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Improving Roadway Safety Programs Through University–Agency Partnerships

Summary of a Conference

November 2–3, 2011
Washington, D.C.

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OF THE NATIONAL ACADEMIES

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Summary of a Conference

Katherine F. Turnbull, *Rapporteur*

November 2–3, 2011
Keck Center of the National Academies
Washington, D.C.

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This report has been reviewed by a group other than the authors according to the procedures approved by a Report Review Committee consisting of members of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine.

This project was sponsored by the University Transportation Centers Program, Research and Innovative Technology Administration, U.S. Department of Transportation, and the Transportation Research Board.

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Preface

Improving roadway safety continues to be a priority of transportation agencies at the federal, state, and local levels. Within this national effort to improve roadway safety, vital partnerships exist between public agencies and the academic community, the transportation industry, and nongovernmental enterprises. Although traffic fatalities are at a 60-year low in the United States, more than 30,000 lives are still lost on America's highways each year. To develop a better understanding of the dynamics at play between university–agency partnerships and how they focus on improvements in roadway safety, the Transportation Research Board (TRB) hosted the Improving Roadway Safety Programs Through University–Agency Partnerships Conference at the Keck Center of the National Academies in Washington, D.C., in November 2011.

This meeting was the sixth in a series of Spotlight Conferences funded by the U.S. Department of Transportation's Research and Innovative Technology Administration (RITA) University Transportation Centers (UTC) program. The UTC program awards grants to universities across the country to advance the state of the art in transportation research, to conduct technology transfer activities, and to educate the next generation of transportation professionals.

The statement of task for this research conference project was to "organize a conference to review new safety tools and concepts, highlight current successful university–transportation agency safety partnerships, identify current and potential capabilities to fully utilize these new tools and concepts, and explore collaborative approaches by transportation agencies and universities to improve highway safety. The conference would serve as a forum for practitioners and researchers in highway safety, including state department of transportation safety engineers and planners, governors' representatives for highway safety, safety specialists in public health and local government, safety data experts, and academics involved in transportation safety research." TRB assembled a planning committee, appointed by the National Research Council (NRC), to help organize and develop the conference program. The planning committee was chaired by Daniel S. Turner of the University of Alabama. Committee members provided expertise in roadway safety, traffic engineering, public policy, advanced technologies, and safety education and training.

The planning committee was responsible for planning and organizing the conference, identifying speakers, reviewing poster abstracts, and developing topics for the breakout group discussions. Katherine Turnbull of the Texas Transporta-

tion Institute served as the conference rapporteur and prepared this document as a factual summary of what occurred at the conference. Responsibility for the published conference summary rests with the rapporteur and the institution.

The conference attracted 98 participants. Agency personnel responsible for road safety joined faculty, students, and researchers from UTCs and other universities to explore programs, tools, techniques, policies, research, and training to reduce crashes and fatalities. Forty-one roadway safety–related research abstracts were reviewed and accepted for presentation in a poster session. In addition, the conference, which was characterized by broad and active participation and discussion, considered the unique aspects of university–agency partnerships in advancing roadway safety.

These proceedings consist of summaries of presentations from the general sessions and summaries of key topics discussed in the breakout groups. Through a series of presentations, panels, breakout discussion groups, and poster sessions, conference attendees and panelists considered case studies, research needs, and the challenges and opportunities associated with improving roadway safety. On the basis of expert panels and facilitated discussion, attendees identified promising directions for research that could help implement the state of the practice and advance the state of the art.

During the breakout sessions, discussions focused on questions related to what makes a successful agency–university partnership and the role of universities and agencies in improving roadway safety. Major comments from all the breakout groups were summarized by a member of the conference planning committee during general sessions. More detailed summaries of key topics discussed by each group are included in the Summary of Breakout Sessions section of this report. A number of common themes emerged from the discussions in the breakout groups. Among the themes are keys to successful partnerships, approaches to enhance collaboration, and research needs and outreach activities.

The views expressed in this summary are those of the speakers and discussants, as attributed to them, and are not the consensus views of the conference participants or of the conference planning committee members. Any opinions, conclusions, or suggestions discussed in this summary are solely those of the individual participants at the conference and should not be construed as reflecting consensus or endorsement by the conference, the planning committee, or the National Academies.

This report has been reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise in accordance with procedures approved by the NRC Report Review Committee. The purposes of this independent review are to provide candid and critical comments that will assist the institution in making the published report as sound as possible and to ensure that the report meets institutional standards for objectivity, evidence, and responsiveness to the

project charge. The review comments and draft manuscript remain confidential to protect the integrity of the process.

TRB thanks the following individuals for their review of this report: Kim Alexander, Automotive Safety Research Institute, Clemson University, Clemson, South Carolina; Brian K. Gage, Minnesota Department of Transportation, St. Paul; Shauna L. Hallmark, Iowa State University, Ames; and Bryan L. Reimer, New England University Transportation Center–Age Lab, Massachusetts Institute of Technology, Cambridge.

Although the reviewers listed above provided many constructive comments and suggestions, they did not see the final draft of the report before its release. The review of this summary was overseen by C. Michael Walton, University of Texas at Austin. Appointed by the NRC, he was responsible for ensuring that an independent examination of this report was conducted in accordance with institutional procedures and that all review comments were carefully considered. Suzanne Schneider, Associate Executive Director, TRB, managed the proceedings review process.

The conference planning committee thanks Katherine Turnbull for her work in preparing this conference summary report and extends special thanks to RITA for providing the funding support that made the conference possible.

OPENING SESSION

Realizing Safety Improvements from University–Agency Partnerships

Daniel S. Turner, *University of Alabama, presiding*
Gregory D. Winfree, *U.S. Department of Transportation, Research and Innovative Technology Administration*
John Porcari, *U.S. Department of Transportation*
Bernard J. Arseneau, *Minnesota Department of Transportation*
Stephen Albert, *Western Transportation Institute*

WELCOME

Daniel S. Turner

Welcome to the University Transportation Center (UTC) Spotlight Conference, Improving Roadway Safety Programs Through University–Agency Partnerships. The conference is sponsored by the Research and Innovative Technology Administration (RITA) of the U.S. Department of Transportation (DOT) and organized by the Transportation Research Board (TRB). I recognize and thank the members of the conference planning committee. I also thank Tom Palmerlee, TRB staff, for his assistance in organizing this conference.

We have reached an all-time low in highway fatalities because of the hard work and concerted efforts of many agencies, universities, and groups. While we should all be proud of this progress, much work is still to be done to reduce crashes and fatalities. We have all been touched by losing a friend, a coworker, or a family member in a traffic crash. This conference focuses on advancing traffic safety through agency and university partnerships.

The conference will have three general sessions. Each general session will be followed by a breakout group session. Speakers in the general sessions will highlight aspects of traffic safety and agency–university partnerships from around the country. You will then have the opportunity to discuss the topics in more detail in the breakout groups and to provide suggestions on follow-up outreach activities, research, and training. We will also have a poster session this evening where you will be able to talk with the poster authors in addition to the other participants. This will provide another perspective through examples of exciting roadway safety projects under way at universities across the nation.

The planning committee has organized an interesting and informative conference. I encourage you to participate actively in the breakout sessions. Please share your experiences, ideas, and suggestions. Working together, we can advance traffic safety through agency–university partnerships.

U.S. DOT: IMPORTANCE OF SAFETY

Gregory D. Winfree

I am excited about this year's UTC Spotlight Conference program and by the level of participation. This diverse group brings together leaders from America's academic institutions, industry, and government. The transportation enterprise is well represented, which is great news for the research community and for the nation.

I want to let you know that the Bureau of Transportation Statistics (BTS) is relaunching the *Journal of Transportation and Statistics*. BTS is inviting papers on safety data for policy makers as part of a special issue on transportation safety. My colleague from RITA, Robin Kline, can provide more details on the journal.

To begin, I emphasize this administration's commitment to the UTC program and to the colleges and universities that have helped make it a success over the past two decades. America's academic community has always been a driver of innovation in transportation. It is in our country's best interest for the UTC program to thrive and become stronger than ever.

The UTC program brings together three crucial elements that will underwrite the health and resiliency of our transportation systems long into the future. The first is rigorous, peer-reviewed interdisciplinary research—great ideas that become tangible solutions. The second is education and workforce development—preparing the next generation of talented transportation leaders. The third is national, regional, and local partnerships—working with critical stakeholders to address transportation priorities.

There is no better example of how these elements are brought together for the common good of making transportation safer and better for all Americans than the UTC Spotlight Conferences. This year's theme is no exception: Improving Roadway Safety Programs Through University–Agency Partnerships.

Safety is the highest national priority at U.S. DOT, so the importance of this forum cannot be overstated. Despite the fact that America's roadways are the safest they have ever been, in 2010, a total of 32,788 people lost their lives on our roads and highways. Should we all be proud of the fact that the 2010 number is the lowest on record? Absolutely. This decline is the culmination of decades of vigilant, collaborative action to make vehicles safer and to help people make better decisions behind the wheel. However, as a nation, as a community of decision makers, scientists, engineers, researchers, students, and officials, we cannot be complacent. Those 32,788 people were lost and untold numbers of families were

affected: mothers, fathers, wives, husbands, children, brothers, and sisters. One life lost is unacceptable.

The great news is that we are at a crossroads. Science, technology, and innovation offer the promise of a profound transformation in roadway safety. Those here today are on the leading edge of this transformation. Exciting new technologies, such as connected vehicles, as well as new approaches to understanding vehicle and driver safety through human factors research and other disciplines, are at the forefront.

Many of us grew up in an era when seat belts were optional and air bags were not even part of the conversation. Today these technologies are ubiquitous and more effective than ever. They are not the final solutions.

We have an opportunity to usher in the next era of roadway safety—an era defined by intelligent transportation systems (ITS), the Global Positioning System (GPS), smart infrastructure, and countless other innovations that will bring unprecedented safety benefits. The challenge for all of us—government, industry, and the academic community—is to continue to work together and to address roadway safety and related issues with an eye on the big picture.

We need to consider roadway safety from an inclusive perspective. We need to engage in research and development focused on all vehicles, including motorcycles, scooters, and bicycles, as well as on pedestrians and wildlife. We need to implement life-saving safety technologies that reflect the diversities of the nation's communities—urban, rural, and in between.

At U.S. DOT, cooperative initiatives, such as the Connected Vehicle Safety Pilot Program, will help lay the groundwork for innovators throughout the country. The long-term success of this and other initiatives depends on building new partnerships and strengthening those we already have. Let's all embrace the spirit of this year's UTC Spotlight Conference, seize the opportunity to set a forward-thinking, game-changing agenda for roadway safety, and make this a true call to action for the transportation community.

U.S. DOT: IMPORTANCE OF SAFETY

John Porcari

We have made a lot of progress in traffic safety, but much more work is needed to reach the goal of zero deaths. This conference brings together representatives from agencies, universities, the private sector, and other groups to discuss how we can continue to make progress in roadway safety.

Safety is the highest priority at U.S. DOT. Secretary LaHood is passionate about improving safety and reducing crashes and fatalities. Safety is a common theme in everything we do at the department.

As a former secretary of a state DOT, I have a good understanding of the partnerships needed to advance roadway safety. One of my first initiatives as Deputy Secretary was to establish a Safety Council at U.S. DOT. While each of the modal agencies had chief safety officers, there was no departmentwide mechanism to build a safety culture, to share best practices, or to collaborate.

The Safety Council is made up of 10 modal administrators and the chief safety officers. Bob Johns, Director of the Volpe Transportation Center, is guiding the efforts of the council. It focuses on building a safety culture within all parts of the department, propagating safety management systems, and continuing to raise the bar for transportation safety. The work of the council is crosscutting. For example, fatigue is an issue in the aviation, trucking, motor coach, and railroad industries. The Safety Council helps in bringing a more comprehensive and holistic approach to safety issues within the department.

Transferring research into practice is an important component of addressing safety concerns. I am excited about the potential for ITS and other advanced technologies to assist in reducing crashes and fatalities. ITS can make our roads safer and our commutes faster in a cost-effective manner. The connected vehicle program will help reduce congestion and reduce unimpaired vehicle collisions—both of which impose enormous costs on the public and private sectors.

There are nearly 3,000 companies in the United States, employing almost half a million people, in the ITS business. The $48 billion industry is one of the fastest-growing segments of the economy. We think that the ITS industry will continue to grow at some $4 billion each year through 2015. Thus, ITS not only improves roadway safety but also provides jobs and enhances America's economic competitiveness in the global marketplace.

Toward Zero Deaths (TZD) must be our common goal. While the nation's fatality rate is at a 60-year low, we cannot rest on the progress that has been made. Zero fatalities is a stretch goal, but it has to be our goal. We can make progress, and our citizens demand it.

The UTCs are key partners in helping us reach this goal. Secretary LaHood and I look forward to continuing to work with you to make progress in this critical area. I hope you have a productive conference, and I look forward to hearing about your discussions.

MINNESOTA DOT: IMPORTANCE OF SAFETY

Bernard J. Arseneau

My comments focus on the approaches and programs being used by the Minnesota DOT and our partners to improve roadway safety and to reduce crashes and fatalities in the state. There are real opportunities today to address safety issues

and to reduce crashes. All groups are aligned to work together to improve traffic safety.

The number of roadway fatalities has declined on a national basis in recent years. Progress is being made, and we ought to be proud of these improvements. There is a need to do more, however, and to focus on zero deaths. This conference focuses on advancing traffic safety programs. Partnerships between universities and agencies are critical in moving toward a world with fewer roadway fatalities.

An understanding of the roles, responsibilities, and needs of agencies and universities is key in making these partnerships work. I will highlight the perspective of a state DOT and how we work with universities, other agencies, and groups to advance roadway safety in Minnesota. The Minnesota DOT has a strong relationship with the University of Minnesota and other universities in the state, which includes a focus on reducing roadway crashes.

