also provides the means to assess the changes in collision risk associated with each of these factors and their interactions.

Driving behavior is a critical factor in nearly all traffic crashes. Driver impairment—primarily due to alcohol—and driver inattention, distraction, drowsiness, and judgment-related errors are believed to be responsible for significant increases in crash risk. After-the-fact crash investigations, however, cannot determine accurately a driver's behavior before the crash.

The naturalistic driving method offers two key advantages: (*a*) detailed and accurate precrash information, including objective information about driving behavior, and (*b*) exposure information, including the frequency of behaviors in normal driving, as well as the larger context of contributing factors. The larger context for exposure enables risk estimates for various driver behaviors and for other contributing factors. The information will support the development of new and improved safety countermeasures to prevent traffic collisions and injuries.

[1]http://onlinepubs.trb.org/onlinepubs/shrp2/RevisedSafetyResearchPlanMarch2012.pdf.

Photo: SHRP 2

The in-vehicle data acquisition system (DAS) unit gathers and stores data from forward radar, four video cameras, accelerometers, vehicle network information, a Geographic Positioning System, and onboard computer vision algorithms.

Photo: SHRP 2

Composite image showing a driver's head position in relation to the dashboard and windshield, calibrated with eyes forward (*at left*) and looking at the speedometer (*at right*). The SHRP 2 Naturalistic Driving Study has equipped participants' cars with data-collecting devices to gain a deeper understanding of driving behavior.

Recruiting Participants

The SHRP 2 NDS is the largest study of its kind ever conducted and is under way with nearly 2,360 participants on the road or having completed assignments as of September 2012. Participants are recruited in six sites across the United States, with each site hosting 150 to 450 participant vehicles. The sites, the coordinating groups, and the numbers of participating vehicles are as follows:

- Bloomington, Indiana—Indiana University: 150 vehicles;
- Central Pennsylvania—Pennsylvania State University: 150 vehicles;
- Tampa Bay, Florida—the research, development, and testing firm CUBRC and the University of South Florida: 441 vehicles;
- Buffalo, New York—CUBRC: 441 vehicles;
- Durham, North Carolina—Westat: 300 vehicles; and
- Seattle, Washington—Battelle: 409 vehicles.

Participants are recruited through call centers and traditional methods. The original study design required approximately equal numbers of participants across 16 age and gender groups. The Virginia Tech Transportation Institute (VTTI), which serves as the technical coordination and study design contractor for the NDS, operates a central call center for all sites; Battelle operates a separate call center in Seattle. The call centers use lists of household phone numbers for each NDS site, screened for licensed drivers and eligible vehicles.

Traditional recruitment consists of advertisements in various media, including the web-based Craigslist, flyers, presentations, mass mailings, and e-mails. Internet-based methods are particularly effective for younger drivers. The Washington State Department of Transportation (DOT), for example, ran an advertisement on its main traffic advisory web page with a link to the NDS recruiting site.

Traditional screening approaches offer the option of calling an 800 number to connect to the VTTI call center or of linking to a web-based screening tool supported by the call center. With the web tool, a potential participant who sees the ad does not need to speak with a study representative but can complete the screening questionnaire online and join the pool of participants to be scheduled at the nearest NDS site.

Preparing Participants and Vehicles

The SHRP 2 NDS adheres to appropriate informed consent and privacy requirements. Four of the NDS sites operate under their own Institutional Review Boards (IRB), and two operate under the VTTI IRB. The IRB of the National Academy of Sciences and the VTTI IRB provide oversight for the entire study. All available mechanisms—technological and legal—are being applied to prevent disclosure of the names or identities of participants to NDS data users or to the public.

Each NDS participant completes the informed consent process. The participant's vehicle is checked for suitability; many recent model-year passenger vehicles in good working order are eligible.

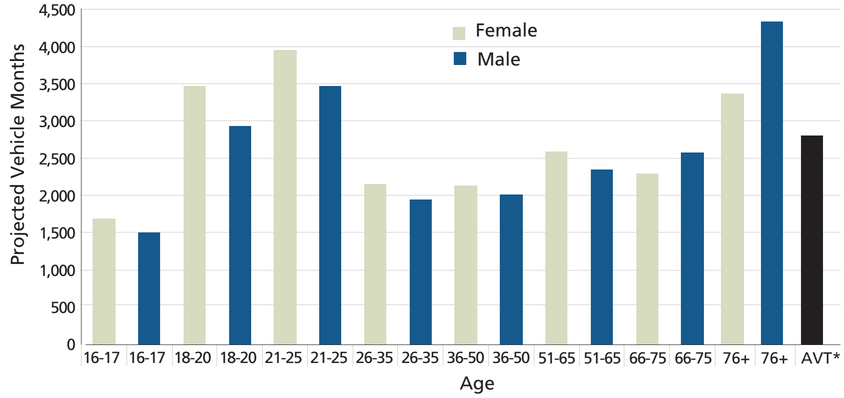

FIGURE 1 Projected participant-months by age and gender. (AVT = advanced vehicle technology.)

The participant's vehicle is taken to a field contractor's installation facility. While the data acquisition system (DAS) is being installed, the participant completes a variety of driver assessment tests. These include executive function and cognition; visual perception; visual–cognitive, physical, and psychomotor capabilities; personality factors; sleep-related factors; medicines; general medical condition; and driving knowledge. The tests include standard vision tests, a grip strength test, and a rapid-pace walk. Some are in the form of web-based questionnaires that the participant can complete at home. The driver assessment tests take 2 to 3 hours.

Each participant receives an annual incentive of $500, paid in installments. Participation requires that the driver provide access to the vehicle, so that the hard drive with accumulated data can be removed and replaced every four to six months.

The SHRP 2 NDS accumulates 5 participant-years of driving in a single day. Data collection continues through November 2013. More than 1,840 participant-years of data have accumulated as of the end of August 2012, and by the end of the study, a total of 3,700 participant-years is expected from the nearly 2,600 total participants.

Some participants will remain in the study for the entire term, but others will be replaced with a new participant and vehicle after one year in the study. Figure 1 (above) shows participant-months of driving

Photos: SHRP 2

(*Left:*) A forward radar unit, mounted near the license plate, is among the data-gathering devices installed in participant vehicles.

(*Right:*) A head unit, attached near the rear-view mirror, comprises cameras recording four different fields of view. It also receives data from accelerometers and a passive alcohol sensor.

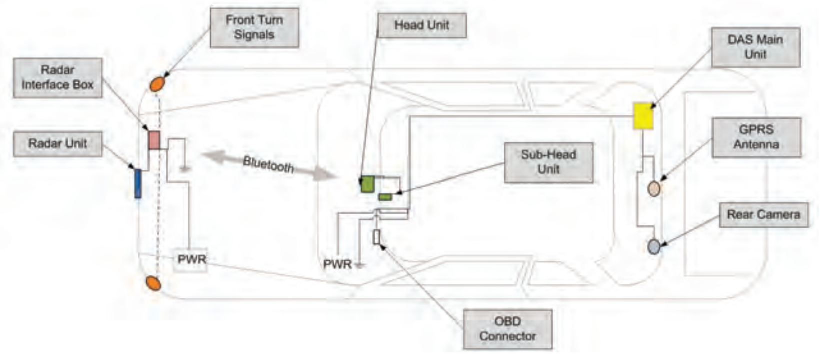

FIGURE 2 DAS schematic view.

as projected for the study by age group and gender. Ongoing recruitment is focusing on younger and older drivers, to increase the coverage of those age groups.

Data Acquisition System

VTTI developed the DAS for the study to support the research questions and objectives of the SHRP 2 program. Manufactured by American Computer Development, Inc., the DAS includes forward radar; four video cameras, including one forward-facing, color, wide-angle view; accelerometers; vehicle network information; Geographic Positioning System; on-board computer vision lane tracking, plus other computer vision algorithms; and data storage capability.

Data from the DAS are recorded continuously while the participant's vehicle is operating. This continuous recording allows for an exposure-based approach and is central to the SHRP 2 safety focus area.

Figure 2 shows a schematic of the DAS installation (above). Installation in the participant's vehicle takes approximately three hours. The central computer, or main unit, encrypts and records all data on a removable hard drive that must be replaced every four to six months. The forward radar communicates wirelessly to the main unit.

Four cameras are located away from the driver's view in a head unit attached behind and to the right of the rear-view mirror. The head unit also includes accelerometers and a passive alcohol sensor. Figure 3 (below) shows a schematic of the field of view for each camera.

The DAS records information from the vehicle network through a connection under the dashboard to the on-board diagnostics port. A rear-facing camera and a cellular general packet radio service for data transmission with Wi-Fi antenna are attached to the rear window. The cellular capability allows the DAS to send regular "health checks" to VTTI, including the capacity of the hard drive.

The camera images are combined in a single frame and compressed for efficient storage as shown in the composite image on page 33. The color forward view is in the upper left, with the driver face view in the upper right, rotated to make better use of the available pixels. The lower left image presents a downward view of the instrument panel from the

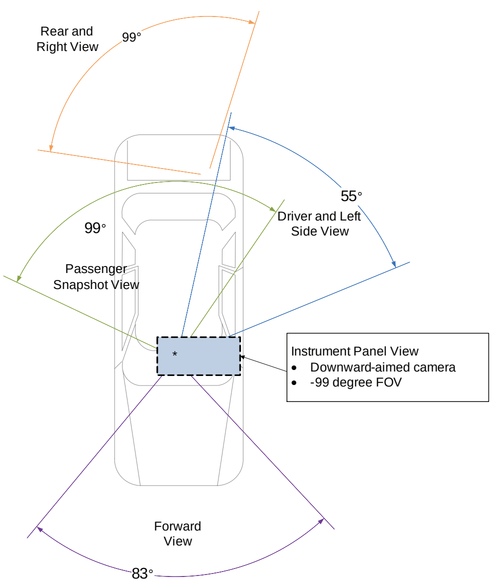

FIGURE 3 Fields of view for the DAS.

The Optec 6500P is used to assess NDS participants' visual perception. Also tested are drivers' visual–cognitive, physical, and psychomotor capabilities; personality factors; sleep-related factors; health; and driving knowledge.