The department's strategic vision is to be a global leader in transportation committed to upholding public needs and collaboration with internal and external partners to create a safe, efficient, and sustainable transportation system for the future. This vision may seem lofty, but it reflects the goals and aspirations of the agency. Members of the public deserve to know whether we are spending their money in ways that matter most to them. That is why the department's strategic vision includes a commitment to uphold public needs. Understanding what the public wants and expects from Minnesota DOT is a key part of fulfilling the strategic vision. Over the years, we have asked members of the public to tell us what they need. The responses have focused on providing a safe, efficient, and sustainable transportation system.

Understanding and responding to customers have been key concerns for the department over the past 3 years under the leadership of Commissioner Sorel. Minnesota DOT uses extensive market research to improve its understanding of what the citizens of Minnesota and other customers want and expect from the department.

Minnesota DOT has recently examined how transportation affects the quality of life in the state. Market research techniques used by the department include an online customer community and annual performance tracking surveys. The online community is a new tool for receiving timely customer feedback. Questions can be posed weekly to the online customer community on a range of topics. The annual performance measurement tracking surveys allow us to monitor customer responses to different programs, strategies, and technologies and to record changes in perception and use over time.

The department undertook quality-of-life pilot studies to improve its understanding of what quality of life means to Minnesotans, how transportation fits into the larger quality-of-life mix, and how the department contributes to the quality of

life in the state. Initial pilot focus groups were conducted in the Minneapolis–St. Paul metropolitan area, followed by 29 focus groups statewide. The focus groups obtained input on what matters most to Minnesotans and how transportation influences their quality of life. A statewide quantitative analysis is being completed to quantify what we learned in the focus groups. The results of both efforts will be used to develop transportation and quality-of-life performance measures.

The focus groups included nearly 300 residents. The quantitative analysis included a survey of 7,000 individuals, with 44 percent completing and returning a 10-page questionnaire. The results indicate that transportation is considered in the same type of category as employment, education, and the environment. While this result is impressive, it also means that Minnesota DOT is accountable for contributing to the quality of life of residents.

The focus group results indicate that transportation both contributes to and detracts from residents' quality of life. The results identified 11 quality-of-life categories. The categories include education; employment and finances; the environment; housing; and family, friends, and neighbors. Other categories are health, local amenities, recreation and entertainment, safety and security, spirituality and individual serenity, and transportation. As a positive contributing factor, transportation was not ranked as high as employment, health, safety and security, and other factors. A bad transportation system was identified as reducing the quality of life.

Seven transportation-related quality-of-life themes emerged from the survey. They focus on access, design, the environment, maintenance, mobility, safety, and transparency. Access refers to the ability to reach destinations. Design describes the physical layout of the transportation system and includes multiple components that make up the system, such as roads, signs, and lights. The environment includes carbon emissions and pollution as well as the addition of noise and light to the environment by transportation. Maintenance is a broad category that describes road surfaces, paint indicators, general repair, and seasonal upkeep. Mobility describes movement—moving from one point to another in the course of everyday life. Safety reflects the interaction of physical conditions and human behavior. Safety subthemes include lane departures, troubled intersections, distracted drivers, speeding, and interactions between vehicles and bicyclists or pedestrians.

One of the results of these efforts is that Minnesota DOT developed a sustainability policy statement. The statement focuses on respect and support for sustainable transportation practices and, where possible, regenerating environmental systems, the economy, and society over many generations. This approach requires balancing the three components: the economy, society, and the environment.

The economy includes productivity, employment, business development, the tax burden, and trade. Environmental elements include pollution, habitat preservation, biodiversity, air and water quality, and aesthetics. Society elements address

equity, health, culture and history, accessibility, involvement, livability, and values. All of these elements come together to form sustainable solutions. The public understands and supports this concept to improve quality of life.

The quality-of-life and sustainability policy statement provides the background for the development of the TZD vision. TZD is the state's primary traffic safety initiative. It is a partnership between Minnesota's Departments of Public Health, Safety, and Transportation; the University of Minnesota led by the Center for Transportation Studies (CTS); and local traffic safety partners.

TZD's mission is to create a culture in which traffic fatalities and serious injuries are no longer acceptable through the integrated application of education, engineering, enforcement, and emergency medical and trauma services. The efforts are driven by data, best practices, and research. The TZD vision is to reduce fatalities and serious injuries on Minnesota's roads to zero.

TZD was initiated in 2003. Developing a synergistic approach outside the traditional agency and organization silos was a key element of TZD. The work of the Federal Highway Administration (FHWA), the American Association of State Highway and Transportation Officials (AASHTO), and other groups on the Strategic Highway Safety Plan helped set an example to follow at the state level.

Minnesota DOT and the Minnesota Department of Public Safety led the effort of bringing together our partners in education, engineering, enforcement, and emergency medical services (EMS) in the development of the TZD program. The approach used in Minnesota provides an example for other states. I hope we will discuss how we spread best practices to other states and areas that may not be as advanced in addressing traffic safety as participants at this conference. I think that we can achieve zero deaths on our roadways through partnerships with agencies, universities, and other groups. Technologies, strategies, and policies are all available to help in reaching the TZD goal.

One of the key elements in our approach is that agencies and individuals have to leave their pursuit of credit for work done on the back burner. We want the whole group, not certain agencies or individuals, to be responsible for the outcome and the improvement in traffic safety. This approach, which promoted collaboration and effective solutions, is working in Minnesota, Louisiana, Utah, Missouri, and several other states. A growing number of states are becoming successful in reducing roadway fatalities. We are using data and best practices to achieve these outcomes.

Using systematic and proactive solutions to traffic safety represents a change from the hot spots approach used 10 years ago. Addressing education and enforcement related to behavior and human factors is critical today. Alcohol and failure to use safety belts still account for numerous crashes and fatalities. We could address

one-third to one-half of all fatalities if everyone buckled up. Building trauma centers to allow EMS and first responders to transport injured persons to the right facility is part of the approach.

We are seeing positive results in reducing fatalities in Minnesota. Before 2003, annual fatalities had been increasing, including highs of 657 fatalities in 2002 and 655 in 2003. In 2003, we began implementing the Strategic Highway System Plan concepts, bringing the key stakeholder groups together, and initiating specific activities. TZD has implemented many strategies that have worked to reduce fatalities. The 2008 goal was 500 fatalities; the actual number was 455, though the downturn may have had an influence. There were 411 fatalities in 2010. As of yesterday, there have been 55 fewer fatalities than by the same date 1 year ago.

While we have made great progress, there are numerous challenges. There were 15 roadway fatalities over a 3-week period this fall, which indicates that much work remains to be done.

The universities in the state play important roles in TZD. CTS, the ITS Institute, and other groups at the University of Minnesota are close partners in many programs and projects. CTS provides administration and outreach support for the TZD program. The center provides continuity to the program. Activities conducted by CTS include website management, a contact database, and expertise for event planning. This outreach support role is critical in allowing agency staff to focus on safety projects and programs.

There are a number of elements and activities to consider in the university and agency partnership. A first activity is to identify knowledge gaps. We have spent much time discussing basic versus applied research. We realized the need for universities to conduct basic research, but our needs focus on applied research. State DOTs have scarce resources for delivering solutions tomorrow, not in 10 years. We realize, however, that major advances in safety will come about through basic research. We have been able to develop a balance of applied and basic research with the University of Minnesota and other universities.

Once the knowledge gaps and research needs have been identified, we must champion the research projects and partner on research activities. Implementing research results is a critical step. We need to define end user products, test new approaches and technologies, and identify training needs. Maintaining positive working relationships throughout all these activities is key to successful partnerships.

One of the elements of TZD is moving from the “where” to the “why.” The “why” focused on examining the top critical emphasis areas for fatal and serious injury crashes between 2006 and 2009 to include the following:

- Unbelted vehicle occupants;
- Alcohol-related incidents;
- Speeding and aggressive driving;
- Young drivers; and
- Inattentive, distracted, and sleeping drivers.

Infrastructure-based emphasis areas include road departure, intersections, and head-on collisions and sideswipes. Intersections now rank highest in fatality and serious injury crashes, which is why we have been working with the University of Minnesota to use new technology to aid in intersection safety.

The Cooperative Intersection Collision Avoidance Systems–Stop Sign Assist is a cooperative effort between the ITS Institute and Minnesota DOT. The system was being deployed at four intersections, including Highway 52 south of Cannon Falls. This location is a rural four-lane divided highway. The system was deployed at an intersection that had numerous crashes and fatalities. The project included examination of the intersection and human behavior by testing various signs and technologies in the driving simulator.

The signs include a red rectangle and circle with the slash that indicates to the driver at the stop sign that the gap in traffic on Highway 52 is too small to make the indicated movement. The yellow rectangle indicates that a vehicle is approaching on Highway 52 and the vehicle at the stop sign should proceed only with caution. When there is no red or yellow rectangle, it is safe to make the indicated movement. The system helps drivers negotiate the intersection.

There were no crashes or fatalities during the initial 22 months the system was in operation. Then, in the span of 10 days, there were three fatalities at the intersection. We are working with the ITS Institute and other agencies to examine the crashes. One crash involved an elderly driver, and one involved a young driver of a pickup truck who was not wearing his seat belt.

Minnesota DOT and the ITS Institute have partnered on other low-cost intersection warning devices, including cross street and mainline warning signs. Rural intersections continue to be the most important location for fatalities in Minnesota. Another partnership effort with the ITS Institute is use of a smartphone as a platform for the Teen Driver Support System. Teen drivers are overrepresented in fatalities. The system relies primarily on the capabilities of the teen's smartphone. It incorporates a GPS receiver and accelerometer for monitoring of known teen driver risk factors and support of certain provisional licensure provisions. The system alerts teen drivers in a safe way if they are speeding and provides advance notification of speed limit changes. All cell phone communication is subsumed. The system provides real-time feedback by "talking" to the driver to improve learning and reduce risky driving. If the behavior of the teen driver does not change, the system alerts the parents via a

text message. The parents can then take the appropriate action. Also, please continue to tell your teen drivers to buckle up.

Minnesota DOT also partnered with the Center for Excellence in Rural Safety, which is a joint program between the University of Minnesota's Hubert H. Humphrey School of Public Affairs and CTS. It is sponsored by FHWA to facilitate research, training, and outreach activities related to rural transportation safety. The center's research focuses on six public policies to reduce rural road fatalities. The six public policies are primary seat belts in use, sobriety checkpoints, motorcycle helmet mandate, graduated driver's license, automated speed enforcement, and ignition interlock.

Minnesota DOT has worked with faculty and researchers at the University of Minnesota on operational issues. The systematic monitoring of arterial road traffic (SMART) signal was developed by Henry Liu of the University of Minnesota in cooperation with the department. The system time stamps every event that occurs at a signalized intersection. Algorithms are used to compute various measures, including travel times, level of service, and saturation rates. An algorithm is being developed to optimize the signal timing parameters.

The SMART signal provides solutions to two long-standing traffic engineering problems. The first is measuring intersection queue length when the vehicular queue spills over the detector location. The second is estimating arterial travel time reliably. Minnesota DOT is working with a faculty member at the Northland Advanced Transportation Systems Research Laboratory at the University of Minnesota Duluth (UMD), who developed a robotic message painter for special pavement markings. The department is now working with UMD to mount a robotic painter to a department vehicle. The system will improve work zone safety by removing workers from the roadway.

In closing, the keys to the success of agency and university partnerships include developing and maintaining strong working relationships and understanding the environments and needs of each partner. The two groups also need to appreciate the value of research and to champion research.

UNIVERSITY PERSPECTIVE ON IMPROVING UNIVERSITY AND AGENCY PARTNERSHIPS FOR TRANSPORTATION SAFETY

Stephen Albert

My comments focus on the value of agency and university partnerships in improving roadway safety, the complementary skills and assets of the two groups, and various types of models for enhancing agency and university collaboration.

The AASHTO Research Advisory Committee and the Council of University Transportation Centers have been examining working relationships and research programs between state DOTs and universities to enhance these efforts. A survey was

conducted recently to obtain information from state DOTs and universities on joint research activities. Comparing the responses provides insight into the types of joint activities. The most frequently reported joint activities were conducting research projects, maintaining cross membership on committees or advisory boards, conducting joint meetings and workshops, and developing research ideas. Other joint activities were developing the workforce, managing the local technical assistance program, and providing continuing education.

Both state DOTs and universities reported the use of formal agreements for research and technology transfer activities. A total of 88 percent of the responding universities and 74 percent of the state DOTs reported formal agreements. Most of these agreements are between state DOTs and universities in the state, although some formal agreements between agencies and universities in other states were noted.

Master agreements with project-specific task agreements were the most frequently noted type. Project-specific agreements only and memorandum of agreement or memorandum of understanding were also reported by both groups. Project-specific funding was reported by 64 percent of the responding state DOTs and 75 percent of the universities. Lump-sum funding was reported by 13 percent of the state DOTs and 21 percent of the universities.

The responses from state DOTs and universities indicated that the agreement process is working well. A total of 54 percent of the state DOTs reported that the agreement process works well, and 29 percent reported that it sometimes works well. Among the universities, 63 percent responded that the agreement process works well, and 29 percent responded that it sometimes works well.

The Western Transportation Institute (WTI) at Montana State University (MSU) examined these responses in more detail and explored opportunities for research in other states. We found that research program policies and procedures vary considerably from state to state and even within a state. Most state DOTs do not regularly solicit research partnerships with agencies outside their state. A number of state DOTs give preference to in-state agencies. Our initial analysis indicated that out-of-state research opportunities are limited. This finding raises questions about how national objectives and priorities can be achieved if research is conducted on a state-by-state basis.

Representatives from FHWA, the Federal Transit Administration, and other federal agencies serve on the WTI Advisory Committee. These individuals provide input on national objectives and issues. They can partner on research identification, but not selection, because of a potential conflict of interest. We have found limited knowledge or interest among federal agencies in UTC research results. This response is a bit disconcerting. There appears to be varied success in using research results at the federal level.