Data Acquisition System Channels

- Multiple videos
- Machine vision
  - Eyes forward monitor
  - Lane tracker
- Accelerometer data (3 axis)
- Rate sensors (3 axis)
- GPS: latitude, longitude, elevation, time, velocity
- Forward radar
  - X and Y positions
  - X and Y velocities
- Cell phone
  - Automatic collision notification, health checks, location notification
  - Health checks, remote upgrades
- Illuminance sensor
- Infrared illumination
- Passive alcohol sensor
- Incident push button—audio (only on incident push button)
- Turn signals
- Vehicle network data
  - Accelerator
  - Brake pedal activation
  - Automatic braking system
  - Gear position
  - Steering wheel angle
  - Speed
  - Horn
  - Seat belt information
  - Airbag deployment
  - Many more variables

head unit near the rear-view mirror. The rear camera view is in the lower right. The views are recorded at 15 Hz and can be separated for analysis.

A fifth camera takes a still image of the interior every few seconds, showing passengers in the vehicle. The image is permanently blurred so that the passengers cannot be recognized. The DAS also runs a machine vision algorithm while the system is recording, to determine the direction the driver's head is facing. Sample video output is shown in the photo below. The primary DAS data channels are listed in the box on page 32.

VTTI provides technical coordination for the six NDS sites and houses all of the NDS data. Encrypted data are transferred via secure high-speed networks from each site to VTTI for processing, quality control, and addition to the NDS database. The final SHRP 2 NDS database is expected to approach 2 petabytes (2,000 terabytes) in size.

Roadway Information

Roadway information is necessary to relate driver actions to the roadway characteristics. Two additional projects are gathering this information for the six NDS sites. The Center for Transportation Research and Education (CTRE) of Iowa State University is developing the roadway information database. The database will combine roadway data from the state highway departments and other sources with data collected by Fugro Roadware–equipped vans, which measure roadway characteristics while traveling at posted speed limits on routes selected by SHRP 2.

The roadway data include the number of lanes, lane type and width, the grade, the superelevation, the beginning and end points of a curve, the curve radius, the lighting, the rumble strips, the median type, the width of the paved shoulder, the speed limit signs and their locations, the location of intersections, the number of approaches, and the traffic control devices. CTRE selects the routes to be measured and provides quality assurance of the roadway data collected.

Photo: SHRP 2

The four fields of view from the car's interior are combined in a single frame and compressed for efficient storage.

To assist in the route selection, VTTI prepared GPS traces of the roads traveled by the initial participants at each NDS site. Figure 4 (page 34) shows the routes measured and to be measured in Durham, North Carolina, by Fugro Roadware. Approximately 72 percent of the mileage will be rural and 28 percent urban. In contrast, in Seattle, Washington, 72 percent of the mileage will be urban. In all, approximately 12,000 miles of roadway will be measured in both directions for the six sites.

SHRP 2 NDS Analysis

The SHRP 2 NDS will support a comprehensive assessment of how driver behavior and performance interact with roadway, environmental, vehicular, and human factors and the influence of these factors and their interactions on collision risk, especially on lane departure and intersection collisions. Two central issues for the planned analysis are the statistical relationship of surrogate measures of collisions—such as conflicts, critical incidents, near-collisions, or roadside encroachments—with actual collisions, and the formulation of exposure-based risk measures using these surrogate measures.


Photo: SHRP 2


Photo: SHRP 2

(*Far Left:*) In this still image from a video recording, a machine vision algorithm helps determine in which direction the driver's head is facing.

(*Left:*) A separate camera takes still images of passengers, permanently blurred, every few seconds.

Photo: Fugro Roadware

Fugro Roadware's Automatic Road Analyzer vehicles collect data on roadway characteristics of routes selected by SHRP 2.

Crashes are rare events—time is needed to record enough crashes of any specific type to analyze. The use of surrogates for collisions—such as near-collisions, critical incidents, or traffic conflicts—would greatly increase the power of the field studies, because the surrogate events occur much more frequently than crashes and without harm.

Joseph I. Harris and Stuart R. Perkins of General Motors Corporation Research Laboratories introduced the first surrogate measure, traffic conflicts, in 1967. Interest in the use of surrogates increased with new data collection technologies that can support continuous measurement of crash margin measures such as the time-to-lane departure or time-to-collision. These kinds of measures can be used to form surrogate risk estimates for specific traffic maneuvers.

Key aspects of the analysis projects include the application of crash surrogate approaches, development of exposure-based collision risk measures, and the formulation of analytic methods to quantify the relationship of driver behavior and performance, vehicle, roadway, and environmental factors to collision risk.

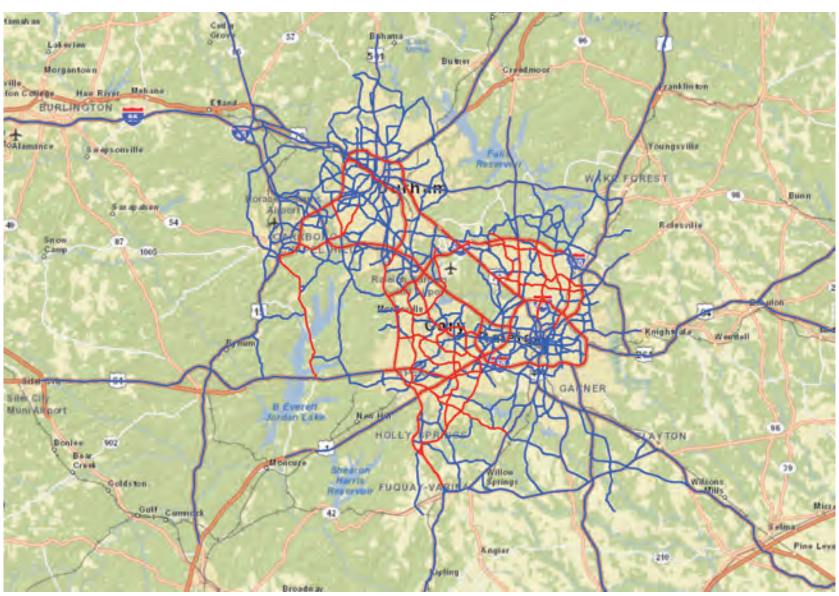

FIGURE 4 Roads measured and to be measured in Durham, North Carolina.

Analysis Projects

Four analysis projects began in 2012 to address specific research questions using the already available SHRP 2 NDS and roadway data. Priority was given to projects that will have direct applications for safety. These projects address road departure, offset left-turn lanes, driver inattention, and rear-end collisions on congested freeways.

Phase I of the projects involves a trial of the research approach and will produce a detailed plan for the full analysis. Projects selected for Phase II will carry out the full analysis in 2013. Brief descriptions of the four analysis projects follow.

Safety on Curves

The Iowa State University CTRE project will address the relationship between driver behavior and safety on curves. Crash rates are three times higher on horizontal curves than on straight road sections. Various roadway measures are applied to improve safety on curves, such as warnings with signs and rumble strips, delineations with chevrons and pavement markings, and paved shoulders and guardrails to minimize the impact of road departures.

Information is lacking about how drivers respond to these roadway measures and about why these roadway measures work or do not work. The CTRE study will use the NDS trip and roadway data to examine how drivers interact with the roadway environment and what roadway cues and measures are the most effective in influencing driver behavior. The study will help highway departments implement more cost-effective measures to prevent or mitigate road departure crashes on curves.

Rear-End Crashes

The University of Minnesota Center for Transportation Studies (CTS) will address rear-end crashes on congested freeways. These kinds of crashes produce substantial traffic delays, as well as injuries and fatalities.

The CTS study will use the NDS trip and roadway data to explore how the likelihood of a crash in these circumstances depends on factors such as vehicle speed, following distance, driver reaction time, and driver attention and distraction. The results will help DOT officials reduce crashes by suggesting cost-effective methods for warning drivers of current or periodic congestion and perhaps for reducing driver distraction.

Driver Inattention

The SAFER Vehicle and Traffic Safety Centre at Chalmers University, Sweden, will address driver inattention and crash risk. Driver distraction and

PHOTO: ANDREW BOSSI

Offset left-turn lanes are the subject of an MRI Global study utilizing NDS and roadway data.

inattention is implicated in at least one-quarter of all crashes, yet no methods are available for measuring driver inattention or for estimating the effect of inattention on crash risk. The SAFER study will use NDS data to develop a measure of driver inattention from observable driver actions, such as eye glances away from the road, and will estimate how driver inattention and the roadway environment combine to influence crash risk. The results will help in establishing guidelines for how long a driver can safely look away from the road and in designing in-vehicle technologies to measure driver inattention and warn inattentive drivers.

Offset Left-Turn Lanes

MRIGlobal will evaluate offset left-turn lanes. More than eight percent of all traffic fatalities involve left-turn crashes at intersections. Vehicles waiting in standard left-turn lanes, in which the roadway's centerline continues straight through the intersection, however, may have the view of oncoming through-traffic obstructed by vehicles in the opposing left-turn lane.

One way to address this problem is to offset the left-turn lanes to the left, so that vehicles waiting to turn left are positioned to the left of the centerline on the opposite side of the intersection. Highway designers have accepted offset left-turn lanes in principle but without any conclusive evidence of beneficial effects on driver behavior or crashes.

The MRIGlobal study will use NDS and roadway data to analyze how driver left-turn behavior—such as gap acceptance—is influenced by intersection and traffic characteristics and in particular by offset left-turn lanes. This will help DOT officials design intersections that balance construction and maintenance costs against crash risk.

NDS Data Access

Activities are under way to support implementation of the SHRP 2 results. The priority for the SHRP 2 safety focus area is to make the naturalistic driving study data and the associated roadway data accessible and usable for a range of researchers.

A data dissemination and user support project started this year to address this task. VTTI has established a SHRP 2 data access forum website,[2] which offers a data access guide, documentation on all NDS data files, sample data, and a video viewing tool, in addition to the opportunity to ask questions and share information online about the NDS data. NDS data that have been approved for public access will be added to this site.

Another implementation priority is planning for the long-term stewardship of the NDS data, to ensure that the data will be available and accessible to researchers after SHRP 2 concludes. FHWA is conducting initial activities through a contract with the Volpe National Transportation Systems Center.

Resources

http://onlinepubs.trb.org/onlinepubs/shrp2/SHRP2_S2-S05-RR-1.pdf.
www.shrp2nds.us/.

[2]http://forums.shrp2nds.us/.

Blueprints to Improve HIGHWAY SAFETY

Rapid Renewal, Accelerated Construction Schedules, and Worker Fatigue

J. ELIZABETH JACKSON AND TOM SANQUIST

Predictions of labor demand for the next 10 years indicate that 25,000 to 29,000 workers will be engaged in rapid renewal highway construction projects annually nationwide. This workforce is expected to sustain up to 1,300 occupational injuries caused by fatigue each year.

Working conditions associated with rapid renewal projects include off-peak hours, continuous construction on weekends, extended nighttime operations, and work in zones adjacent to traffic. These working conditions can increase workforce fatigue and stress, reducing the levels of workforce safety and productivity.

Rapid renewal construction is designed to minimize the impact of projects on traffic flow. As adoption of the approaches expands, however, concern has grown about the effects on the health and safety of the highway construction workforce. Investigators at Battelle Memorial Institute in Seattle are working with the second Strategic Highway Research Program (SHRP 2) to evaluate the effects of rapid renewal construction approaches on workforce fatigue.[a]

Phase 1 of the research characterized the rapid renewal construction landscape, identifying typical construction scenarios, investigating the extent of worker and manager fatigue and responses to fatigue, outlining potential countermeasures and other mitigation strategies for fatigue, and estimating the future extent of rapid renewal construction and related workforce needs. Researchers analyzed more than a dozen rapid renewal construction projects in six states and targeted several for detailed studies.

The team conducted in-depth interviews with 20 management personnel at contractors and state departments of transportation and administered comprehensive surveys to 47 workers at three projects in Florida, New York, and Washington State. The survey work used validated scales to measure worker fatigue.

Findings demonstrated that work schedules could change at short notice, that weekly overtime was the norm, and that fatigue levels were substantially higher with more demanding schedules—for example, during weekend closures after a full week of work. Fatigue was widely acknowledged, but methods for dealing with the problem were informal and did not include adequate training.

Using research findings from other areas of transportation, combined with findings from the interviews and survey, the team developed sets of mitigations—that is, preventive and operational countermeasures to fatigue—to implement at the individual level and as features of the safety management system at the organizational level.

Phase 2 of the research is concluding. Battelle is developing an integrated suite of products for fatigue management to meet the needs of laborers and managers in the private and public sectors. Industry-relevant training about fatigue will target the populations at risk and will focus on prevention and mitigation in the work setting. Guidance for organizational practices and project work practices, along with work scheduling aids, will provide tools for incorporating fatigue prevention and mitigation strategies into a contractor's safety management system.

An outreach program is in development to increase stakeholder understanding and support for implementing best practices for fatigue management. Communications strategies and materials will target industry participants and will determine appropriate channels for dissemination to raise awareness of the new support tools.

PHOTO: MISSOURI DOT

Rapid renewal projects require construction workers to work into the weekends, in traffic-adjacent areas, and at night—conditions that can increase stress and fatigue.

[a]SHRP 2 Project R03, http://apps.trb.org/cmsfeed/trbnetprojectdisplay.asp?projectid=2676.

The authors are with Battelle Memorial Institute, Seattle, Washington. Jackson is Research Scientist, Battelle Center for Analytics and Public Health, and Sanquist is Research Scientist, Pacific Northwest National Laboratory, Richland, Washington.

Blueprints to Improve HIGHWAY SAFETY

POINT OF VIEW

Road Safety Capacity Building

Working Toward Comprehensive Certification

SUSAN HERBEL AND FRANK GROSS

Herbel is Principal, Cambridge Systematics, Inc., Washington, D.C., and Chair, TRB Task Force on Highway Safety Workforce Development. Gross is Highway Safety Engineer, Vanasse, Hangin, Brustlin, Inc., Raleigh, North Carolina.

> This transition from a "pragmatic" to a more "rational" style of road safety management is hungry for factual knowledge and for professionals to be its purveyors. Consequently, a broad class of professionals, those who influence the future of road safety, needs to be trained in what fact-based road safety knowledge exists. In addition, a vibrant, competent community of road-safety researchers has to be created. They need to be trained in the same road safety knowledge as well as in research methods. The best interest of society is to move toward the gradual establishment of the rational style of road safety management.
>
> —*Ezra Hauer (1)*

In the context of road transportation, the term "capacity" means the maximum traffic flow on a given roadway, but the term also can refer to the workforce employed to manage, build, and maintain the transportation system. Noting that human capacity in transportation is shrinking, an article in the January–February 2012 *TR News* highlighted the difficulty of recruiting and retaining qualified employees for the transportation workforce:

> The retirement of the baby boomer generation…has been one of the greatest challenges. The effects have been downplayed, because the economic recession has delayed many workforce departures; nevertheless, the number of retirement-eligible employees is growing, and a significant number of senior-level employees will leave [departments of transportation (DOTs)] in the next 5 to 10 years. In many cases, the retirees possess specialized knowledge and unique experiences critical to the efficient operation of the organization. (2)

In the case of road safety, this affects not only state DOTs, but also other departments critical to the highway safety enterprise, such as highway safety offices, state police, licensing agencies, public health departments, and education.

PHOTO: OREGON DOT

David McKane, Oregon DOT, discusses motor carrier safety at an occupational safety and health professionals event in Portland. Continuing education and training are vital to the road safety profession.

Safety Workforce Challenges

Retirement is only one of the challenges to the road safety workforce; others include the following:

- **The evolving science of road safety**—new and improved methods for identifying and diagnosing safety issues and for evaluating the effectiveness of actions are developing at a rapid pace;
- **The lack of trained professionals**—road safety is a specialized field that requires an advanced level of training generally not attained by many in the workforce; and
- **Insufficient training opportunities**—graduate schools offer few opportunities for formal training in road safety, and undergraduate courses on safety are nonexistent (3).

Laying the Groundwork

In April 2002, the Federal Highway Administration (FHWA) Office of Safety, the Institute of Transportation Engineers (ITE), the Transportation Research Board (TRB), and the American Association of State Highway and Transportation Officials (AASHTO) convened a workshop to discuss road safety workforce development. The purpose was to identify strategies for building the supply of road safety

TRB Special Report 289, *Building the Road Safety Profession in the Public Sector*, examines the growing need for government experts to develop and implement safety management approaches based on systems and science.

professionals and for informing elected officials and other public decision makers about the important role of the road safety profession.

Workshop participants discussed strategies for providing resources for training and educating road safety professionals, ensuring ample opportunities for comprehensive safety capacity building, and creating incentives for careful and explicit consideration of safety in all decisions and actions affecting road safety performance.

To pursue the ideas and goals discussed at the workshop, TRB created a Road Safety Workforce Development Subcommittee—subsequently elevated to a task force—charged with the following:

- ◆ Identify the fundamental knowledge requirements for the road safety profession;
- ◆ Develop a training program to teach the fundamentals;
- ◆ Assess the state of practice in road safety training and education in America;
- ◆ Generate support for a TRB policy study to analyze the current status of road safety training and educational opportunities in the United States and to recommend research and policy requirements; and
- ◆ Identify research needs for moving the initiative forward.

Need for Expertise

The task force proposed a National Cooperative Highway Research Program (NCHRP) project to develop and vet a set of road safety fundamentals; the project designed a training program based on the fundamentals, published as NCHRP Report 667, *Model Curriculum for Highway Safety Core Competencies* (4). Other activities included a review and analysis of the state of practice on at least two occasions—the findings were not promising; the completion of a policy study, published as TRB Special Report 289, *Building the Road Safety Profession in the Public Sector* (3); and the continual generation of new research ideas.

Despite the obvious need for a comprehensive training program, the task remains incomplete. The AASHTO Standing Committee on Research may be reluctant to fund the development of training programs because any curriculum would have a short shelf life—the rapidly increasing level of safety knowledge renders the information obsolete.

TRB Special Report 289 determined that efforts to improve road safety training and education were not keeping pace with the growth in motor vehicle travel. The report pointed out that continued improvement in road safety will require experts capable of applying rigorous scientific and systems approaches to safety management. The finding calls into question the ability of government agencies to meet the public's expectations for continued improvements in road safety.

The scale and complexity of the road safety problem requires an increasingly precise and systematic approach to safety management carried out by a highly skilled, analytical, and multidisciplinary safety workforce. The demand for safety professionals

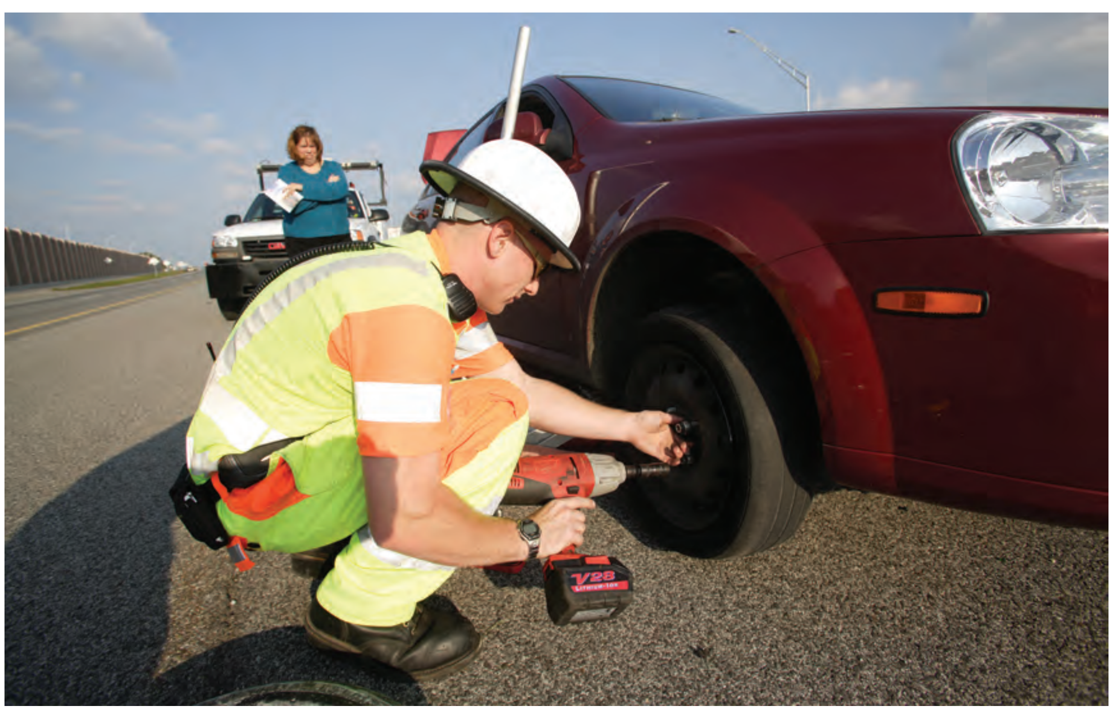

Photo: Trevor Wrayton, Virginia DOT

A safety service patroller provides assistance to a motorist in Virginia's Salem District. The safety workforce includes a wide range of skill sets and poses challenges for recruitment, training, and retention.