As we consider safety improvements, we know that we cannot focus only on the individual. We must address many levels of the system. Use of the social ecological model, which was originally developed to describe how individuals learn, represents one approach to addressing this broader audience. It has become powerful as a framework for addressing health and safety issues. By working across the entire system—family, individuals, and peers; schools and workplace; community; and society—we can transform culture and affect behavior.

A good example of beginning to work across systems in a transformational way is the road to zero deaths initiative. The initiative is transforming how we talk about and consider the issue of traffic safety. No longer do we accept even a small number of fatalities. When we accept that our work is about seeking zero fatalities, we begin to examine all aspects of our work differently. We begin to tell a new story about traffic safety. This approach requires a cultural transformation to communicate a new story about how individuals, families, schools and workplaces, and communities address health and safety issues.

Universities provide unique resources. At WTI, we have ecologists; biologists; aviation management specialists; planners; and civil, corrosion, electrical, industrial, and mechanical engineers. Within MSU are departments of civil, mechanical, industrial, and electrical engineering and computer science, as well as departments of ecology, fish and wildlife, plant sciences and plant pathology, psychology, and land resources and environmental science. Other departments include political science, mathematical sciences, physics, and health science.

Expertise in all of these areas is needed in a human-centered systems approach to traffic safety. This approach focuses on culture, geography, environment risk, road design hazards, and human factors. We know that behavior and individual compliance are key elements in reducing fatalities. Examination of human factors issues is critical in making advances in this area.

Universities can play important roles in examining regional issues and solutions. Comparing strategic highway safety plans from various states and examining the experience with various safety strategies are examples of the benefits of a regional approach.

Opportunities also exist for using the testing facilities and laboratories available at many universities throughout the county. For example, WTI, the Texas A&M Transportation Institute, the Pennsylvania Transportation Institute, the University of Michigan, and Virginia Tech all have extensive test facilities.

WTI is working with RITA to inventory the test facilities and laboratories at UTCs. The database is being developed to provide easy access to individuals interested in different types of testing facilities. The database will eventually be housed on the RITA website. Users will be able to search for laboratories on the basis of research themes, location, equipment categories, and UTC name. Examples of research

themes in the safety area include human factors and driver behavior, traffic safety and traffic management, security and emergency response, infrastructure safety, enforcement, and technology applications and ITS.

In conclusion, the UTCs are investments. They offer objective resources. The UTCs leverage skills and resources. Sustainability of the UTCs predicated on relevance and minimizing research isolationism is important. Project-by-project funding does not build the institutional base necessary for sustaining successful UTCs. Finally, I think that collaborative models are better than competitively selected models.

GENERAL SESSION

Collaborative Efforts to Enhance the Value of New Tools and Techniques

John Milton, *Enterprise Risk Management, Washington State Department of Transportation*
Monique R. Evans, *Federal Highway Administration*
Denise Osborn, *Public Health Consultant*
Jake Kononov, *Colorado Department of Transportation*
Leanna Depue, *Missouri Department of Transportation, presiding*

SKILLS NEEDED FOR *HIGHWAY SAFETY MANUAL*, SAFETY ANALYSIS, AND POTENTIAL SAFETY IMPROVEMENTS

John Milton

My presentation focuses on the skills needed for the *Highway Safety Manual* and for safety analysts. The first step in the university transportation center (UTC) and agency partnership is to understand the perspective of state departments of transportation (DOTs) and universities. The focus on Toward Zero Deaths and fatality reduction will guide much of our future research and the directions we take on safety.

Our overall goal is to have no fatalities on the roadway system. Multiple agencies are involved in accomplishing this goal. All these agencies face challenges related to the scope, schedule, and budget in project delivery. They also have a focus on practical solutions. The UTCs exist in a publish-or-perish environment. Universities have a science exploration focus, as well as a focus on preparing the future workforce.

The *Highway Safety Manual* represents an advance in the science of safety. It raised the bar in roadway safety. The science of safety is continuing to advance, however, partly because of the contributions of the academic community. The *Highway Safety Manual* represents a point in time. We need to focus on the next advances in safety, and research will be key.

The other aspect we have to realize is that agencies are at different stages in addressing safety and have different levels of safety expertise. Some state agencies have limited expertise, while others are well advanced in the science of safety and safety strategies. The safety expertise available at the UTCs also varies on the basis of the interests and backgrounds of faculty and researchers.

The range of implementation varies across agencies. At some, the use of analysis beyond historical approaches of crash rates, for example, is limited because the more advanced analysis techniques are not yet practical. Practical implementation issues

need to be addressed in advancing the science of safety. Agencies are focused on implementing practical applications of information that come out of the safety science realm. In contrast, universities focus on advancing the science of safety, part of which may not be practical or implementable, especially in the short run.

The *Highway Safety Manual* focuses primarily on nominal safety. As a result, nominal safety is the most common approach to incorporating safety and driving down fatalities implemented at agencies. Nominal safety relies on the use of design standards and manuals and on perceived notions about how to improve the safety performance of locations and projects. While practical and part of the tools and the culture of many agencies, it is unfortunately not the most optimal and cost-effective means for reducing fatalities and serious injuries. Before the *Highway Safety Manual*, agencies were faced with literally thousands of research papers and reports providing perspectives on the impact of roadway features on safety performance. In other words, these approaches were not practical or easy to implement. Staff at agencies generally did not understand statistical aspects of the science of safety, which were not readily available or even agreed on in the scientific community.

The *Highway Safety Manual*, along with tools such as the Federal Highway Administration (FHWA) Crash Modification Factors (CMF) Clearinghouse, SafetyAnalyst, and the Interactive Highway Safety Design Model (IHSDM), has helped move agencies into the present. The tools allow agencies to use advanced analytical approaches that will support more cost-effective investments to reduce fatalities. The challenge for most agencies is that the use of these tools is not yet at a higher practical level, which is needed for agencywide deployment and for making the more advanced approaches the standard methods.

Numerous tasks need to be conducted in implementing elements of the *Highway Safety Manual*. We ask our staff to maintain the necessary skills relating to a general understanding of safety science. The UTCs can assist by providing training to employees and by educating the next generation of transportation professionals.

Issues that need to be addressed include data availability, data collection methods, and data analysis techniques. Other issues include examining needed changes in policies, changing crash rate prioritizations, and identifying and implementing information technology resources. The UTCs can assist in all these areas.

The UTCs and transportation agencies can work together to provide for a general understanding of scientific methods. Universities, depending on knowledge, skill levels, and availability of staff and faculty, play a role in assisting agencies in moving the advanced approaches of the *Highway Safety Manual* to a more practical level. Universities can provide faculty and staff with a basic knowledge of safety and can provide a minimum understanding of the scientific tools and their concepts related to safety. In addition, they can provide educational programs reflecting the significance

of safety within the broader curriculum and promote partnerships where skills are not available. Transportation agencies can embrace the *Highway Safety Manual*, update policies and programs to reflect *Highway Safety Manual* recommendations, and coordinate with universities on workforce development and additional research. Agencies must be willing to embrace statistical concepts, such as regression to the mean, and to update policy and programs to reflect current scientific safety knowledge. Agencies also must have a minimum understanding of the scientific tools for improving safety.

To provide for a general understanding of scientific methods, UTCs and agencies can collaborate to assist agencies in identifying data collection methods, data analysis techniques, and data reporting. Together, agencies and UTCs can identify the most likely method of achieving higher fatality reductions from a given level of investment in safety by utilizing and calibrating safety performance functions, assessing policy changes and their impacts, and assessing performance change and issues. Agencies and UTCs can work together on human factors evaluations. Data-driven decisions are key to the future.

UTC and agency partnerships can help advance the science of safety both at a practical level and at a longer-term research level. Universities can educate students on the impacts of statistical methods and the benefits and disadvantages of using these methods. An explanation of the importance of estimation bias and how it can improve estimation and lead to improved prioritization and project selection is needed. An understanding of diagnostics and human factors is important.

I think that the *Highway Safety Manual* should focus more on improving diagnostic skills. In Washington State, we try not to use the term "safety." Instead, we use crashes and factors contributing to different types of crashes on various highways and roads. This approach focuses on addressing the contributing factors for different types of crashes. How we communicate basic research is also important. We need to translate basic research into practical implementation to reduce fatalities. The tools we develop and advance in basic research can be executed by agencies. We are also interested in developing the skill set of the current and future workforces at agencies.

Agencies are interested in advancing the scientific basis for decisions and processes. We need a workforce that is knowledgeable and embraces cost-effective safety investments to maximize fatality reductions. Having the tools available to implement advancements in the science of safety is key.

Leadership at state transportation and safety agencies should understand the balance between research priorities and should both move science into practical application and advance science suitable for publication in journals. Leadership is needed in identifying research needs in practical and basic research, preparing statements that reflect topic-specific scientific needs, selecting research projects, and executing research. Knowledge of the development of the science of safety, understanding why an agency is changing approaches, and supporting quantification of safety as appropriate are all needed.

The UTC faculty can assist in identifying research needs that address both practical and basic research. Faculty with knowledge and skills in study design and statistical analysis of crashes and injuries are needed. Safety must be incorporated as a key element in the curriculum. Research must be communicated and linked to practical outcomes. Universities can help educate the future workforce about safety as a science, about analysis methods for safety quantification, about basic concepts of safety, and about the concept that nominal safety does not equate to substantive safety. Universities can provide training to the workforce to help in changing beliefs, advancing skills and knowledge, and using and integrating analysis methods and tools into daily decision making.

In closing, it is important to remember why we are all here—to learn techniques and approaches for reducing crashes and fatalities. Remember, the life you save may be your own.

FHWA SAFETY RESEARCH AND DEVELOPMENT AND UNIVERSITY PARTNERSHIP OPPORTUNITIES

Monique R. Evans

My comments focus on the FHWA safety program. I will highlight the activities of the various groups. I will also describe the partnership mechanisms, including temporary personnel assignments and the contract research program. These mechanisms provide opportunities for university faculty, researchers, and students. I will close by highlighting a few challenges for the future.

We are in the process of developing a safety program strategic plan within FHWA. As part of the strategic planning process, we have been discussing the vision for the program. We think that the ultimate vision of the FHWA safety program is a safe highway system characterized by zero deaths. I think that we can all agree that the goal is no fatalities, even if reaching this goal is difficult.

We have a long history of using collaboration to deliver our vision. The safety program provided support for the development of the *Highway Safety Manual*, in collaboration with the American Association of State Highway and Transportation Officials (AASHTO), the Transportation Research Board (TRB), and the National Cooperative Highway Research Program. The FHWA Office of Safety Research and Development (R&D) developed the crash prediction algorithm for two-lane rural highways for the IHSDM that has been incorporated into Part C of the *Highway Safety Manual*. The IHSDM now provides software implementation of all *Highway Safety Manual* Part C predictive methods. FHWA also developed the CMF Clearinghouse to support and supplement Part D of the *Highway Safety Manual*.

Various organizational units within FHWA focus on safety. Among them are the Office of Safety, the Office of Safety R&D, the Resource Center, and the division offices. The Office of Safety is responsible for administrative stewardship and lead-

ership in advancing safety technologies and innovations. The Office of Safety R&D conducts research and performs analyses, develops and evaluates new technologies, identifies emerging issues and trends, and assesses the long-range needs for improving safety. The Resource Center advances transportation safety technologies and solutions through training, technical assistance, technology development, and partnerships. The divisions advance transportation safety at the state level.

The roadway pavement safety edge is one of nine proven countermeasures identified by the Office of Safety that were selected as part of FHWA's corporate Every Day Counts initiative. This beveled pavement edge enables a safer and more controlled return to the roadway by an errant vehicle. The Office of Safety R&D evaluated the effectiveness of the safety edge and found, on average, a 6 percent reduction in total crashes in areas where it was installed. The Office of Safety, the Resource Center, and the division offices have all led efforts to promote the use of the safety edge.

The mission of the FHWA Safety R&D program is "to reduce highway crashes and related fatalities and serious injuries by developing and implementing safety innovations in a nationally coordinated safety research and development program." The effectiveness of two speed-activated curve warning devices is being evaluated by university researchers under a contract managed by our office and the speed management program.

The five Safety R&D focus areas are comprehensive approach to safety (CAtS), roadway departure, intersections, pedestrian and bicycle safety, and speed management. The CAtS research defines data needs, identifies or develops effective data collection methods and technologies, and develops analytical tools and processes to convert those data into good decisions for allocating safety resources. Analytical tools, such as IHSDM and SafetyAnalyst, which support the *Highway Safety Manual*, as well as the digital highway measurement system, are examples of the results of this research. The Highway Safety Information System is maintained under a contract by a university research center. It is the source of data for research studies conducted by faculty and students at numerous universities.

Roadway departure focuses on preventing vehicles from leaving the roadway and mitigating the impacts when they do veer off the road by conducting research to improve visibility and roadway design. Researchers in this area also develop and apply advanced analytical tools, digital models, and crash simulation to produce measures to make the roadside safer. Longitudinal barriers are one example of these measures.

The intersection safety area identifies the most severe safety issues at intersections and evaluates and documents innovative designs and treatments to address those concerns. The research focuses on signalized and unsignalized intersections. The primary purpose of the pedestrian and bicycle research area is to reduce injuries

and fatalities involving these modes by identifying and evaluating potential safety measures. Fostering public awareness of pedestrian and bicycle travel and providing resources for use at the national, state, and local levels are other purposes. Speed management researchers develop and test measures and technologies for managing speed while seeking wider adoption of travel speeds appropriate for the class of roadway, roadway design, and travel conditions.

There are a number of crosscutting research topics that support work in the focus areas. Human factors research examines the role of behavior in road safety. At Turner–Fairbank, this research includes a range of topics addressing visual attention to traffic control devices and sources of distraction external to the vehicle. Other research topics are improvements in the legibility and comprehension of road signs and other traffic control devices, pedestrian safety, traffic management center design, advanced driver simulation, and intersection design. The visibility area focuses on research assessing the safety impacts of roadway lighting and on developing models of visual information required for appropriate performance. The Office of Safety R&D also supports intelligent transportation systems (ITS) and advanced research projects. Advanced research focuses on longer-term, higher-risk breakthrough research. The office has the modal lead for vehicle infrastructure for the safety portion of the ITS connected vehicle program.

Partnership mechanisms within the FHWA Office of Safety R&D include temporary personnel assignments and the contract research program. Both of these partnership mechanisms can be used with universities. Temporary personnel assignments allow university faculty and students to work with us on site. Universities also can conduct research through the contract research program. For example, a university research center recently conducted a before-and-after assessment of a road treatment through the contract research program. Opportunities for temporary personnel assignments for students are available through the Summer Transportation Internship Program for Diverse Groups, the Student Educational Employment Program, the Student Career Experience Program, and the Eisenhower Grants for Research Fellowships.

Temporary personnel assignments for recently completed PhDs are available through the National Research Council Postdoctoral Research Associateships. Opportunities are available for faculty through the Intergovernmental Personnel Act Assignments. We currently have one postdoctoral researcher and one faculty member on sabbatical working in the office.

The contract research program includes three types of agreements: contracts, cooperative agreements, and grants. Contract research is the most common. Cooperative agreements are generally used in partnership arrangements. Funding programs available through the contract research program include the Safety Innovation Deployment, which is our applied research program, ITS–Connected Vehicle Research, Exploratory Advanced Research, and Pooled Fund projects.

Achieving the vision of zero deaths is a challenge for the future. Universities can contribute to this vision by ensuring that future safety professionals are adequately prepared to meet challenges; assisting in achieving better integration and coordination of long-term, higher-risk advanced research within the national safety research portfolio; and advancing commercialization and deployment of innovations. FHWA is committed to deploying research and to advancing commercialization.

SUCCESSFUL EXAMPLES AND TECHNIQUES FOR COLLABORATION WITH NONTRADITIONAL PARTNERS SUCH AS PUBLIC HEALTH AGENCIES

Denise Osborn

I appreciate the opportunity to bring a public health perspective to the discussion. I am a nonpracticing attorney, and I work with federal policy makers and approximately 22 states on a variety of public health issues. In 2009 and 2010, I had the opportunity to work solely on a transportation project, which I will describe today.

I consider motor vehicle safety through the public health lens. I focus first on people, before road infrastructure and vehicles. Roads, highways, public transit, planes, and bicycling and walking paths are beneficial to society. The design and construction of the transportation system shapes communities and affects the public's health.

The American Public Health Association (APHA) has recently announced a call to action for public health professionals. Elements of this initiative include increasing opportunities for physical activity, keeping people safe, improving air quality, and addressing social and health inequalities. Other elements are achieving positive health outcomes through transportation and supporting transportation policy at the national, state, and local levels.

Transportation affects health costs in many ways. Transportation investments influence land use patterns, travel behavior, individual health, and the cost of health care. Chairman Deborah Hershman of the National Transportation Safety Board has made the point that states are in a position to influence policy and to move transportation safety to the next level. State health officials (SHOs) are partnering with state transportation officials to identify opportunities to affect transportation safety. I think universities are in a unique position to provide the data needed to evaluate evidence-based safety interventions and safety policies. Universities can help promote better data-driven decisions.

I had the opportunity to be involved in an interesting project when the Arkansas SHO, Dr. Halverson, became Chairman of the Board of the Association of State and Territorial Health Officials (ASTHO). He has a passion for injury prevention. At that time, the Centers for Disease Control and Prevention was in the process of launching

a campaign called Winnable Battles. One of the Winnable Battles was to reduce the number of people dying in automobile crashes.

Let me explain more about SHOs. SHOs are appointed by the governor. There is a SHO in every state. They are typically doctors, nurses, epidemiologists, or people in related fields. They are responsible for the public's health in their state. In some cases, they run the state health agency. The SHOs are the members of ASTHO.

While serving as the Chairman of ASTHO, Dr. Halverson decided to make transportation safety a primary focus. I was his staff person on the effort. Barbara Harsha from the Governors Highway Safety Association was the first person I talked with to explore opportunities. She connected me with Tony Kane at AASHTO, Rick Pain at TRB, and other transportation advocates. Soon we had numerous national associations collaborating on how to begin a dialogue concerning interventions based on public health and transportation.

A meeting was held on May 11, 2010, in Washington, D.C., to initiate the dialogue. Approximately 75 people attended the meeting, including representatives from five federal agencies, 25 national associations, 10 state health agencies, and local health departments. The discussion focused on identifying effective safety strategies. The keynote speaker was the New Hampshire SHO—an interesting choice since New Hampshire does not have a primary seat belt law. The discussion focused on developing policies and programs, creating public support to change state laws, and leveraging data to change culture.

As a result of the meeting, ASTHO joined the State Highway Safety Alliance, lending support to AASHTO and other national organizations that are promoting transportation safety on a national level. The State Highway Safety Alliance urges Congress to act on numerous issues, including increasing safety funding, streamlining program administration and enhancing flexibility, and strengthening strategic highway safety planning. Among other issues are supporting enhanced data collection and analysis, increasing investments in safety research and development, and preparing the safety workforce of the future.

Our project encountered many of the barriers, issues, and concerns discussed in the previous breakout groups today. Among the issues were political will, interagency cooperation, and funding. During his year as Chairman of ASTHO, Dr. Halverson was a true champion of collaboration between public health and transportation. The focus of the initiative that he led was on data-driven, evidenced-based interventions available today that states can implement to prevent motor vehicle crashes.

After the May 2010 meeting, ASTHO, working with other organizations and groups, drafted a policy brief. The policy brief covered the multidisciplinary nature of motor vehicle safety. We obtained input from diverse groups, including emergency medical services professionals, public health officials, police officers, state DOTs, state health departments, and federal agencies and organizations. The brief was 11

pages long; we tried to provide equal discussion on the various issues and intervention strategies.

The title of the ASTHO brief is "Preventing Injury and Death due to Motor Vehicle Crashes Strategies for the States." It noted that although the toll of motor vehicle crashes is substantial, it does not represent an insurmountable problem. We know how to prevent these tragedies through technological and behavioral intervention and, importantly, through policies supporting these interventions.

The brief was widely disseminated throughout the country with the assistance of AASHTO and other organizations. The feedback that we received was positive. We heard from numerous groups and agencies that it helped foster local dialogues and activities. Another positive outcome was that recommendations included in the brief have been incorporated into recommendations, reports, and policies of other agencies and organizations. In some states, it appears that public health is being incorporated into transportation safety policies.

APHA also has a focus on transportation and public health. I like APHA's use of the phrase "reinvent the transportation system to better promote health, safety, and equity."

Change needs to occur—to partner with other agencies and organizations—especially nontraditional partnerships. Working together to promote change is not easy. We must overcome barriers to change. These barriers are not insurmountable, however, and they can be overcome by working together toward common goals.

The costs associated with traffic crashes and fatalities have been well documented. A recent policy brief titled "Transportation, Public Health, and Safety," which can be found on the T4 America website (http://www.t4america.com), includes some recent public health figures. Traffic crashes cost about $163 billion annually in property damages and injuries and are the largest contributor to congestion nationwide. U.S. health costs associated with poor air quality caused by transportation are estimated at between $40 billion and $60 billion per year.

The role of public health and traffic safety is emerging and evolving. At the end of the day, the safety data and science must be combined with the art of policy making, which requires creativity and tenacity. The universities play a key role in providing the data and the science for advancing transportation safety and reducing traffic crashes and fatalities.

SUMMARY OF KEY POINTS ON WHAT MAKES A SUCCESSFUL AGENCY–UTC PARTNERSHIP

Jake Kononov

We had an informative exchange of ideas in the first breakout session this morning. Karen Dixon and I have summarized a few of the key points from the various groups. I will also discuss the importance of communication in the safety area.

State DOT needs focus on planning and designing, constructing, operating, and maintaining transportation facilities. I have spent the past 30 years doing all of those things at Colorado DOT. In addition, I have taught highway and traffic engineering and road safety at the University of Colorado. As a result, I have a good understanding of the needs of both state DOTs and universities.

University needs focus on educating students, obtaining tenure, obtaining research grants, publishing, increasing student enrollment, soliciting funds, and contributing to the state of the art. Obviously, state DOTs and universities have different needs. There are opportunities for confluence and mutual benefits in the area of highway safety.

Safety is a unique field. Safety is supposed to be a science, yet over the past 70 years of modern road building, we have not managed to write a fundamental book on road safety. We have fundamentals of traffic theory, structural design, and hydrology and hydraulics. In my opinion, we have not established the fundamentals of roadway safety.

To improve roadway safety programs through university–agency partnerships, I believe we need a common goal. Agencies and universities need to agree to focus on highway safety, and they must commit to excellence. We need to identify a champion who understands both sides. It would be good to form a joint advisory safety board. The DOT controls the data, and the university has the analysis expertise. They need to work together to turn data into information and intelligence. Universities must focus on the needs of DOTs for the alliance to be successful. The DOTs need to be sensitive to how universities conduct business. Universities need to be able to convince state DOTs that innovative research will improve safety.

It would be useful for faculty and students to spend a day at a DOT, and it would be good for a department engineer to spend a day at a university. State DOTs should be comfortable with accepting new methods and ideas. They should have realistic expectations and remember that scientific breakthroughs cannot be scheduled. Universities need to understand the institutional reluctance of state DOTs to try new things, since state DOTs only want to try new things that work.

For example, the mission of the Texas A&M Transportation Institute is to solve transportation problems through research and to develop diverse human resources to meet transportation challenges of tomorrow. This mission statement provides institutional credibility and establishes a climate of acceptance at a DOT.

University faculty and researchers must be able to communicate new and esoteric ideas in a way that resonates with state DOT engineers. Examples of new concepts are safety performance functions for segments and intersections and correcting for the regression to the mean bias. These are somewhat advanced ideas from a practitioner standpoint. University faculty and researchers need to be able to communicate these concepts to practitioners in a way that resonates with their interest and responsibilities.

The accident rate is the most common measure of safety. The accident rate is the ratio of the number of accidents normalized on the basis of exposure. The computation of the accident rate is illustrated in the following equation:

$$\text{rate} = \frac{\text{number of accidents} \times 1{,}000{,}000}{\text{AADT} \times 365 \times \text{length}}$$

We can examine the application of the accident rate in an example in Colorado. Highway 119 connects Highway 6 with the town of Blackhawk. The distance along the two-lane rural mountainous alignment is 5.86 miles. The annual average daily traffic (AADT) from 1988 to 1991 was 3,000 vehicles. The average crash rate for this 4-year period was 2.28 accidents per million vehicle miles traveled (VMT). Solely on the basis of that number, we cannot determine whether the road is safe.

After gambling was introduced in Blackhawk in 1992, the AADT increased to 10,618 vehicles in that year, yet the crash rate per million VMT declined to 1.22. The average crash rate for the 1992 to 1995 period was 1.24 per million VMT, whereas before gambling was introduced in 1992, the average accident rate was 2.28 per million VMT. The highway alignment and typical cross section have not changed over the years.

After the introduction of gambling, the percentage of accidents involving alcohol in the eastbound direction (coming home after gambling) increased by 500 percent. These results might indicate that drinking and driving, in concert with gambling, is good for safety. While this is obviously not the case, if accident rates are used as a measuring device, one would have to conclude that it is. This example makes a compelling case for the need for a safety performance function.

A second example focuses on C-470, an urban freeway in the Denver metropolitan area. In 1990, there were 58 crashes on an 11-mile segment of C-470, and the AADT was 36,010 vehicles. In 2004, there were 308 crashes, and the AADT was 77,682 vehicles. Between 1990 and 2004, the AADT increased from 36,010 vehicles to 77,682 vehicles. Over the same period, the total accident rate increased by 146 percent, and the injury and fatality rate increased by 60 percent.

These two examples indicate that the different facilities are responding in different ways to the changes in congestion. Clearly, the rate is changing with AADT. To understand how the crash rate is changing, we need to develop a relationship between safety and traffic exposure. This relationship is reflected by the safety performance function.

Some of you have training in public health. Assume a young man who is 26 years old, who weighs 164 pounds, and whose blood pressure is 110 systolic and 65 diastolic. Does he have high blood pressure? Most people would say no. Now, assume a 43-year-old man who weighs 264 pounds and whose blood pressure is 180 systolic and 100 diastolic. Does he have high blood pressure? Most people would say yes.

While none of us has training in internal medicine or cardiology, we have forged a consensus rapidly and we are collectively correct.

Now assume an urban four-leg, six-lane signalized intersection that is fully actuated on every approach. Over a period of 4 years from 1997 to 2000, the mainline AADT is 51,000 vehicles and the side road AADT is 9,000 vehicles. The 4-year crash history is approximately 24 crashes a year, nine injuries a year, and no fatalities. It is difficult to assess whether this intersection is safe.

The safety performance function of an intersection can be viewed mathematically as a three-dimensional response surface, where the number of crashes per year = f(ADT mainline, ADT side road). Use of the safety performance function at this intersection shows that 18 crashes are predicted, compared with the 26 observed crashes. Clearly, we need an analytical tool to help practicing professionals assess the magnitude of the safety problem. We also need analytical tools to assess the nature of the safety problem and some form of diagnostic methodology similar to diagnostics science in medicine.

Correcting for regression to the mean bias by using the empirical Bayes (EB) method can help address these needs. The best estimate about the future is usually obtained by computing the average of past events. In road safety as well as other disciplines, the precision of this estimate can be improved by correcting it for regression to the mean bias. This phenomenon reflects the tendency of random events such as vehicle crashes to move toward the average over time. Regression to the mean bias has been long recognized and is now effectively addressed by using the EB method. The EB method increases the precision of estimation and corrects for regression to the mean bias. If we examine crash data, the spread around the mean shrinks with more years of data. Using the EB correction for regression to the mean bias allows us to obtain a better estimate of the true mean of safety performance for the individual site.