Photo: Highways Agency, Department for Transport, UK

A traffic officer patrols southbound M6 in central England. An academy of road safety professionals, like those in the United Kingdom and other countries, has been proposed for the United States by the American Association of State Highway and Transportation Officials.

threatens to outpace the ability of public agencies to attract interested and talented workers to the field and to educate and train them to perform effectively. The report called for professional member associations, led by AASHTO and the Governors Highway Safety Association, to establish a broad alliance to advance the road safety profession (*3*).

Silo Effects

The TRB Task Force has accomplished its original objectives and continues to generate support and attention for the results. Nonetheless, an institutional approach to the development of a road safety workforce has not taken hold. What is the reason?

Safety issues and solutions continue to be siloed within government agencies, divisions within agencies, and professional member associations. For example, some have proposed creation of a U.S. Academy of Road Safety Professionals, modeled after those in Canada, Australia, the United Kingdom, and other nations. The member associations, however, are reluctant to support yet another association that requires dues, energy, and attention. AASHTO has proposed funding to support the development of a road safety academy, but Congress typically directs those funds to support siloed projects in university transportation centers.

Road safety professionals gain their knowledge, skills, and abilities through on-the-job training, which is insufficient, incomplete, and inefficient. Road safety professionals come from a variety of backgrounds—for example, civil engineering, public health, public safety, highway safety, law enforcement, human factors psychology, and public law. One common characteristic of the highway safety community is a passion for safety.

Few universities offer a course in safety, and then almost exclusively at the graduate level. Some professors do provide instruction on the most effective methods of road safety analysis and on countermeasure selection and prioritization. Building a curriculum piecemeal from the variety of programs available through NHTSA, FHWA, ITE, and others may be possible. The problem is that these courses are not oriented toward the comprehensive, data-driven, multidisciplinary, multimodal approach required to create an effective program of road safety improvements.

Advantages of Certification

The Highway Safety Research Center (HSRC) at the University of North Carolina, Chapel Hill, has

A first responder arrives at a simulated accident scene during a training exercise at the Center for Domestic Preparedness. The TZD initiative will include emergency medical services agencies in incident planning and training.

Photo: Federal Emergency Management Agency

A state trooper provides information about safety at railroad crossings to motorists as part of Rail Safety Week in Missouri. The road safety workforce includes state troopers and other law enforcement officials and staff of state DOTs, public health agencies, and other departments.

PHOTO: MISSOURI DOT

updated the training course described in NCHRP Report 667 and has created a blended learning environment with a web-based application. HSRC's long-term goal is to create a series of courses that result in a certification program for road safety professionals.

This step needs to be accomplished. Certification would encourage all levels of government to insist that employees and consultants achieve a minimum level of understanding to work in the safety arena. Some state DOTs, such as Iowa and Louisiana, are creating training programs for employees and for graduate students, but piecemeal efforts will not be sufficient.

U.S. DOT, state DOTs, highway safety offices, motor carrier safety programs, and others continually assert, "Safety is our number one goal." The time has come to generate the resources required to establish a bona fide safety curriculum and a road safety professional association consistent with the most current research information, to ensure that the next generation of safety professionals is effectively trained to accomplish the goal and continue toward zero deaths on the nation's highways.

Comprehensive Approach

A comprehensive approach is needed to attract, train, and retain road safety professionals, beginning with kindergarten, continuing through 12th grade, and culminating in ample opportunities for continuing education, essential for this rapidly evolving field. The goal in kindergarten through 12th grade is to generate interest in math and science through programs such as those offered by the Science, Technology, Engineering, and Mathematics (STEM) Education Coalition.[1]

Undergraduate transportation engineering and public health courses should introduce road safety principles and fundamentals. Adding a full undergraduate course on highway safety may be unlikely—although offered by a few programs—but a formal course or series of courses is appropriate at the graduate level. Graduate programs are appropriate for encouraging and exposing upcoming professionals to interdisciplinary collaboration, the key to reducing injuries and fatalities on roadways.

On-the-job training and continuing education are common to most fields but are particularly important in road safety, because knowledge and tools are rapidly evolving. Postcollege training is necessary for those who did not have the opportunity to learn the science of safety in school. Safety professionals must practice interdisciplinary collaboration—encouragement and exposure are not enough.

The First Pillar

Under the auspices of TRB and FHWA, a panel of experts is crafting a national road safety strategy to move the nation toward zero deaths. The first pillar of the national strategy should support the education of future road safety professionals—and should incorporate incentives. Without this initiative, the nation risks losing the benefits of the vast knowledge developed in the past decade, as well as the enthusiasm and dedication evident in the current cadre of road safety professionals. The time to act is now!

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[1] STEM serves several roles, including the support of research to inspire current and future generations to enter STEM-related fields; www.stemedcoalition.org.

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

Chip Seals for Improved Pavement Preservation

North Carolina's Approach

JUDITH CORLEY-LAY AND DENNIS WOFFORD

Corley-Lay is State Pavement Management Engineer, and Wofford is State Pavement Preservation Engineer, North Carolina Department of Transportation, Raleigh.

Chip seals are used routinely in the maintenance and preservation of roadways. In the United States, emulsion-based chip seals, with emulsified asphalt binders and natural mineral aggregate chips, are commonly used.

The chip seal is constructed by spraying the asphalt emulsion onto the asphalt pavement, then spreading chips of aggregate into the emulsion, embedding the chips with pneumatic and rubber-tired rollers, and finally sweeping to remove the excess chips. Sometimes, the process is repeated—a double seal, with emulsion sprayed again and a second layer of chips added. The process seals fine cracks in the underlying pavement surface, reducing pavement deterioration by preventing water from intruding into the base and subgrade.

Problem

Despite the apparent benefits and widespread use of chip seals as a preservation treatment, some state departments of transportation (DOTs) have been reluctant to adopt the technology because of limited familiarity with chip seal practices. North Carolina DOT maintains an extensive network of low-volume roads—roads traveled by less than 3,000 vehicles per day; for these roads, chip seal is a logical preservation option and has been employed for many years. With tightening budgets, however, the department sought ways to improve chip seal performance by optimizing the material selection, mix design, and rolling equipment and pattern.

Rolling the chip-seal surface treatment.

PHOTO: NORTH CAROLINA DOT

Solution

Documentation and Research

North Carolina DOT personnel began to document chip seal practices and performance, to increase familiarity with the preservation treatment, to understand its performance and benefits, and to support targeted research to enhance its application. In particular, NCHRP Synthesis 342, *Chip Seal Best Practices (1)*, helped department staff increase familiarity with the technology. In addition to encouraging the use of chip seal as a preservation treatment, the synthesis led North Carolina DOT to sponsor a series of research projects to optimize the chip seal process and increase its benefits.

North Carolina DOT's in-house maintenance crews perform most of the state's chip sealing. Roadways are selected for treatment at the division or county level. The NCHRP synthesis report noted that every aspect of the chip seal process can be improved and optimized; North Carolina DOT therefore sponsored a series of research projects at North Carolina State University (NCSU) to evaluate and improve the various aspects of chip seal design and construction. A committee that included pavement management engineers, road maintenance engineers, and bituminous supervisors was appointed to oversee each project.

Projects and Findings

One project aimed at optimizing chip gradation. Researchers investigated the aggregate retention and frictional characteristics of lightweight and granite

Photo: North Carolina DOT

Preparation for sampling before placement of chip seal.

aggregates. The project demonstrated that lightweight aggregate with a 5/16-inch, or 7.5-millimeter (mm), nominal maximum aggregate size, a more cubical shape, and uniform gradation provided better aggregate retention than the fine-graded granite aggregate ranging from 12.5 to 2.36 mm in size. For both aggregate types, uniform gradation was most critical in minimizing aggregate loss. The research recommended using only material larger than 2.36 mm, with the amount of fines—or material smaller than 0.075 mm—not to exceed 1.5 percent.

Another project undertook a performance-based analysis of polymer-modified emulsions. The research evaluated the performance of single, double, and triple seals with unmodified and polymer-modified emulsions. The polymer modification was found to enhance rutting resistance—especially at high temperatures—as well as aggregate retention. A life-cycle cost analysis concluded that to be cost-effective, polymer-modified chip seals would need to last at least two years longer than unmodified chip seals—that is, for seven years.

A third project evaluated rolling methods to determine the optimal equipment, number of coverages, and rolling pattern (see photo, page 41). According to the findings, the best results were achieved when the rolling began with a pneumatic tire roller and finished with a combination roller; therefore, use of both the pneumatic roller and the combination roller was recommended.

Three coverages were found optimal, considering both the time for rolling and the aggregate retention. For multiple-layer chip seals, another key finding was that rolling the layer immediately below the top layer improved the aggregate retention in the top layer.

Other projects developed a mix design for chip seals with modified polymer and lightweight aggregate, a field test to predict the performance of recently placed chip seal, and methods for constructing samples in the field (see photo, left) that could be removed and tested in the laboratory (see photo, below, left). In addition, the most promising laboratory tests for chip seal performance were identified. An ongoing project is examining chip seal application on roadways with traffic volumes of more than 5,000 vehicles per day.

Application

The collaboration between NCSU and North Carolina DOT has led to implementation of several significant findings. For example, polymer-modified emulsions are now in use, and the department plans to acquire combination rollers when equipment is due for replacement. In addition, maintenance crews now have a better understanding of what makes a chip seal perform well and are testing new approaches to improve performance further.

All 14 divisions of North Carolina DOT have adopted the recommended chip gradation and are using lightweight aggregate and polymer-modified emulsions to some extent. All divisions have adopted the recommended number of coverages, and most are using either a pneumatic tire or combination roller.