GENERAL SESSION

Actions to Improve Collaborative Capabilities in Agencies and Universities

Chris Monsere, *Portland State University*
Paul Jovanis, *Pennsylvania State University*
William Stone, *Missouri Department of Transportation*
Max Donath, *University of Minnesota*
Barbara Harsha, *Governors Highway Safety Association, presiding*

The goals of this general session were to

1. Discuss the problems that the roadway safety workforce of the future faces, the progress that has been made to date, and the role of universities in meeting roadway safety workforce needs; and
2. Provide examples of successful agency–university collaboration in areas beyond workforce development.

SUMMARY OF KEY POINTS FROM PROJECT COLLABORATION AND SYNERGY BREAKOUTS

Chris Monsere

In summarizing the discussion in the second set of breakout groups, I will highlight the general topics discussed in response to the three questions posed to the participants. I will also note possible next steps identified by some groups.

The first question focused on the roles agencies and universities play in improving traffic safety. Among the university roles identified were educating students, developing future leaders, and conducting research and analyzing data. The importance of undergraduate- and graduate-level education in the traffic safety area was noted, as was continuing education and training for the existing workforce. Participants in the breakout groups noted the role universities play as innovation generators, especially in advanced technology, and their role as the unbiased evaluator of technologies and products developed by others. Universities typically take a longer-term view of research. Universities can and do play important roles in educating the public and policy makers about traffic safety, convening forums and conferences, and facilitating dialogue between diverse stakeholders.

Among the key roles identified for agencies was deploying, applying, and operating safety measures on the roadway system. Implementing innovative ideas was noted as an agency role, with the caution that agencies are risk-averse, concerned about practical applications, and accountable to policy makers and the public for the safe operation of the roadway system. State departments of transportation (DOTs) provide data for research and help identify key research needs. They fund research and provide links to other state and local agencies.

The second topic discussed in the breakout groups focused on the skill sets needed at agencies and universities to support and advance traffic safety. In addition to their core traditional strengths in civil engineering, universities bring diverse multidisciplinary expertise in human factors, psychology, planning, computer science, statistics, and other topics. Universities can bring the resources needed to address a variety of safety issues. Many universities have outreach and education programs focusing on students from kindergarten through 12th grade. Many of them address traffic safety and teen driving.

Skill sets identified as needed within agencies included an understanding of key safety concerns, potential countermeasures, and basic analysis methods. Agency staff members have strong expertise in design and operation of the roadway system. Additional expertise in the major elements included in the *Highway Safety Manual* was suggested.

The discussions of tools and processes to achieve collaboration generated the longest list of suggestions. Relationships and leadership were noted in all the breakout groups. Building on strong working relationships, developing new partnerships, and reaching out to additional agencies and partners were suggested as process elements. The need for strong leadership within state DOTs and universities was thought to be critical for advancing traffic safety. The use of universities as extensions of agencies was discussed. In this model, universities work collaboratively with agencies to extend research activities, training, and technology transfer. The local technical assistance program (LTAP) is one example of this approach.

Other suggestions included agencies providing topics and case study examples for capstone classes. These types of courses engage students in addressing safety issues and practical solutions. Continuing education provides training for agency staff members and helps build and strengthen relationships among agency and university personnel. Conferences, workshops, and peer exchanges promote information sharing, learning, and collaboration.

Various contracting methods, including memoranda of understanding, memoranda of agreement, cooperative agreements, task orders, and project contracts, were described. The streamlining of contracting methods was discussed, along with development of joint proposals and pooled fund projects involving universities.

One possible next step was development of research and outreach efforts around safety culture issues that would involve partnerships among universities and agen-

cies. Developing a state-level sabbatical program modeled after the Federal Highway Administration (FHWA) program was identified as a possible future activity. This approach could involve faculty working in an agency for a few months and agency personnel working at a university research organization. Colocating staff members from universities and agencies is another suggestion, as well as sharing laboratories and testing facilities. Ideas for high-level commissions and boards were suggested. The Washington Traffic Safety Commission was cited as an example. These commissions can bring together the leaders from agencies and universities involved in safety. Techniques for attracting and retaining the best students were discussed.

ROAD SAFETY WORKFORCE DEVELOPMENT

Paul Jovanis

Road safety is everybody's business. Everyone in this room has an impact on road safety. I would extend the responsibility for road safety to the general public. We are all, in one way or another, responsible for safety on our roadways. We begin by teaching our kids to "look right, look left, look right, and buckle up," and it goes on from there.

My comments focus on answering three questions. What are the skills required in the road safety workforce? What is the role of universities? What are the requirements for collaboration between the universities and the state agencies?

Let me begin with an exam. Who do you think made the following comment, a novice or a safety professional? "What is needed to improve U.S. road safety is to adopt British driver licensing standards and have everyone drive on narrow British two-lane rural roads." The correct answer is a novice. Who do you think made this statement? "Road safety countermeasures do not work; changing driver behavior is the only way to improve road safety." The correct answer is a safety professional. The point of this exam is that we have come a long way, but we still have a long way to go.

In 2005, Ezra Hauer published a paper titled "The Road Ahead." He said then, "Road safety management is in transition. The transition is from action based on experience, intuition, judgment and tradition, to action based on empirical evidence, science and technology; from consideration of road safety that is tacit and qualitative, to consideration of road safety that is explicit and quantitative." So, is the past really prologue? Have we made progress? To answer these questions, we can take a trip down history lane during the first decade of this century.

In 2002, the Transportation Research Board (TRB), FHWA, the American Association of State Highway and Transportation Officials (AASHTO), and the Institute of Transportation Engineers sponsored a conference on road safety workforce needs. In 2003, the TRB Joint Subcommittee on Road Safety Workforce Development was

formed. The joint subcommittee focuses on transportation safety management, education, safety data, analysis, and evaluation. *Research Results Digest 302: Core Competencies for Highway Safety Professionals* was published in 2006. It includes the results of a university scan for highway safety professionals. The core competencies include the nature of road safety; the history and institutional settings of road safety management; origins, characteristics, and uses of crash data; contributing crash factors, countermeasure selection, and evaluation; and road safety program management.

Follow-up activities included the development of training and educational materials for the core competencies and the conduct of a TRB policy study on the issue. Learning objectives for each of the core competencies, PowerPoint presentations, an instructor's guide with scripts for each slide, and other information were developed and included in *National Cooperative Highway Research Program (NCHRP) Report 667: Model Curriculum for Highway Safety Core Competencies*. Articles, meeting results, and other materials have been documented and published since that time, and some universities began developing new courses and fine-tuning existing courses to incorporate more science of safety into their curricula.

The results of the policy study, which was championed by Jeff Paniati at FHWA, appeared in *Special Report 289: Building the Road Safety Profession in the Public Sector*, which TRB published in 2007. The report included the following findings:

1. Road safety is a major responsibility of governments at all levels.
2. Road safety management must be guided by science and a safety system perspective.
3. Road safety management requires a talented and diverse workforce.
4. Road safety professionals must possess a common body of knowledge and skills.
5. Education and training for road safety are scarce.
6. Career advancement in the road safety profession is currently limited.
7. The need for road safety professionals is growing.
8. More attention must be given to building the supply of safety professionals.

The report also provided a set of recommendations. Among them were forging a broad-based alliance to advance the road safety profession. A number of recommendations were made for championing the road safety profession on multiple fronts. One recommendation was commending and publicizing public agencies leading the way in recruiting, developing, and building a professional road safety workforce within their organizations. Promoting the methods used by such agencies to foster these outcomes was a related recommendation. Encouraging the continued development and wider use of core competency definitions to guide the education, training, and promotion of road safety professionals who are skilled in scientific methods and in pursuing safety solutions from a systems level was another.

Promoting road safety management as a distinct profession and a desirable career path and persuading public agencies, industry, and universities of the value of forming road safety education and training partnerships were other recommendations. Such partnerships can help foster demand for road safety training and education and expose road safety professionals to the methods and results of science-based safety research. Advocating support for science-based safety research was another recommendation. Taking advantage of federal workforce training funds; advocating for road safety education and training by universities, including the publicly funded research centers; and creating one or more specialized institutes were additional recommendations.

NCHRP Project 20-07, Task 290, Highway Safety Training Synthesis/Roadmap, was completed in March 2011. It identified 184 courses related to highway and roadway safety. The report concludes, however, that "training is scarce and no institution or agency offers a partial, comprehensive, or integrated highway safety training program necessary for any of the different disciplines practicing at any level within a transportation agency . . . the gaps in highway safety training are global." This conclusion indicates that we still do not have comprehensive, multidisciplinary educational curricula to train future safety leaders before they graduate. We still find ourselves mired in the need for on-the-job training regardless of educational background. This condition has profound implications for the implementation of the *Highway Safety Manual*. The Final Report for NCHRP Project 20-07, Task 290, includes recommendations for overcoming this condition. Among the recommendations are the following:

1. Generating educator packages to build training into a broader implementation plan and to develop training for trainers;
2. Incorporating *Highway Safety Manual* training in the policy development of state DOTs and other agencies to empower change;
3. Developing new positions and job descriptions for existing positions at agencies at all levels for those graduating with scientific safety training and those completing a science of safety training program;
4. Including training resources as a requirement in the scope of projects;
5. Generating a train-the-trainer program with individual training for each type of trainer from various fields of practice, state programs, and local agency programs;
6. Developing a training package for undergraduate and graduate university and college programs;
7. Developing guidance for educators and trainers on how to modify existing courses for compatibility with the *Highway Safety Manual*; and
8. Issuing a national call for a get-together of educators and trainers to launch safety as a science and discipline initiative.

The Safety Management System Subcommittee of AASHTO's Standing Committee on Highway Traffic Safety has a Working Group on Safety Data and Analysis and Workforce Development. One of the tasks included in NCHRP 20-07 was to develop an online location for posting and sharing course content to encourage the expansion of training and to minimize redundancy.

The information gathered for each of the 184 training courses can be found at the AASHTO Safety Portal: USRoadwaySafety.org. To access the information, the user is required to register on the site. On receiving a password, the user will be able to access all course information and search the site as needed. It is possible to enter new courses or to update existing courses found in the searchable tool by contacting Brent Wilhite, Traffic Safety Account Supervisor of Penna Powers Brian Haynes, at 801-487-4800 or at bwilhite@ppbh.com.

More universities are offering courses that at least touch on safety. A comprehensive, multidisciplinary curriculum is still lacking, however. The University of North Carolina has updated Road Safety 101 and is offering it in an online, self-paced webinar format. In addition, the National Highway Institute and FHWA have teamed to develop a textbook based on the core competencies.

While there is not a formal set of next steps, it is obvious from this presentation that curriculum materials are needed beyond the fundamentals of road safety. Such materials could be developed by individual universities or by a widespread collaboration. After five or six courses are developed, tested, and documented, an effort should be made to have the curriculum nationally certified. Position descriptions and requests for proposals (RFPs) should require the certificate as a condition of hire. We have been discussing the concept of a national association of road safety professionals for the past few years. Of course, no association wants the competition, and no one wants to pay another organization fee, but other countries, including Australia, England, and Canada, have accomplished this goal. It would provide an opportunity for more cross-disciplinary research, training, and collaboration.

With regard to initiatives under way in road safety education, it is clear that in the past 3 to 4 years, the level of activity has been tremendous. But we must be able to differentiate activity from accomplishment. Therefore, there is a need to determine which initiatives are effective in improving roadway safety. Finally, we need close collaboration between universities and state agencies, and beyond state DOTs. While state agencies are responsible for establishing road safety training, job positions, and promotion requirements, universities are responsible for creating the training curriculum. The training has to be made available. We all have a responsibility to remind ourselves continually that safety is everybody's business.

MISSOURI DOT: EFFORTS TO IMPROVE COLLABORATION CAPACITY IN ROADWAY SAFETY PROGRAMS WITH AGENCY–UNIVERSITY PARTNERSHIPS

William Stone

My comments focus on the responsibilities of the Research Section of the Construction and Materials Division at Missouri DOT. I will highlight our partnerships with universities in the state, other agencies, and state and national organizations. I will also describe a few research projects that are under way.

Missouri DOT has a number of research responsibilities. They include research contract administration, multistate research project coordination, management of in-house research activities, and research implementation. Missouri DOT solicits research ideas each year between January and April. The ideas are solicited within the department and from university and private researchers. Some of the statements are combined or used in conjunction with other statements to formulate the research RFPs posted as part of each year's research program.

The Missouri DOT librarian is contracted with the University of Missouri. The librarian spends 2 days a week at Missouri DOT and the remainder of the week at the Missouri Secretary of State Library Office. The librarian updates Research in Progress and Transport Research International Documentation databases and conducts literature searches. Missouri is the lead state in the pooled fund library project.

The department's Innovation Library lists all our online research publications by date, with the most recent publications first. The library website can be searched for title words, document numbers, or project numbers. Printed versions of reports are available by e-mail. More transportation-related documents are available in the Missouri DOT Transportation Library.

The department recently completed a 2-year research program that had two thrust areas. One was geotechnical research and the other was structures research. Missouri DOT, the Missouri University of Science and Technology (Missouri S&T), the University of Missouri–Columbia, and the University of Missouri–Kansas City were involved with the research. The thrust areas were developed collaboratively and executed in an agreement between the Missouri Highways and Transportation Commission and the curators of the University of Missouri.

For the FY 2012 research program, Missouri DOT considered potential research areas. After several meetings, it was determined that pavement research most effectively met the department's research needs, in collaboration with the University of Missouri–Columbia and Missouri S&T. A draft work plan is being refined, and it is anticipated that research will be initiated soon. The pavement thrust area will pursue planning and programming research and will examine technologies for understanding site conditions to determine the best treatments to use.

As I noted, research ideas may come from a variety of sources, including depart-

ment staff and university faculty and researchers. There is a short research statement form, and instructions are posted on the Missouri DOT website. A simple two-page form is used that asks for the title of the research and the goal and objective of the research. The researcher is also asked to identify project deliverables and how they will affect Missouri DOT and the citizens of Missouri. The department also asks for an estimated project cost and the duration of the research. The research statement is used to develop an RFP if the idea is selected.

The following are examples of recent research projects, initiatives, and programs with a safety-related focus:

- The work zone software enhancement project evaluated software programs. The software evaluated in the study included Quick Zone, CA4PRS, VISSIM, and a custom spreadsheet that was developed in the study. The project included a literature review, a survey of select state DOT software use, and case studies.
- The motorist assist return on investment project examined the impact of the motorist assist program. The project found that the program had reduced secondary crashes by 1,082 per year, with annual net social benefits of more than $78.2 million. The motorist assist program also saved more than $1.1 million in annual congestion costs, supported community emergency response, and resulted in safer and quicker incident response and clearance. Other benefits included reductions in emergency response resources for traveler incident management activities, freeing them for other community needs. The research study found a benefit–cost ratio of 38.25:1 for the motorist assist program.
- The dynamic message sign (DMS) evaluation research project examines the benefits of DMS deployed on rural roadways in the southeast region of Missouri. The deployments are on I-55 from St. Louis to Arkansas and I-57–US-60, which carries traffic to and from Illinois. Closed-circuit television cameras have been deployed at several locations on these roadways to assist with DMS evaluation. The real-time video from the cameras also provides a teaching opportunity.
- The smart work zone deployment initiative began as a pooled fund project in 1999. Nebraska was the lead state from FY 1999 through FY 2003. Kansas was the lead state for FY 2004. Since FY 2005, Iowa has been the lead state. Five states—Iowa, Missouri, Nebraska, Kansas, and Wisconsin—participate in the project. The objective is to test and evaluate new technologies for improving safety and traffic flow through work zones.
- Missouri DOT has been active in developing and conducting research with two university transportation centers (UTCs): the Mid-America Transportation Center, which is a regional UTC, and Missouri S&T, which is a national UTC. With the reduction in resources, it will become even more important to leverage resources for

research. Thus, we have been pleased with our UTC partnerships and look to build on what we have established.

• Strategic Highway Research Program 2 (SHRP 2) Project R-07—Performance Specifications for Rapid Renewal—is another example of leveraging resources. The project is developing performance specifications for roadway grading. As part of the project, Missouri DOT is piloting "intelligent compaction" on a construction project in the St. Louis district. We have been working directly with researchers from Iowa State University and Trauner Consulting Services, Inc. The department's involvement with this SHRP 2 project has allowed us to advance our efforts with intelligent compaction, and we are excited about the potential of this innovative technology.

• The Missouri LTAP is contracted with Missouri S&T. The Missouri LTAP hosts more than 100 training sessions per year and reaches more than 3,000 local participants. The Missouri LTAP's resource library makes various publications, videos, DVDs, and other information available to anyone needing information. It also provides a link to other library resources such as the National LTAP–Tribal Technical Assistance Program (TTAP) Clearinghouse. Personalized technical assistance is available to customers by calling 1-800-MO ROADS or e-mailing the LTAP staff. The Missouri LTAP also sponsors the Road Scholar Program. The website and newsletter for the Missouri LTAP provide an updated calendar of various events and meetings of local interest.

UNIVERSITY OF MINNESOTA'S EFFORTS TO IMPROVE UNIVERSITY–AGENCY COLLABORATION IN UTC ROADWAY SAFETY PROGRAM

Max Donath

I will talk about the relationships between UTCs, state DOTs, other agencies, and groups. In addition, I will provide a few examples of research projects at the University of Minnesota involving multiple partners, especially in the safety area.

The Intelligent Transportation Systems (ITS) Institute has a strong working relationship with Minnesota DOT and other agencies in Minnesota. We have also worked with agencies in other states and with the private sector. For example, Nissan approached us because it did not want to conduct a field operational test in Japan. Taking advantage of serendipity and leveraging is key.

The Center for Transportation Studies (CTS) serves as the single university point of entry and coordination nexus for transportation research and education at the University of Minnesota. It manages a master agreement with Minnesota DOT. Faculty, departments, and laboratories conducting research for Minnesota DOT go through CTS.

Founded in 1987, CTS serves as a catalyst for transportation innovation, advancing knowledge through research education and outreach. Strategic goals include

strengthening university expertise, championing formal education, and fostering ideas and knowledge development. Goals are initiating public and stakeholder participation and promoting applied problem solving.

The ITS Institute is the UTC within CTS. The ITS Institute was established in 1991 under the Intermodal Surface Transportation Efficiency Act of 1991 and renewed in 1997 through the Transportation Equity Act for the 21st Century and in 2005 through the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users. The theme of the ITS Institute is human-centered technology to enhance safety and mobility. The ITS Institute conducts an interdisciplinary research program. Departments involved in the institute's research program include civil engineering, computer science and engineering, electrical engineering, mechanical engineering, industrial engineering, design, psychology, law, and policy and public affairs. The institute's primary research areas focus on human performance and behavior; computing, sensing, communications, and control systems; technologies for modeling, managing, and operating transportation systems; and related social and economic policies.

The ITS Institute's focus is on reducing road fatalities and crashes by concentrating on high-risk driver populations. It conducts research related to transit, travel time, and congestion. The ITS Institute focuses on emerging technologies that are "human-centered" and that take advantage of a new expanded digital infrastructure that incorporates data from novel sensor technologies, human–machine interface design, and wireless communications. In addition, the institute focuses on research that leads to deployable solutions—research that takes solutions and ideas to the prototype stage and tests them in the real world. This type of research is expensive, and it cannot rely strictly on the faculty–student model of research.

Teenage drivers are one high-risk group. Teenage drivers are overrepresented in fatal crashes. On a national basis, teenage drivers are approximately 4.5 percent of all registered drivers, but they are involved in almost 9 percent of fatal crashes. In Minnesota, teenage drivers involved in fatal crashes are above the national average. On the basis of data from 2000 through 2006, Minnesota teenagers were among the worst drivers in the country. The Minnesota legislature approved a graduated driver's license in 2008. Data from 2009 indicated that Minnesota was still above the national average for fatal crashes involving teenage drivers as a percentage of all fatal crashes.

As Bernard Arseneau mentioned yesterday, the smartphone project, which serves as the platform for the Teen Driver Support System, was developed to help address crashes and fatalities involving teenage drivers. The idea began as the project of a master's student a number of years ago. The initial project used a laptop computer. Another graduate student built on the concept with a Windows-type operating system in an older-generation smartphone.

Full-time researchers were assigned to the project, and a full-blown Android-based smartphone system was developed. The system relies primarily on the capabilities of the teenager's smartphone for monitoring known teenage driver risk factors and certain provisional licensure provisions. A number of tools have been incorporated into the system. They include advance notification of speed limit changes and graduated speeding warning. All cell phone communication is subsumed. The system provides real-time feedback by talking to the driver to improve learning and to reduce risky driving. The system reports critical parameters back to parents via automated text messaging and a website. The system will be deployed in an operational test.

Another project, the driver assist technology—deploying bus rapid transit (BRT) along narrow road shoulders to bypass congestion—was part of the Minnesota Urban Partnership Agreement (UPA). The Minnesota partners include Minnesota DOT, the Metropolitan Council, Metro Transit, the Minnesota Valley Transit Authority (MVTA), and cities and counties. The agencies and jurisdictions were selected for the national UPA through a competitive application process.

The Minnesota UPA projects include conversion of a high-occupancy vehicle lane to a high-occupancy toll lane and addition of high-occupancy toll lanes on I-35W South, new park-and-ride lots, dual bus lanes in downtown Minneapolis, and the driver assist technology for shoulder-running buses. The ITS Institute was involved in the driver assist technology, which helps bus drivers operate in narrow bus-only shoulders. Buses are allowed to operate in the shoulders on many freeways and some arterial streets in the Minneapolis–St. Paul area during congested peak periods. Passenger complaints that operators did not make sufficient use of bus shoulders raised interest at MVTA and Metro Transit in the project. Technology from lane departure warning systems, which was used initially to address safety concerns on rural roadways, was applied to the driver assist system for urban bus routes in Minneapolis.

On the basis of rural fatalities per 100 million vehicle miles traveled, Minnesota is well below the national average. A different picture emerges on the basis of rural road fatalities as a percentage of all road fatalities, however. In this case, Minnesota is above the national average. The most significant causal factors for drivers involved in fatal crashes tend to be slightly different in rural and urban areas. Speeding; failure to keep in the proper lane; driving under the influence of alcohol, drugs, or medication; inattention; and overcorrecting or oversteering are all higher for rural fatalities on the basis of national data. Failing to stay in the proper lane is a problem in rural Minnesota, especially on two-lane roadways.

The bus driver assist technology built on a previous project that developed an augmented conformal heads-up display. By referencing the vehicle and the driver's eye position within an accurate digital map, the field of view from the driver's eye perspective can be accurately re-created. The system allows all lane boundaries and obstacles to be drawn and projected in real time on a virtual screen.

The bus driver assist system elements include a heads-up display for vision enhancement and forward collision avoidance, a graphical display for forward and side collision avoidance, steering wheel torque feedback for lane departure prevention, and a tactile seat for lane departure prevention with directional buzzing of the seat cushion. The system also includes IBEO Lux lidar for lane tracking. Audio communication cannot be used on buses because passengers could hear the suggestions. The system works well, with a total of 10 MVTA buses equipped with the driver assist system operating in regularly scheduled service.

A number of economic benefits may be realized from the use of bus-only shoulder BRT, especially in comparing capital costs with light rail transit and other BRT systems. The capital costs of light rail transit projects vary from $15 million to $100 million per mile, with an average cost per mile of approximately $46 million. The capital costs of BRT are lower, ranging from $2.5 million to $2.9 million per mile in mixed flow with general traffic, excluding any cost associated with acquiring the right-of-way. The capital costs of bus-only shoulder BRT in the Minneapolis–St. Paul area range from as little as $1,500 to $200,000 per mile. Other benefits include maximizing the road capacity of regular lanes and improving transit travel times and reliability.

We worked with the Alaska Department of Transportation and Public Facilities on a project that used similar technologies. We deployed the differential Global Positioning System (GPS)–based driver assist systems on snowplows, airport rescue, and firefighting vehicles at Deadhorse Airport in Alaska. The system was also used on two snowplows in Polk County, Minnesota. We have operational data from these and other deployments since 2004. These data were important in documenting the system for insurance purposes. The information was critical for MVTA's operator's insurance company to agree to cover the bus driver assist system.

A key element with the driver assist systems is accurate data on the roadway lane boundaries. At present we use our own lane boundary digitizing capability. We examined Minnesota DOT's paint striping machine to determine whether we could add high-accuracy differential GPS to lane stripers. With our technology, it is possible to develop a lane boundary digital map that can lead to more efficient lane striping and new lane departure warning systems. We have also examined video logging vehicles, which are operated by most state DOTs.

The FHWA Office of Safety has developed a model inventory of roadway elements (MIRE). It includes a recommended listing of roadway inventory and traffic elements critical to safety management and provides guidelines to help transportation agencies improve their roadway and traffic data inventories. MIRE provides a basis for a robust data inventory and helps agencies move toward the use of performance measures. The need for improved and more robust safety data is increasing because of the development of a new generation of safety data analysis tools and methods. We

believe that our high-accuracy maps and geospatial database can be integrated with MIRE.

Another example of a partnership is the accessible pedestrian signal (APS). A number of years ago, when current Minnesota DOT Commissioner Tom Sorel was the FHWA Minnesota Division Administrator, he noted the problem with maintaining APSs, as required by the Americans with Disabilities Act. There was interest in working with the low-vision community to address the issue.

Numerous challenges are associated with visually impaired individuals crossing at signalized intersections. Examples of challenges include knowing the intersection geometry, locating the edge of the street and the crosswalk, and interpreting the signal and traffic patterns. Other challenges are aligning toward the crosswalk; locating the push button, if one exists; determining when to cross; and maintaining the alignment while crossing.

We considered how to use data available from signal controllers and other sources to address some of these challenges and examined available technologies. A major concern with APSs is the cost, which is approximately $6,000 per intersection plus labor. Maintenance costs are also significant, especially in winter weather. APSs are noisy; they add 5 decibels of noise within 6 to 12 feet of the push buttons. They require an additional sidewalk stub and push-button station poles. Furthermore, there is no standard push-button location.

The ITS Institute conducted research to develop a mobile APS prototype. The system integrates GPS, a digital compass, accelerometer sensors, and a digital map on a smartphone. It allows wireless communication with a traffic signal controller. It includes Bluetooth geo-ID to correct the GPS location at an intersection. A user can obtain text for speech information by single- or double-tapping on a smartphone screen. We hope to move toward deployment with the system.

We are examining how ITS can support the end-to-end emergency response process. ITS can provide information that can be used at the point of care as well as in guiding traffic safety analysis and improvements. A number of technologies may assist in enhancing emergency medical services (EMS). They include advanced automatic collision avoidance systems, computer-aided dispatching, GPS, automated vehicle location, and geographic information systems. Technologies at hospitals and trauma centers include patient care records, hospital availability and diversion systems, and patient tracking systems.

A major gap in the current system is the information exchange from first responders to the trauma center or emergency room (ER) physicians. ER physicians want information about the condition and the injuries of the victims to identify what will be needed on arrival.

We have developed a CrashHelp system prototype to address this need. The system includes components for first responders and physicians at a trauma center or an

ER. A Google Android-compatible smartphone application is used for EMS personnel in the field, and a web-based interface is used for ER and trauma center personnel. The smartphone application allows for secure transmittal of voice, video, and data from a crash site to the ER. The system provides for recording and transmitting audio messages on vital signs, origin of an incident, treatments given, and other information. Pictures and video can also be transmitted.