Benefits

The program of research on surface treatments has produced obvious benefits. Better performing, longer-life chip seal is now in use. Although several years of operation are needed to quantify these benefits, positive improvements have occurred.

The use of lightweight aggregate has reduced tort claims for windshield damage. In one division, the annual tort claims associated with the preservation program have dropped from approximately 20 per season to none since the implementation of lightweight aggregate.

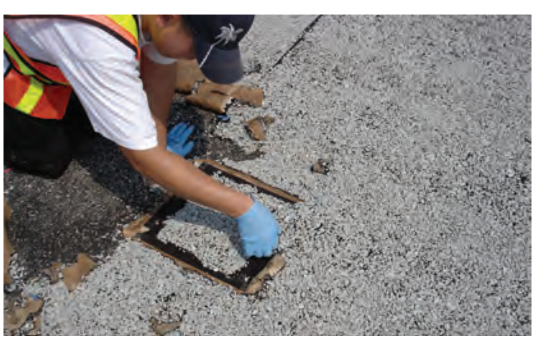

Photo: North Carolina DOT

North Carolina State University student carefully removes a sample for laboratory testing.

Adopting polymerized emulsions has improved aggregate retention—chip loss was reduced by 30 percent. The surface treatments are now being used on higher volume roadways. Although polymer-modified chip seals cost about 20 percent more than unmodified chip seals, other preservation treatment options for higher-volume roads—such as thin (1.25-inch) hot-mix asphalt overlays—cost nearly three times as much as the unmodified chip seals. The ongoing research will help quantify—in terms of performance and cost—the benefits of using polymer-modified chip seals on roads with higher traffic volumes.

North Carolina DOT maintenance crews have recognized their role in supporting a research effort that has improved performance and earned public satisfaction. The research provided university students with an opportunity to learn about pavement preservation and maintenance.

Although each road treatment is a relatively low-cost activity, North Carolina DOT's annual budget for chip seal was $63.2 million in 2010 and approximately $75 million in 2011. The cost savings accrued from the increased service life, improved performance, and increased public satisfaction, reduced tort liability, and increased safety will allow the preservation of more roadways with the same budget, compounding the benefits year after year.

For more information, contact Judith Corley-Lay, State Pavement Management Engineer, North Carolina Department of Transportation, 4809 Carl Sandburg Court, Raleigh, NC 27606; 919-835-8201; jlay@ncdot.gov; or Dennis Wofford, State Pavement Preservation Engineer, State Road Maintenance Unit, North Carolina Department of Transportation, Beryl Road, Raleigh, NC 27606; 919-733-3725; dawofford@ncdot.gov.

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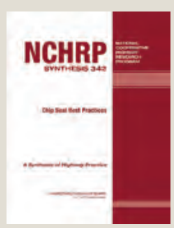
Kim, Y. R. and J. Lee. *Quantifying the Benefits of Improved Rolling of Chip Seals*. Final report, FHWA/NC/2006-63, North Carolina DOT, Raleigh, June 2008.

EDITOR'S NOTE: Appreciation is expressed to Amir Hanna and G. P. Jayaprakash, Transportation Research Board, for their efforts in developing this article.

Suggestions for Research Pays Off topics are welcome. Contact G. P. Jayaprakash, Transportation Research Board, Keck 488, 500 Fifth Street, NW, Washington, DC 20001 (202-334-2952; gjayaprakash@nas.edu).

NCHRP Develops Manual on Chip Seals



NCHRP Synthesis of Highway Practice 342, *Chip Seal Best Practices*, focuses on the preservation treatment for flexible pavements in the United States and Canada, with some design and application procedures from Australia, New Zealand, South Africa, and the United Kingdom.[a] Design methods, the selection of materials, the equipment, the construction procedures, performance measures, and contract administration are described, supplemented with case studies of successful applications of the technology.

In the United States, a lack of nationally accepted guidance for the design and construction of chip seals, along with a lack of specifications and testing procedures for evaluating constituent materials, has hampered use. To address these needs, NCHRP initiated Project 14-17 to develop a manual that would identify the factors influencing chip seal design, construction, and performance and provide guidelines for practitioners considering chip seal as a preservation treatment. The resulting NCHRP Report 680, *Manual for Emulsion-Based Chip Seals for Pavement Preservation*, is available online.[b]

In addition to providing a rational approach to the design of chip seals for pavement preservation, the research identified several test methods for controlling construction. A laboratory test, for example, can be used to predict the time required before rotary brooms or uncontrolled traffic can be allowed on the surface of the chip seal. A simple-to-operate, portable test that measures the viscosity of emulsions was adapted from tests that measure the consistency of paints. Other tests were identified for determining the embedment depth for chip seal aggregates and for estimating chip seal loss.

The Highway Subcommittee on Materials of the American Association of State Highway and Transportation Officials (AASHTO) is considering the incorporation of these test methods into the AASHTO Standard Specifications for Transportation Materials and Methods of Sampling and Testing.

For more information, visit the NCHRP website, www.TRB.org/NCHRP/.

—*Amir N. Hanna*

[a] http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_syn_342.pdf.
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Michael J. Markow

Consultant

In 1969, as a recent graduate of the Massachusetts Institute of Technology (MIT) with bachelor's and master's degrees in civil engineering, Michael J. Markow joined fellow MIT researchers to work on a new project for the World Bank—developing a computerized system that would appraise investments on low-volume roads in developing countries. The system featured several innovations for its time—a life-cycle analysis of road performance and cost, an investigation of trade-offs between road design and maintenance, and the optimization of total project costs, which included road agency expenditures and road user costs.

"The project was concluded successfully in one year, but it was only later that I could appreciate how this initial study influenced the direction of my career interests," Markow observes. "It led me to a focus on facility performance, the importance of maintenance, the need for understanding project economics and engineering, and the value of good data supported by information technology."

"The project ... led me to a focus on facility performance, the importance of maintenance, the need for understanding project economics and engineering, and the value of good data supported by information technology."

Markow interrupted his research work from 1970 to 1973 to serve as an officer in the U.S. Navy's Civil Engineer Corps in Brunswick, Maine. "Military service provided valuable practical experience in managing projects in new construction, rehabilitation, and maintenance," he recalls. "Projects addressed a wide range of facilities—road and airfield pavements, military housing, and buildings such as commissaries and training centers." The Navy also encouraged continuing professional development, including licensure; in 1974, Markow successfully passed the Professional Engineer (P.E.) exam in Massachusetts. He subsequently obtained a P.E. license in Kansas.

In late 1973, Markow returned to a research staff position at MIT, where he worked for 16 years—eventually rising to the position of principal research associate. The 1970s and 1980s presented vibrant opportunities for studies in his fields of interest; for example, significant investment in the Interstate Highway System spurred interest in techniques such as life-cycle cost analysis and their application to long-lived pavement, capital–maintenance trade-offs, and marginal- and average-cost pricing for highway cost allocation.

Markow worked with the Federal Highway Administration (FHWA) and international transportation organizations, as well as state departments of transportation (DOTs), as they took early steps to incorporate a more business-process footing into highway maintenance. He conducted performance and cost studies of rail track, inland waterway locks and dams, and hard-rock tunneling and managed major transportation analysis projects in Egypt and for the Spanish National Railway.

As an MIT research staff member, Markow also developed and taught graduate-level courses in transportation infrastructure management, supervised master's theses, and employed several undergraduate students on his projects. "Working with students on real-world research was one of the most positive aspects of my position," Markow comments.

In 1989, Markow accepted a consulting position with Cambridge Systematics, Inc.; he soon was named a principal of the firm. He managed a wide range of projects for U.S. and international transportation agencies, as well as for legislative committees, performance auditing agencies, and environmental agencies. His assignments included transportation asset management guidance for FHWA, state DOTs, and for National Cooperative Highway Research Program (NCHRP) projects; updates to strengthen performance-based project identification, prioritization, and evaluation for agency capital programming processes; and maintenance management with performance-based budgeting for state DOTs.

Markow's record of TRB service goes back to 1984, when he joined the Revenue and Finance Committee. He served on several NCHRP project panels and on the National Research Council's Committee for the Truck Weight Study and the Committee for Review of the National Transportation Science and Technology Strategy. He is an emeritus member of the Maintenance and Operations Management Committee—which he first joined in 1988.

"Throughout my career, I've been privileged to work with top-notch people," Markow observes. "I've learned much from them, and hope that I've contributed to my profession in turn." He sees the next several years as an exciting and critical time in transportation, with the emphasis on performance-based management in the recently passed transportation reauthorization bill.

Markow retired in 2004 from Cambridge Systematics, but continues to pursue professional and personal interests. In 2007 he coauthored a book with Fred Moavenzadeh of MIT, *Moving Millions: Transport Strategies for Sustainable Development in Megacities.*

Eric J. Miller

University of Toronto

Eric J. Miller has spent most of his career at the University of Toronto (UofT), where he started as a graduate research and teaching assistant and now is founding director of Cities Centre, the university's urban research center. His research focuses on travel behavior analysis and modeling—particularly on agent-based microsimulation modeling as a framework for developing behavioral and policy-sensitive models and integrated models of travel demand and the evolution of urban form.

"Travel demand depends fundamentally on the urban form, which is shaped by the accessibility that the transportation system provides to activity locations," Miller notes.

Miller joined the teaching staff at UofT in 1983, becoming full professor by 1990. In 1997, he became director of the Joint Program in Transportation (now the Urban Transportation Research and Advancement Centre), and in 2008, stepped up as director of the Cities Centre. The multidisciplinary institute facilitates research on cities and urban policy issues and communication between UofT and the urban community.

"For me, it is not enough to say, 'we can build this,' I think we need to know why we should build it and what the intended and unintended consequences of building it will be."

"As I've progressed through my career, it has become very evident to me that cities are first-order design and management problems," Miller muses, adding that with more than half the world's population now living in cities, the environmental, economic, and societal consequences of urban design, construction, and maintenance continue to increase in importance. "Transportation infrastructure and services are central to this problem, since it is the transportation system that gives physical shape to the city and that literally provides the means for us to interact with each other over space and time," he observes.