A pilot test and evaluation of the CrashHelp system are under way in Idaho. We plan to initiate a second pilot test and evaluation in Minnesota. Evaluation metrics include improved information collection by on-scene EMS personnel and improved communication between EMS and ER personnel. Other evaluation metrics are improved care decision making by hospital personnel for some incidents and improved resource utilization by hospital personnel.

Moving university research to deployment prototypes and commercialization is a complex process. There is a big difference between a research project conducted by a master's or PhD student and research that develops a prototype for field-testing and evaluation. Wider deployment and commercialization are even bigger steps. Full-time researchers, intellectual property experts, lawyers, and other personnel are needed to move research products into prototyping and deployment.

Examples of issues and challenges include funding for statewide and national prototype testing and venture capital for start-up companies. Risk management is a concern throughout the process. Marketing to technology-deploying organizations, such as state DOTs, transit agencies, driver and vehicle licensing agencies, and insurance companies, is important, as is marketing to identify companies seeking new products. The identification of prospective CEOs who can build start-up companies is another challenge. There are unique problems in the transportation field compared with the medical field, where the return on investment is high. A firewall between research design, testing, and the licensee is needed to prevent conflicts of interest. Development of conflict-of-interest policies is also necessary. Finally, we do not want researchers to leave and to join the start-up company. As an example, the University of Minnesota's Office of Technology Commercialization recently signed a licensing agreement with a start-up company to develop the systematic monitoring of arterial road traffic signal technologies.

The ITS Institute has a number of educational initiatives. Among them are grade K–12 outreach activities and curriculum development to support transportation education. The National Summer Transportation Institute at the University of Minnesota College of Science and Engineering Summer Camps are other efforts. We have developed a career video, which is available at http://www.its.umn.edu/Education/careers/video/.

We have also developed games to attract high school students to ITS and transportation. Gridlock Buster is a web-based traffic control game and curriculum. It has had more than 3 million hits online and teaches high school students about traffic

engineering. It is available for downloading for classes and summer camps. It can be found at http://www.its.umn.edu/GridlockBuster/game/index.html. We recently finished a second game, called Distraction Dodger. The game involves a pizza delivery truck in which the driver encounters obstacles and distractions along a route. It is available at http://www.its.umn.edu/DistractionDodger/game/.

GENERAL SESSION

Priorities for Moving Forward

Shauna Hallmark, *Iowa State University*
Karen K. Dixon, *Oregon State University*
Bernard J. Arseneau, *Minnesota Department of Transportation*
Robert C. Johns, *Research and Innovative Technology Administration*
Daniel S. Turner, *University of Alabama, presiding*

SUMMARY OF KEY POINTS ON RESEARCH DIRECTIONS BREAKOUT

Shauna Hallmark

I appreciate the opportunity to summarize the results from the third set of breakout sessions on moving forward and research directions. The groups discussed key issues, opportunities, and challenges and identified potential research topics and directions.

Training and education on traffic safety at all levels were identified as important needs. Education should begin with grades K–12 and continue in university courses. Community colleges and trade schools have roles to play in roadway safety education and training. Providing ongoing training to agency personnel is important. Ensuring that training activities are appropriate for the target audience, that they are well timed, and that they provide efficient use of time is critical.

Opportunities for improving existing training and education and for undertaking new activities were identified. Leveraging training with the Transportation Research Board (TRB), the Institute of Transportation Engineers (ITE), the American Society of Civil Engineers (ASCE), and the National Society of Professional Engineers was suggested. The training could include reviews of success stories. Better integration of traffic safety into university curricula is one opportunity. Establishing a certification for safety engineering similar to ITE's professional traffic operations engineer (PTOE) was suggested. This effort could use Safety 101 and the *Highway Safety Manual*. Training of frontline personnel was noted. Development of training manuals that include case studies for personnel that are directly applicable to their daily work activities would be beneficial.

Possible barriers to these activities include obtaining the resources to develop and deliver courses, training, and other activities. The success of these efforts depends to some extent on the job market in traffic safety. At the university level, there may be constraints on changing the curriculum and on adding new courses.

Agencies may have a culture of focusing on solving immediate problems. This short-term view may limit the undertaking of long-term research that will lead to major solutions. Among the approaches to addressing the short-term focus are estab-

lishing research advisory councils, finding political champions, and including implementation elements in research proposals and projects. More rapid deployment of research results leads to more opportunities for research.

The championing of the safety cause by multiple voices was noted as both good and bad. Making the need for traffic safety improvements personal was discussed as a strategy. Taking greater advantage of social norming to promote traffic safety was suggested as an opportunity, as was enlisting influential champions. The *Highway Safety Manual* may provide a mechanism for finding the multiple voices needed to advance traffic safety. Universities can conduct public outreach and education activities. Traffic safety competes with other priorities for limited resources. As a result, having a unified message on the importance of reducing crashes and fatalities is key.

Remembering that traffic safety is a continuum is important. Ongoing improvements, public education, and outreach are needed. We must stay vigilant to emerging safety issues in addition to addressing known problems.

The potential of systemwide deployment of safety countermeasures to desensitize drivers at extreme locations was discussed. Developing best management practices, including practical design documents, was suggested as an opportunity to improve understanding of the impacts of widespread deployment of countermeasures.

Better understanding of how human factors and physics concepts can be merged to address traffic safety was discussed. More research focused on the interaction of drivers and the roadway would be beneficial, including the use of driving simulators and consideration of methods for incorporating safety and exposure levels into the design criteria process. It was suggested that the university transportation center (UTC) process can facilitate the merging of these concepts.

Communication was a theme throughout the conference. The need to communicate the importance of traffic safety and a wide range of safety needs to policy makers and the public was noted. Improving and maintaining communication with all the appropriate stakeholders were highlighted by participants, including communicating the importance of safety-driven policies. Documenting case studies, such as the Minnesota Toward Zero Deaths (TZD) initiative, was suggested. Involving all stakeholder groups, including the medical community, and creating a sense of urgency were discussed. Connecting to the United Nations Decade of Action initiative was suggested.

Contractual and administrative impediments were identified as concerns. These issues can be overcome by universities and state departments of transportation (DOTs) working together to identify and resolve any contractual issues. Sharing noteworthy practices among agencies and universities would be beneficial. Conflicting processes between the federal agencies and requirements for addressing human subjects research, including university institutional review boards, were noted as barriers.

It was suggested that perceived ethics issues and resource issues can restrict travel and participation in national conferences and workshops for agency and university

personnel. For example, many state DOTs have limited budgets for travel to meetings and conferences. Developing pilot programs to overcome the funding, conflict-of-interest, and ethics barriers was suggested, as was developing information about the nature of these barriers.

The importance of educating the public about the TZD initiative was noted. Targeting programs for grades K–12 was suggested, as was developing and implementing ongoing public awareness programs.

The process for establishing trust and partnerships is a concern. Approaches to addressing this concern include development of guidelines for partnerships to foster trust, documentation of best practices for actual or imagined ideal partnerships, and identification of characteristics of successful partnerships. A peer exchange program with university faculty during the summer was also suggested.

Participants suggested that traffic safety could be used as a leverage point for university and agency partnerships. Development of a shared safety culture among agency and university personnel would be beneficial. Inventorying and marketing university skills and facilities, determining methods for measuring and growing safety cultures, collaborating, and using an interdisciplinary system definition of safety could help in promoting such a shared culture. Another suggestion was a National Cooperative Highway Research Program project to develop a model for a safety conference or workshop on establishing and maintaining safety cultures throughout state DOTs.

A number of topics for further research were identified. Examples of research needs included identifying and analyzing behavioral crash modification factors and adjusting such factors for regional differences and temporal changes, such as fleet and driver behaviors. The following are other topics for further research:

- Developing and calibrating safety performance functions for state levels and implementing and evaluating elements from the *Highway Safety Manual*;
- Developing methodologies for diagnostic assessments, including human factors issues;
- Developing safety simulation models;
- Developing safety performance measurement and management approaches;
- Examining pavement friction, pavement conditions, and safety prediction;
- Examining the interaction of drivers, vehicles, and the roadway;
- Developing guidelines for in-car driver–vehicle interfaces for emerging technologies;
- Assessing safety applications of predictive traveler information; and
- Identifying what information should be communicated to drivers and how and when to deliver it to optimize safety.

A number of suggestions were made for webinars, meetings, workshops, and conferences. One was to sponsor a meeting between federal agencies, state DOTs, other agencies, and universities to discuss an overall research agenda focused on the TZD initiative. A second was to conduct periodic updates through webinars on traffic safety issues, TZD, research projects, and related activities. A third was to implement peer assistance for lead states mentoring other states needing to accelerate safety efforts. Such peer assistance could take numerous forms, including site visits, webinars, and meetings. A final suggestion was to establish a certification program in safety for agencies and deliver it through distance learning. The ITE PTOE could serve as a model for this effort.

ACTIONS FOR UNIVERSITIES TO IMPROVE COLLABORATION

Karen K. Dixon

My comments focus on the opportunities for universities to enhance collaboration with other professionals, agencies, private-sector groups, and the public to address transportation safety. As other speakers have noted, everyone needs to know about and understand safety. My comments address education and outreach, including both systematic and individual outreach.

A number of good suggestions were made concerning safety education and outreach during the conference. I thank the breakout group participants for their great ideas, many of which I have tried to capture in this presentation.

One of the opportunities at the university level is enhancing existing undergraduate transportation courses. We need to make sure that students in civil engineering and other fields have an understanding of transportation safety. We need to develop safety modules for undergraduate courses and share them with colleagues at other universities. These modules, which should address the fundamentals of safety, could be added to existing undergraduate transportation courses. This approach would provide a better-educated workforce with an understanding of key safety components.

Many universities are reducing the number of credit hours for various majors, including civil engineering, so safety content should be integrated into existing classes where possible. At Oregon State University, this change is being driven by the ASCE initiative for the master's degree as the terminal degree for civil engineering students.

As an Accreditation Board for Engineering and Technology–approved university, we are required to develop learning objectives and document how the objectives are being met. I think that we should share the safety-related learning objectives with other professors and other universities to help them develop safety modules and courses. Sharing course materials, including handouts, interactive or flash graphics, and case study examples, would be beneficial.

We need to expand graduate-level transportation courses that address safety. Developing a series of courses emphasizing safety may be possible at some universities. I currently teach a two-course series on transportation safety. We should be sharing

our courses with other universities. Developing course materials and texts for staff members and exploring distance learning courses, which could address initial student density issues, are other activities.

There was a train-the-trainer session earlier this year for the *Highway Safety Manual*. The session was well attended by both faculty and state agency transportation professionals. After the session, many of the faculty discussed approaches for improving the focus on safety in the university environment. One suggestion, which we are moving forward on, is to initiate a joint task force on education among the various TRB safety committees. We have a core group of volunteers, and we have begun dialogues with the education and safety committees.

There are other education collaboration opportunities. Among them are inviting professionals to give classroom lectures and exercises and developing site visits so students can interact with the professional community. I use safety professionals, including a crash reconstructionist, as guest speakers in my classes. Another opportunity is developing and teaching continuing education classes for professionals. The classes can provide information on safety strategies, the science of safety, and related topics. The *Highway Safety Manual* and Safety 101 courses could form the basis of such continuing education classes. We need to seek K–12 outreach opportunities. One example is developing safety-focused activities for science camps. A colleague is working with ASCE to introduce a safety concept video similar to the steel bridge competition. The safety video competition would be based on a selected topic or theme.

Research and outreach are other opportunities for advancing safety. Facilitating research idea forums for agencies and universities is one mechanism. Such forums promote better understanding of the needs, capabilities, expertise, and roles of university faculty and agency personnel. They seek colleagues within different departments and with other universities. They provide opportunities for working with other universities and UTCs to develop collaborations and to help new professors build specialties and contacts.

Reaching out to other departments to involve diverse disciplines in safety research and teaching is important. Reaching out to faculty at other universities is beneficial. The safety community is small. Mentoring new faculty with an interest in safety will help build a larger group of researchers and educators.

"Taking your sponsor or researcher to work day" is a great way for agency staff and faculty to improve their understanding of each other and the nature and constraints of different jobs. It provides opportunities to review research projects and test sites and to discuss future projects.

University professors and researchers should learn to provide usable products. Writing for the target audience is important. Do not use complex equations in reports, and minimize statistical "lingo." Develop two- to three-page technical bulletins that

convey key research findings. Publish the results in ways that will address the needs of the sponsor and the needs of the professor. Faculty need to publish in academic journals for tenure and promotion. They can also publish in more applied journals to help promote safety among a wide audience. Presenting research at conferences, meetings, and technical workshops can be targeted toward both applied and academic audiences.

Among other opportunities for faculty are developing and participating in a safety seminar series and joining and participating in safety efforts such as TRB committees. Readiness to communicate, share ideas, and seek opportunities is important. Reaching out to students in grades K–12 by developing safety-themed learning activities for new and ongoing science and engineering camps is another opportunity. Developing and participating in train-the-trainer activities for safety are other opportunities. Safety needs to belong to more than just the safety experts. Safety needs to belong to designers, operators, maintenance personnel, planners, and policy analysts. We need to find methods for engaging all of these groups.

I will close by highlighting a few essential elements of successful research collaboration. One key is to improve the sponsor's understanding of the demands on faculty, which include the timing of project, funding levels, tuition for students, and the final products. A second is to improve the faculty researcher's understanding of the demands on the sponsor's representative, which include the timing and deployment of research. Each group needs to understand the priorities, responsibilities, demands, limitations, and opportunities of the other partners.

My final point is that we need to close the loop by engaging safety professionals at all levels, including health, emergency medical services, DOT, city, advocates, universities, and citizens. Seeking ways to determine not only what we need from our partners to improve safety but also finding out what they need from us is important. Ongoing communication is critical. We can begin today.

ACTIONS FOR TRANSPORTATION AGENCIES TO IMPROVE COLLABORATION

Bernard J. Arseneau

I want to build on a few of the points Karen Dixon made, as well as comments from the speakers and participants during the conference. I also want to conclude with a charge for follow-up activities.