Miller's research work has centered on the development of next-generation simulation models and of improved operational models. These include travel demand forecasting models used by the Greater Toronto–Hamilton Area (GTHA) for operational planning. He has served on review panels throughout Canada and the United States—such as the Ridership Peer Review Panel for the California High-Speed Rail Authority—assisting in the enhancement of urban and intercity travel demand models. He also serves as director of UofT's Travel Modelling Group, an applied research unit that provides technical model development and support services to transportation agencies in the GTHA.

A graduate of UofT with a bachelor's degree in engineering science and a master's degree in aerospace studies, as well as a Ph.D. in civil engineering from the Massachusetts Institute of Technology, Miller recalls a lifelong fascination with science and a desire to understand how things work. As an undergraduate, he was drawn to the field of transportation planning, seeing in it the opportunity to delve into the role of technology in people's lives; to use a broad, multidisciplinary set of skills and knowledge, from engineering to social sciences; and to search all sides of a problem to find one—or more—solutions.

"I am fascinated by the ways in which technology changes our lives," Miller comments. "For me, it is not enough to say, 'we can build this,' I think we need to know why we should build it and what the intended and unintended consequences of building it will be."

Along with supervising undergraduate and graduate thesis papers and postdoctoral fellows at UofT, Miller is the author of many research reports, journal papers, and conference papers. In 1984, he coauthored *Urban Transportation Planning: A Decision-Oriented Approach* with Michael D. Meyer; the second edition of the bestselling text was published in 2001.

Miller joined the Transportation Demand Forecasting Committee at TRB in 1982 and in 2008 was elected emeritus member. He also served the Transportation Network Modeling committee from 1988 to 1997 and the Task Force on Moving Activity-Based Approaches to Practice from 2003 to 2008. He currently is chair of the Traveler Behavior and Values Committee and a member of the Travel Analysis Methods Section. In 2011, Miller and his students won TRB's Charley V. Wootan Award for best paper in policy and organization and in 2008, the Pyke Johnson Award for best paper in transportation systems planning and environment.

Miller has a longtime association with the International Association for Travel Behavior Research (IATBR), which he has served as vice-chair and chair and as chair of the Organizing Committee for the 13th International Conference in Toronto in 2012. He currently is a member of the IATBR Executive Committee. Miller is a past member and chair of the Transportation Association of Canada and currently serves on the editorial boards of *Transportation Letters*, the *Journal of Transport and Land Use*, and *Transport Reviews*.

PHOTO: NHTSA

Data on pedestrian fatalities show that only 20 percent of pedestrian deaths occurred at intersection crossings—most occur outside of intersections.

Pedestrian Deaths from Traffic Collisions on the Rise

The number of pedestrians killed in traffic accidents rose in 2010 for the first time in 5 years, according to a recent traffic safety report from the National Highway Traffic Safety Administration (NHTSA). An estimated 70,000 pedestrians were injured and 4,280 killed in traffic crashes in the United States, comprising 13 percent of all traffic fatalities in 2010 and constituting a 4 percent increase in pedestrian deaths from 2009.

According to NHTSA, 73 percent of pedestrian fatalities occurred in urban settings, and nearly 80 percent at nonintersection crossings. Nighttime accidents accounted for approximately 70 percent of pedestrian fatalities, with 30 percent between the hours of 8 and 11:59 p.m. Nearly half of all pedestrian fatalities occurred on Friday, Saturday, and Sunday.

The data also point to the role of alcohol in many traffic accidents involving pedestrian deaths—alcohol was a factor in 47 percent of these accidents, whether on the part of the driver or the pedestrian.

To see the full report, visit bit.ly/NHTSApedestrian.

Cost–Benefit Analysis of Roll Stability Systems for Trucks

Designed to take control of a large truck and apply corrective actions when the vehicle's movement becomes unstable, roll stability systems are used by many motor carriers to reduce truck rollover and loss-of-control crashes. Roll stability control (RSC) systems activate when the truck is at risk of an untripped rollover, and electronic stability control (ESC) systems are triggered by the detection of rollover instability and yaw instability, which can lead to a jackknife crash.

The American Transportation Research Institute used crash data to conduct a cost–benefit analysis of roll stability systems on trucks.

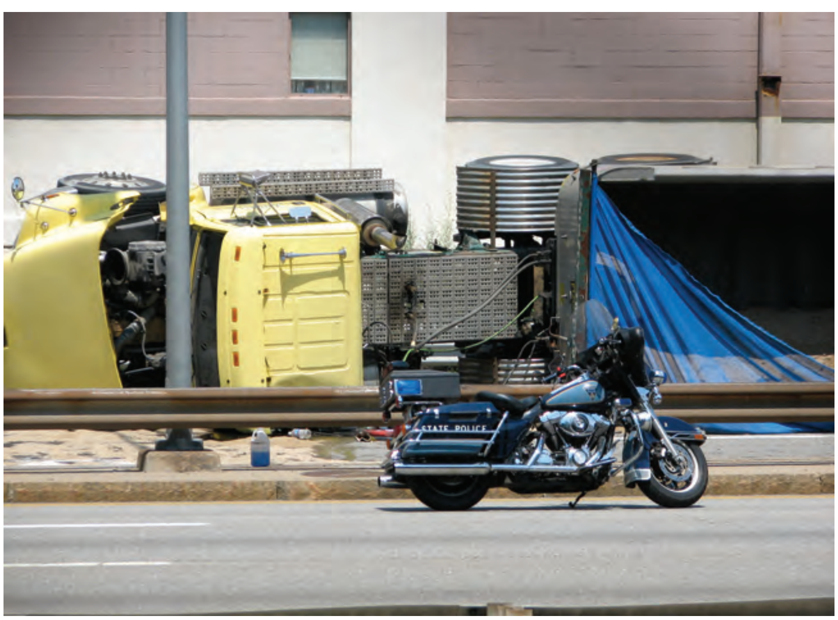


PHOTO: KATHERINE HALA

Using empirical crash data from more than 135,000 heavy trucks, the American Transportation Research Institute conducted a cost–benefit analysis of RSC and ESC systems. Separate crash rates were calculated for trucks equipped with RSC and ESC—and without any roll stability systems—in rollovers, jackknifes, and towing or stuck-vehicle incidents. Trucks equipped with RSC experienced lower crash rates than those with ESC in two accident categories—4.22 rollover crashes per 100 million miles traveled, as opposed to 5.6 for trucks with ESC, and 23.67 towing or stuck-vehicle crashes, as opposed to 30.77. The two systems had similar jackknife crash rates—3.49 for RSC and 3.89 for ESC—and trucks without roll stability systems experienced rollover and jackknife crash rates of 10.62 and 14.39 per 100 million miles traveled.

The study also presented crash costs for trucks with stability controls and trucks without. Vehicles equipped with RSC and ESC had rollover crash costs of $3.77 and $4.81 per 1,000 miles traveled, respectively, and jackknife crash costs of $0.54 and $0.45 per 1,000 miles, respectively. Trucks without roll stability systems incurred an average of $9.58 in rollover crash costs per 1,000 miles and $2.67 in jackknife crash costs per 1,000 miles.

For more information, visit www.atri-online.org.

Safety Pilot Connects 3,000 Vehicles

The U.S. Department of Transportation (DOT) has launched the second phase of the Safety Pilot—the largest road test of connected-vehicle crash-avoidance technology. Conducted by the University of Michigan's Transportation Research Institute, the year-long project has equipped approximately 3,000 cars, trucks, and buses with Wi-Fi technology, enabling the vehicles to communicate in real time with each other and with surrounding infrastructure elements to help avoid crashes and improve traffic flow.

In the first phase of the Safety Pilot, U.S. DOT measured driver acceptance of vehicle-to-vehicle (V2V) technology at a series of clinics across the country. According to the agency, nine out of 10 drivers who experienced V2V technology have a favorable opinion of its safety benefits.

In the road test, volunteer-supplied model deployment vehicles will send and receive electronic data messages to and from other equipped vehicles. In hazardous traffic scenarios—such as a blind intersection collision, a vehicle changing lanes in a blind spot, or a rear collision with a stopped vehicle—data are translated into a warning to the driver.

For more information on U.S. DOT's connected-vehicle research, visit www.safercar.gov/ConnectedVehicles.

SWAPPING STATISTICS—Norah Hillary, Statistics Canada, delivers an update on transportation data in Canada at the 26th North American Transportation Statistics (NATS) Interchange, June 18–20 at the National Academies' Keck Center in Washington, D.C. Hosted by TRB; the U.S. Census Bureau; and the Research and Innovative Technology Administration Bureau of Transportation Statistics, U.S. Department of Transportation (DOT); the event convened representatives from Canada, Mexico, and the United States to explore topics such as quantifying aviation performance, technology for measuring vehicle use, and future directions for the NATS online database. Representatives from U.S. DOT and its Canadian and Mexican counterparts, along with other federal agencies, also signed a memorandum of cooperation to expand the joint development and maintenance of a comprehensive set of comparative transportation statistics for all modes of North American transportation.

SECOND STRATEGIC HIGHWAY RESEARCH PROGRAM NEWS

SAFETY RESEARCH PROGRESS—David Shinar, Ben Gurion University of the Negev, examined the study of crash causation in his keynote address at the second Strategic Highway Research Program (SHRP 2) Safety Research Symposium, July 12 at the Keck Center. The event provided a forum for SHRP 2 researchers to share progress on safety projects and to facilitate the exchange of ideas between transportation professionals in the public and private sectors.

COOPERATIVE RESEARCH PROGRAMS NEWS

Developing Safety Prediction Models for Arterials

Part C of AASHTO's *Highway Safety Manual* includes predictive methods that transportation agencies can use to anticipate and assess the safety performance of new and existing facilities or to estimate the expected effectiveness of proposed improvements to facilities. Part C does not address all facility types of potential interest to transportation agencies, however—although two- and four-lane urban and suburban arterial facilities with undivided and divided cross sections are addressed, arterials with six or more lanes and one-way arterial streets are not.

Texas A&M Transportation Institute has received a $600,000, 30-month contract (NCHRP Project 17-58, FY 2012) to develop a predictive method for use in the *Highway Safety Manual* to address crash frequency and severity for roadway segments and intersections on arterials with six or more lanes and one-way arterial streets and to provide procedures that will assist transportation agencies to consider safety in improvement or design decisions related to these facilities.

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

RAIL IN SPOTLIGHT—Erick Glick, Nevada DOT, participates in discussion at the first meeting of the National Cooperative Rail Research Program Oversight Committee, May 24–25 at the Keck Center. The committee selected an initial round of research projects on topics that included legal aspects of rail programs and building workforce capacity. Authorized by the Passenger Rail Investment and Improvement Act of 2008, the newest Cooperative Research Program will manage applied research on problems of interest to freight, intercity passenger, and commuter rail operating agencies.

Advances in Pavement Design Through Full-Scale Accelerated Pavement Testing

Edited by David Jones, John Harvey, Imad L. Al-Qadi, and Angel Mateos. CRC Press, 2012; 560 pp.; $189; 978-04-1562-138-0.

Full-scale accelerated pavement testing is a valuable tool for improving the understanding of pavement behavior and for evaluating innovative materials and additives, alternative materials processing, new construction techniques, and new types of structures. It allows quick, economical, minimal-risk comparisons between current and new practice and rapid validation and calibration of models. This volume comprises papers presented at the 4th International Conference on Accelerated Pavement Testing, examining instrumentation, testing on asphalt concrete pavements and on portland cement concrete pavements, relating laboratory tests to performance, performing benefit–cost analyses, and more. All four editors are active members of TRB committees.

Recapturing NASA's Aeronautics Flight Research Capabilities

Aeronautics and Space Engineering Board, Division of Engineering and Physical Sciences, National Research Council. 2012; 90 pp.; $39; 978-0-309-25538-7.

With its development of advanced flight-control systems, deicing devices, thrust-vectoring systems, and other innovations, the National Aeronautics and Space Administration (NASA) has contributed substantially to civil and military aviation in the United States. Flight research, or flight demonstration on full-scale aircraft, has been a critical component of these advances; the loss of flight research capabilities at NASA has hindered the agency's ability to make progress throughout its aeronautics program by removing a primary tool for research.

This volume addresses NASA's motivation for pursuing flight research and presents three case studies: the Environmentally Responsible Aviation Project and the Fundamental Research Program's hypersonics and supersonics projects. Also examined are impediments to progress, the NASA Aeronautics Research Mission Directorate, and the current state of research at the agency.

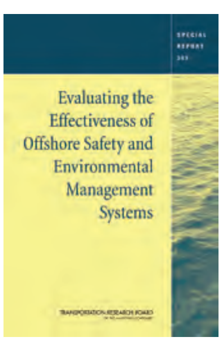
To Forgive Design: Understanding Failure

Henry Petroski. The Belknap Press of Harvard University Press, 2012; 410 pp.; $27.95; 978-06-7406-584-0.

From Galloping Gertie, the Tacoma Narrows Bridge that collapsed in 1940, to the 2010 Deepwater Horizon oil spill in the Gulf of Mexico, spectacular failures of engineering—and the lessons they impart—are explored in this book. Author Henry Petroski, civil engineering professor at Duke University, points out that even the simplest technology is informed by the culture and economic climate of its time and carries with it the possibility of negative consequences. Pointing to the example of early software developers, who drew on lessons from the field of structural engineering, Petroski conjectures that engineers must consider all future scenarios—especially failure—to strengthen practice and foster innovation.

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

TRB PUBLICATIONS



Evaluating the Effectiveness of Offshore Safety and Environmental Management Systems
Special Report 309

This policy study report recommends that the Bureau of Safety and Environmental Enforcement (BSEE) take a holistic approach to evaluating the effectiveness of offshore oil and gas industry operators' Safety and Environmental Management Systems (SEMS) programs: inspections, audits by the operator and BSEE, key performance indicators, and a whistleblower program. As a safety management system, SEMS emphasizes a proactive, risk-based, and goal-oriented approach that can improve safety and reduce the likelihood of disastrous events.

2012; 117 pp.; TRB affiliates, $29.25; nonaffiliates, $39. Subscriber categories: environment; marine transportation; safety and human factors.

Freight Operations 2011
Transportation Research Record 2238

Pricing strategies for storage in import container terminals, regional policies and logistical efficiency, real-time dispatching control, the history of the Pony Express, and e-logistics systems applications are among the topics presented in this volume.

2011; 96 pp.; TRB affiliates, $44.25; nonaffiliates, $59. Subscriber categories: freight transportation; terminals and facilities; rail.

TRB PUBLICATIONS *(continued)*

Developing Countries 2011
Transportation Research Record 2239

Papers examine transit investments in developing countries, location-based data for estimated traffic on urban arterials, same-day mode choice modeling, an analysis of costs of motorcycle accidents in Thailand, a railway regulatory scheme in Indonesia, and more.

2011; 116 pp.; TRB affiliates, $45.75; nonaffiliates, $61. Subscriber categories: environment; planning and forecasting; safety and human factors.

Concrete Materials 2011
Transportation Research Record 2240

The heat of hydration for cement, the effects of roadway contaminants on titanium dioxide photodegradation of nitrogen oxides, internal frost damage of concrete, and the alkali–silica reaction in concrete pavements are among the topics explored in this volume.

2011; 115 pp.; TRB affiliates, $45.75; nonaffiliates, $61. Subscriber category: materials.

Highway Safety Performance, Statistical Methods, and Visualization
Transportation Research Record 2241

Authors present research on such topics as highway safety metrics implementation and evaluation, levels of safety at freeway exits, the effects of underreporting crash data, crash variances estimated by Poisson models, roundabout performance, and a workplace simulator for geometric design of rural roads.

2011; 117 pp.; TRB affiliates, $45.75; nonaffiliates, $61. Subscriber categories: safety and human factors; data and information technology.

Sustainability and Livability; Economic, Environmental, and Societal Impacts
Transportation Research Record 2242

An evaluation of sustainable transportation, the performance of livability programs, environmental impacts in the transportation sector, the introduction of electric vehicles to Ireland, congestion threshold speeds, and a new form of spatial mismatch are among the research topics studied in this volume.

2011; 133 pp.; TRB affiliates, $49.50; nonaffiliates, $66. Subscriber categories: society; energy.

Intelligent Transportation Systems and Vehicle–Highway Automation 2011
Transportation Research Record 2243

The papers in this volume explore lane-level travel times, the integration of variable speed limit control and travel time estimation, an analysis of driver response to variable message signs, a cooperative vehicle and infrastructure system, and more.

2011; 166 pp.; TRB affiliates, $52.50; nonaffiliates, $70. Subscriber categories: operations and traffic management; planning and forecasting; vehicles and equipment.

Planning 2011: Volume 1
Transportation Research Record 2244

State climate action plan strategies, context-sensitive multimodal road planning, China's megaregional mobility, operating a metropolitan planning organization, and managing recreational riverboats on public lands are among the subjects studied in this volume.

2011; 115 pp.; TRB affiliates, $45.75; nonaffiliates, $61. Subscriber category: planning and forecasting.

Planning 2011: Volume 2
Transportation Research Record 2245

Research is presented on improving areawide bikeability scoring, innovative travel demand management strategies, parking guidance systems, transit-oriented development at the urban periphery, complete streets, and other topics.

2011; 139 pp.; TRB affiliates, $49.50; nonaffiliates, $66. Subscriber category: planning and forecasting.

Travel Survey Methods, Freight Data Systems, and Asset Management 2011
Transportation Research Record 2246

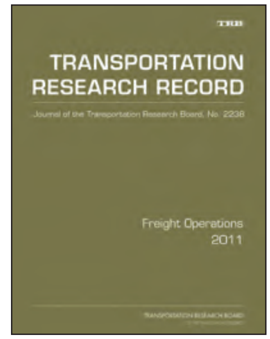
Among the topics covered in this volume are calibration strategies to correct nonresponse in a national travel survey, a comparison of Global Positioning System and diary records, an estimation of transit bus route passenger origin–destination flow, and a web-based truck performance measures program.

2011; 129 pp.; TRB affiliates, $49.50; nonaffiliates, $66. Subscriber category: planning and forecasting.

Bicycles 2011
Transportation Research Record 2247

Estimating bicycle intersection volumes, temporal trends and the impact of weather on cycling in an urban environment, bicycle parking, shared lane markings, and cycle centers are some of the bicycle-related topics explored in this volume.

2011; 125 pp.; TRB affiliates, $45.75; nonaffiliates, $61. Subscriber categories: pedestrians and bicyclists; safety and human factors.



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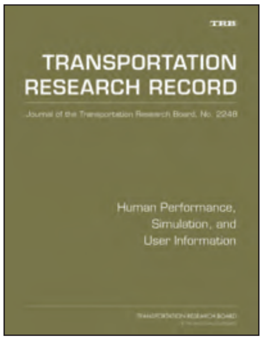
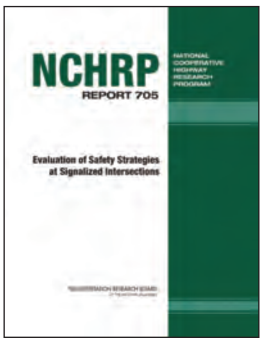
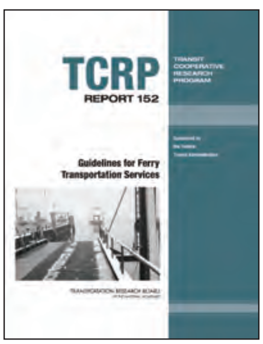
TRB PUBLICATIONS *(continued)*







Human Performance, Simulation, and User Information
Transportation Research Record 2248

Research is presented on driving behavior and traffic flow characteristics, age and gender differences in overtaking maneuvers on two-lane rural highways, bilingual sign layout and information load, influencing drivers' speed choice with sound and vibration, safe highway design and operation, and more.

2011; 110 pp.; TRB affiliates, $45.75; nonaffiliates, $61. Subscriber category: safety and human factors.

Traffic Flow Theory 2011: Simulation Modeling
Transportation Research Record 2249

The 11 papers in this volume examine topics such as wave velocity estimation, a non-lane-based car-following model, the effects of turning maneuvers and route choice on a simple network, a new model for variable speed limits, correlated parameters in driving behavior models, and freeway traffic simulations.

2011; 94 pp.; TRB affiliates, $44.25; nonaffiliates, $59. Subscriber categories: operations and traffic management; planning and forecasting.

Traffic Control Devices, Visibility, and Highway–Rail Grade Crossings 2011
Transportation Research Record 2250

Detection distances to crosswalk markings, the safety effectiveness of actuated advance warning systems, an advance LED warning system for rural intersections, and driver preference for crosswalk marking patterns are among the subjects explored.

2011; 82 pp.; TRB affiliates, $42; nonaffiliates, $56. Subscriber categories: operations and traffic management; safety and human factors; pedestrians and bicyclists.

Evaluation of Safety Strategies at Signalized Intersections
NCHRP Report 705

This report explores crash modification factors—tools for quickly estimating the impact of safety improvements—for safety strategies at signalized intersections.

2011; 38 pp.; TRB affiliates, $30.75; nonaffiliates, $41. Subscriber categories: design; safety and human factors.

Uses of Risk Management and Data Management to Support Target-Setting for Performance-Based Resource Allocation by Transportation Agencies
NCHRP Report 706

Transportation agencies are embracing performance measurement to improve efficiency and accountability. A supplement to NCHRP Report 666, this report assists agencies in using risk management and data management to support target-setting for performance-based resource allocation.

2011; 43 pp.; TRB affiliates, $30.75; nonaffiliates, $41. Subscriber categories: administration and management; data and information technology; highways.

Guidelines on the Use of Auxiliary Through Lanes at Signalized Intersections
NCHRP Report 707

This report provides guidelines for the justification, design, and analysis of auxiliary through lanes (ATL) at signalized intersections. A way to increase intersection and corridor capacity, ATLs begin upstream of a signalized intersection and end downstream of the intersection. This volume is supplemented by NCHRP Web-Only Document 178 and a spreadsheet-based computational engine, both available online.

2011; 85 pp.; TRB affiliates, $39; nonaffiliates, $52. Subscriber categories: highways; operations and traffic management; planning and forecasting; safety and human factors.

Guidelines for Ferry Transportation Services
TCRP Report 152

The history and characteristics of ferry systems throughout North America are examined in this volume, along with guidelines for planning, marketing, operating, and managing a ferry system as a component of an overall transportation network. The report also identifies benchmarks, as well as the benefits and challenges of ferry transportation services.

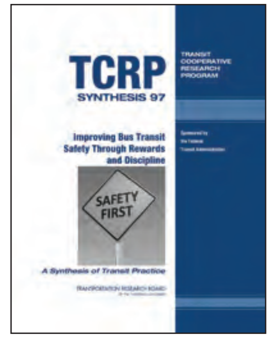
2012; 152 pp.; TRB affiliates, $50.25; nonaffiliates: $67. Subscriber categories: public transportation; marine transportation; terminals and facilities.

Guidelines for Providing Access to Public Transportation Stations
TCRP Report 153

Intended to aid in planning, developing, and improving access to high-capacity commuter rail, heavy rail, light rail, bus rapid transit, and ferry stations, this report includes guidelines for arranging and integrating various station design elements. The print version includes a CD-ROM that features a station access planning spreadsheet tool.

2012; 133 pp.; TRB affiliates, $54.75; nonaffiliates, $73. Subscriber categories: public transportation; planning and forecasting.

TRB PUBLICATIONS *(continued)*



Improving Bus Transit Safety Through Rewards and Discipline
TCRP Synthesis 97

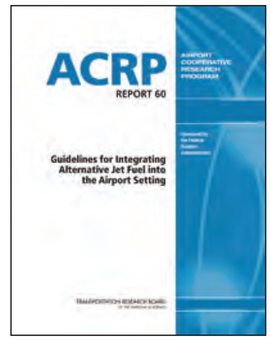
This synthesis addresses the practical experiences of public transit agencies in applying corrective actions and rewards to recognize, motivate, and reinforce a safety culture within their organizations.

2012; 53 pp.; TRB affiliates, $34.50; nonaffiliates, $46. Subscriber categories: administration and management; education and training; public transportation; safety and human factors.

Ridesharing as a Complement to Transit
TCRP Synthesis 98

Ridesharing can close gaps in public transit service and penetrate difficult-to-serve areas. This synthesis reports the state of the practice among transit agencies and explores ways to enhance ridesharing and public transit.

2012; 62 pp.; TRB affiliates, $36; nonaffiliates, $48. Subscriber categories: policy; public transportation.



Guidelines for Integrating Alternative Jet Fuel into the Airport Setting
ACRP Report 60

This report identifies the types and characteristics of alternative jet fuels; summarizes potential benefits; addresses legal and other considerations; aids in evaluating the feasibility of production facilities; and summarizes issues associated with locating on- or off-airport alternative jet fuel production facilities.

2012; 127 pp.; TRB affiliates, $45; nonaffiliates, $60. Subscriber categories: aviation; energy; environment.

Elimination or Reduction of Baggage Recheck for Arriving International Passengers
ACRP Report 61

Alternative procedures are explored for reducing or eliminating the need for baggage recheck for arriving international passengers at U.S. airports. Research is presented describing potential benefits and savings to airports, airlines, and federal agencies.

2012; 130 pp.; TRB affiliates, $47.25; nonaffiliates, $63. Subscriber categories: aviation; security and emergencies.

Guidebook for Airport Irregular Operations (IROPS) Contingency Planning
ACRP Report 65

This volume guides commercial passenger service airports of all sizes in developing, evaluating, and updating contingency plans for irregular operations procedures. Included are step-by-step templates for contingency plan preparation.

2012; 244 pp.; TRB affiliates, $57; nonaffiliates, $76. Subscriber categories: aviation; operations and traffic management.

Plan for Developing High-Speed, Nondestructive Testing Procedures for Both Design Evaluation and Construction Inspection
SHRP 2 Report S2-R06-RW

This report examines existing and emerging nondestructive evaluation (NDE) technologies and their current state of implementation. Also explored is a research plan for the development of NDE technologies to address the most pertinent needs for bridges, pavements, tunnels, soils, and retaining walls.

2009; 113 pp.; web only. Available at http://onlinepubs.trb.org/onlinepubs/shrp2/shrp2-S2-R06-RW.pdf.

2008 Survey of European Composite Pavements
SHRP 2 Report S2-R21-RW-1

Presented is a survey of in-service composite pavement sites in the Netherlands, Germany, and Austria, assessing the design, construction, and performance of asphalt on concrete and on two-lift, wet-on-wet concrete. Results were used to develop a plan to test composite pavements under SHRP 2 Renewal Project R21.

2010, 49 pp.; web only. Available at http://onlinepubs.trb.org/onlinepubs/shrp2/SHRP2_S2-R21-RW1.pdf.

Feasibility of Using In-Vehicle Video Data to Explore How to Modify Driver Behavior That Causes Nonrecurring Congestion
SHRP 2 Report S2-L10-RR-1

This volume examines studies that use video cameras and other onboard devices to collect data and investigates the potential for using these data to modify driver behavior and reduce nonrecurring congestion.

2011; 127 pp.; TRB affiliates, $45; nonaffiliates, $60. Subscriber categories: data and information technology; highways; operations and traffic management; safety and human factors. Also available as e-book for iPad and other e-pub format readers.

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TRB Meetings

November

8–9 Household Travel Survey Symposium*
Dallas, Texas

8–9 University Transportation Center Spotlight Conference on Sustainable Energy and Transportation: Strategies, Research, Data
Washington, D.C.

12–13 12th National Light Rail Conference: Sustaining the Metropolis—Light Rail Transit and Streetcars for Super Cities
Salt Lake City, Utah

December

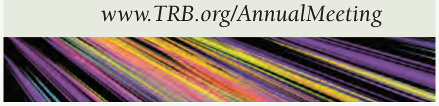
12–16 1st International Conference on Connected Vehicles and Expo*
Beijing, China

2013

January

12 2013 TransportationCamp*
Washington, D.C.

13–17 TRB 92nd Annual Meeting
Washington, D.C.
www.TRB.org/AnnualMeeting



February

TBD Energy Development Impacts on Transportation Workshop*
Dallas, Texas

April

15–18 Joint Rail Conference: Next Generation Rail—Meeting Challenges of the Future*
Knoxville, Tennessee

16–18 International Highway Technology Summit—Delivering Innovative Approaches and Best Practices*
Beijing, China

May

1–2 Adapting Freight Models and Traditional Freight Data Programs for Performance Measurement
Washington, D.C.

15–17 Road Safety on Four Continents*
Beijing, China

20–22 7th National Seismic Conference on Bridges and Highways*
Oakland, California

TBD Integrating Transportation Agency Spatial and Business Data for Improved Management Reporting
Boise, Idaho

June

2–3 10th International Symposium on Cold Regions Development*
Anchorage, Alaska

10–12 International RILEM Symposium on Multiscale Modeling and Characterization of Infrastructure Materials*
Stockholm, Sweden

17–20 7th International Driving Symposium on Human Factors in Driver Assessment Training and Vehicle Design*
Bolton Landing, New York

July

14–17 8th International Conference on Road and Airfield Pavement Technology*
Taipei, Taiwan

17–19 20th International Symposium on Transportation and Traffic Theory*
Noordwijk, Netherlands

September

TBD Development of a Formalized Process for the Adoption, Development, Maintenance, and Enhancement of TransXML Schemas Workshop
Washington, D.C.

October

23–25 7th International Visualization in Transportation Symposium: Visualization for Big Data
Irvine, California

Additional information on TRB meetings, including calls for abstracts, meeting registration, and hotel reservations, is available at www.TRB.org/calendar. To reach the TRB staff contacts, telephone 202-334-2934, fax 202-334-2003, or e-mail TRBMeetings@nas.edu. Meetings listed without a TRB staff contact have direct links from the TRB calendar web page.

*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.

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

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

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

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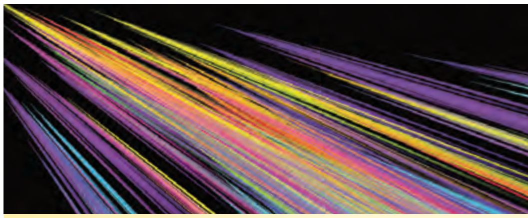

Transportation Research Board 92nd Annual Meeting

January 13–17, 2013 ▪ Washington, D.C.

DEPLOYING TRANSPORTATION RESEARCH

Doing Things Smarter, Better, Faster

In these uncertain times, performance expectations and budget constraints require that transportation agencies do things smarter, better, and faster than ever before. Spotlight sessions, workshops, and in-depth discussions at the Transportation Research Board 92nd Annual Meeting will highlight the critical role that transportation research and its deployment play in meeting these requirements.

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