We are all connected to the transportation system, which provides mobility and access to jobs and schools and enhances our quality of life. Transportation is the backbone of healthy, economically viable, and livable communities. Safety is a key element of the transportation system. We do not want people to be killed or injured on the roadway system.

Implementing safety strategies is a key part of operating a safe roadway system.

Numerous safety strategies can be used to address different situations, issues, and needs. Some states are more aggressive than others in implementing safety strategies. The university and state agency partnership can assist in evaluating the effectiveness of safety strategies and in identifying and developing innovative safety strategies. Exploring innovative strategies through research partnerships is important in making the roadway system safer.

While we continue to implement established safety strategies, we know that additional strategies will be needed to reach the goal of zero fatalities. The university and state agency partnership plays a key role in developing innovative safety strategies. As I said yesterday, I think we can reach the goal of zero deaths. The university and agency partnerships are key in examining all aspects of safety—roadway treatments, human factors, vehicle design, and public policies. This partnership is even more critical in a time of limited resources.

We need to improve understanding of the needs of universities and agencies to nurture these relationships and to meet our goals. We need to acknowledge that we both value research but that we have different perspectives toward research. University researchers want to explore innovative and far-reaching strategies that probably will not pay off in 1 to 5 years. They may have long-term benefits, however. State agencies are focused on strategies that will provide benefits today and in the near future. We also realize the need to examine longer-term strategies and solutions. At the same time, university researchers need to understand the needs and priorities of state agencies, including the daily operation of the roadway system. The short- and long-term needs overlap, and both groups can benefit from ongoing communication and coordination.

The key areas of safety have been discussed during this conference. They include infrastructure, design, human behavior, enforcement, education, emergency medical services, and vehicles. We need to continue to explore connected vehicle research today, although its benefits may be longer term. We had a good discussion in our breakout group about the driver and vehicle interface. Automobile manufacturers are bringing more technologies into vehicles in ways that enhance safety. Universities are actively involved in research on how best to incorporate technology into vehicles and how best to present information to drivers so that they are not overloaded or distracted.

We need to work together to test and evaluate safety technologies and strategies. There are numerous opportunities for partnerships between agencies and universities to improve safety of the roadway system. One of the biggest barriers we have had is our idea of what the solution may be. We cannot enter the partnership with a known outcome in mind. We must have our eyes open and explore innovative approaches and strategies. We need to grow the partnership through collaboration.

The time to move ahead is now. We face limited resources, but we cannot let this issue stop us. We can move forward through collaboration. We need to be willing to

contribute but not own the problem or the solution. Collaboration focuses on contributing, not owning.

We all need to be committed to working together to improve transportation safety. There is no question that everyone in this room is committed. We need to return to our agencies, universities, and other groups and reach out beyond our normal networks to increase the number of people involved in improving roadway safety.

We discussed developing a mentor–mentee partnership in our breakout group. The mentors would be states where all groups are working together to advance safety strategies. The mentees would be the states needing help in either getting started or in moving initial activities further along. The focus would be similar to that of a peer review but would be more of a long-term relationship among all stakeholders in both states to advance transportation safety. At Minnesota DOT, we stand ready, with our university partners, to be a mentor state and to help initiate an ongoing effort.

The concept of building the safety solution at the ground floor was discussed in our breakout group. The friction factor on a road is one example of this concept, since it provides a better pavement and a better infrastructure. If we do not consider the friction factor when we are building a road, we are missing an opportunity to build safety in at the ground floor. This concept holds for all types of safety strategies.

There are clearly many differences across the country. There are different levels of drunk driving and seat belt use; there are different interests, needs, and issues; and there are different geographies and terrain. We need consistency in the safety framework and approach, but we also need to allow individual states to develop packages of safety strategies that best address their issues.

By working together, we can accomplish significant improvements in transportation safety. We need to take what we have learned at this conference and continue to seek opportunities to move toward zero deaths.

FEDERAL PERSPECTIVE ON NEXT STEPS FOR IMPROVING ROADWAY SAFETY PROGRAMS IN A UNIVERSITY–AGENCY PARTNERSHIP FRAMEWORK

Robert C. Johns

This conference has been excellent. I appreciate the opportunity to recap some of the highlights from the speakers and breakout sessions and to offer a few observations on the discussions. I will close by emphasizing the importance of this topic and follow-up activities.

The conference planning committee did a great job of organizing the conference schedule, speakers, and breakout session topics. The opening session featuring John Porcari and Greg Winfree established the importance of safety and set the stage for the conference. The priority of safety at U.S. DOT was reflected by their participa-

tion. Deputy Secretary Porcari is committed to safety, and he is knowledgeable about safety culture, the TZD programs, and the use of intelligent transportation systems and other technologies to improve safety.

Bernie Arseneau made the point in the opening session that state and federal agencies, universities, and other groups have never been more aligned to address roadway safety. He emphasized the opportunities available today and presented examples of successful safety partnerships under way in Minnesota. These efforts have resulted in lowering the number of fatalities on roads in the state. Steve Albert highlighted the progress in agency–UTC relationships but noted that more work needs to be done. He emphasized the need to improve the link between university and federal safety research initiatives.

The session on collaboration to enhance new safety tools and techniques highlighted the potential and the challenges of safety research and the implementation of safety strategies. John Milton suggested that agencies and universities are the perfect combination for addressing roadway safety. These are words you may not have heard 10 years ago. He emphasized the movement toward scientific methods and technologies to address critical safety problems. Monique Evans described the Federal Highway Administration's (FHWA's) Office of Safety R&D programs and activities. She emphasized safety partnerships with universities, including the temporary assignments of university researchers and faculty, contract research opportunities, training efforts, and advanced research and commercialization. Denise Osborn provided a perspective of a nontraditional safety partner. She highlighted the need to focus on behavioral, cultural, and institutional aspects to improve safety. Jake Kononov provided a summary of the main points discussed in the breakout session on successful agency–UTC partnerships. He highlighted common goals and common understanding of the roles of agencies and universities. He noted the need to pursue research partnerships between universities and agencies.

The poster session highlighted recent research, agency programs, and other activities. Discussions with poster authors illustrated the wide range of safety research under way throughout the country and let participants interact and share experiences.

The session on improving collaboration capabilities in agencies and universities demonstrated how collaboration is critical for reaching safety goals. Chris Monsere highlighted the key points from the breakout groups on collaborative efforts for new tools and techniques. Topics discussed included the roles of agencies and universities, the needed skills set of safety transportation professionals, and available tools. Among suggestions for future activities were use of sabbaticals to engage faculty in on-site research, development and use of common laboratories, cooperative boards and committees, and a focus on students.

Paul Jovanis provided an excellent example of collaboration involving TRB, the American Association of State Highway and Transportation Officials, FHWA, and other groups in the development of a safety curriculum. His presentation highlighted

the role TRB plays in facilitating discussions and projects and in helping to develop partnerships. Rick Pain of TRB has done a great job of bringing diverse groups together and advancing needed research. Paul noted the National Cooperative Highway Research Program projects, special studies, and new and updated curriculum and training programs conducted through these efforts.

Bill Stone reminded us of the importance of research administration. If TRB is a facilitator and coordinator of safety research at a national level, the research administration office within a state DOT plays the same role at the state level. He described working with universities to identify research needs and to collaborate on solving problems. He also noted Missouri DOT's 2-year commitment to research thrust areas and their active involvement with universities in the state during the UTC recompetition.

Max Donath described diverse advanced technology projects and working relationships with numerous sponsors at the University of Minnesota as part of Minnesota's TZD program. He emphasized moving beyond research to development of prototypes and deployment strategies. He emphasized the importance of educating students in grades K–12, as well as university students, with examples of web-based games.

In this closing session, Shauna Hallmark summarized the breakout discussions on research directions. Karen Dixon summarized ideas for enhancing collaboration at universities, and Bernie Arseneau presented ideas for enhancing collaboration at agencies. I will close by providing eight observations and perspectives from my experience in working at Minnesota DOT and at the University of Minnesota Center for Transportation Studies, as well as at the U.S. DOT Volpe Center.

My first observation is that we have moved to the next level of addressing safety. Much more sophisticated efforts are under way, with a focus on a safety culture, new scientific approaches, technology, multiagency and multigroup partnerships, and education at all levels.

Second, there is a much better understanding of the differences between universities and agencies and how they can be complementary, with more acceptance of the creative tension that results from bringing two different cultures together. We have come a long way since the early years of the UTCs.

Third, we cannot rest on the progress that has been made in safety and in our partnerships. There are problems to be addressed. We are in a challenging time with limited budgets and limited resources, and cultural forces within agencies and universities can impede partnerships.

Fourth, the role of TRB as a change agent is critical. This role needs to be recognized, supported, and accelerated.

Fifth, there is a much better awareness and appreciation for the role universities play in providing an educated workforce and developing student understanding of safety issues and strategies. However, a better understanding of the important role

research plays in undergraduate and graduate education is needed. More transportation research programs need to provide these opportunities beyond the UTC program.

Sixth, deployment is important, but we need to realize that it is difficult for universities. Developing a prototype or helping deploy a new technology or program typically does not benefit faculty in the tenure and promotion process. Universities are recently focusing more on technology transfer and commercial licensing, but partnerships with the public and private sectors are also needed to help bring products developed through research to implementation.

Seventh, the UTC program needs to mature and be institutionalized. I am not involved in the current recompetition; however, I have been involved in UTC planning and leadership in the past. I hope we can evolve to a UTC program that is less controversial and more stable. The local technical assistance program is a good example of a program that has been institutionalized. A strong UTC program is needed for the safety partnership and successes we have discussed at the conference to continue.

Finally, this is an important conference. It reminds me of a quote from Margaret Mead to "never underestimate how a small band of committed people can change the world." You attended this conference to learn more about and to promote agency and university partnerships to advance safety. Numerous ideas were discussed in the breakout groups for enhancing these partnerships, improving collaboration, and promoting additional safety-related research. The energy and commitment at this conference are a catalyst for the next steps in improving transportation safety.

Thank you for participating in this important conference. I thank Dan Turner and the conference planning committee for the great job they did in organizing this conference. I also recognize Curt Tompkins, who recently retired from the Research and Innovative Technology Administration and who was instrumental in supporting this conference and other TRB–UTC spotlight conferences. Tom Palmerlee of TRB also deserves a great deal of credit for the success of the conference. Thank you again for your active and enthusiastic participation, contributions, and suggestions. Your efforts will have a positive impact.

Summary of Breakout Sessions

Katherine F. Turnbull, *Texas A&M Transportation Institute, Rapporteur*

The conference included a breakout session after each of the three general sessions. The breakout sessions allowed participants to build on the general session presentations and discuss actions, activities, and research to make agency–university partnerships more effective in improving roadway safety. Participants were randomly assigned to a group for the breakout sessions and remained with the same group for all three sessions. Each breakout group had two leaders, with one serving as the moderator and the other serving as the recorder. One of the leaders was from the conference planning committee. The following individuals served as breakout session leaders—Group 1: Leanna Depue, Missouri Department of Transportation, and Benjamin H. Cottrell, Virginia Department of Transportation; Group 2: Karen K. Dixon, Oregon State University, and Jake Kononov, Colorado Department of Transportation; Group 3: Barbara Harsha, Governors Highway Safety Association, and Denise Osborn, Attorney, Public Health Consultant; and Group 4: Nicholas Ward, Western Transportation Institute, Montana State University, and Shauna Hallmark, Iowa State University.

The three general topics discussed in the breakout sessions were keys to successful agency and university transportation center (UTC) partnerships, methods to enhance project collaboration and synergy, and approaches for moving forward and research directions. Additional questions were provided for each of the breakout sessions to help focus the discussion. The leaders recorded the comments and suggestions made by participants and summarized the key elements at the end of each session.

During the next general session, breakout group discussions were summarized by a member of the conference planning group. The more detailed notes from each group were provided to the rapporteur. A number of themes emerged from the discussions in the breakout groups. As summarized in this section, the themes focus on keys to successful partnerships, approaches for enhancing collaboration, and research needs and outreach activities. The following summaries of these themes should not be construed as reflecting a consensus of the planning committee, the conference participants, the Transportation Research Board (TRB), or the National Research Council.

KEYS TO A SUCCESSFUL PARTNERSHIP AND UTC PARTNERSHIPS

The first breakout session focused on the roles of agencies and universities, the different perspectives and goals of agencies and universities, potential challenges and opportunities in agency–university partnerships, and keys to successful agency–univer-

sity partnerships. Participants provided examples of mutually beneficial and enduring partnerships and discussed issues and methods for overcoming concerns. The following themes emerged from the breakout groups on these topics:

- State departments of transportation and other public agencies have a number of roles associated with improving traffic safety. State departments of transportation are directly accountable for the safe operation of state roadways. Agency roles include deploying and operating roadway safety measures; adopting and implementing safety-related policies; and promoting safe driving, bicycling, and walking practices. Supporting and collaborating on safety research at universities and implementing research results were noted as important agency roles. Furthermore, agencies may lead major roadway safety initiatives, such as Toward Zero Deaths (TZD) programs, and collaborate with other agencies, organizations, and universities on safety efforts.
- A number of roles were identified for universities and UTCs related to roadway safety. The roles focus on educating students, providing ongoing training, conducting research, transferring technology, and commercializing research products. Educating the next generation of traffic safety professionals is a key university role. The importance of ensuring that undergraduate and graduate courses address the major safety-related topics and prepare students for the challenges they will face as transportation professionals was noted. Providing ongoing training and continuing education for the existing workforce was identified as a key role for universities, as well as for junior colleges and trade schools. Universities conduct research on all aspects of traffic safety. Among them are design, pavements, operations, human factors, distracted driving, advanced technologies, and market research. Universities typically have laboratories and other facilities that can be used in safety-related research. Universities can bring together experts from multiple disciplines and departments to address issues in new and emerging areas. The roles of universities as innovation generators, idea and product incubators, product commercializers, and unbiased evaluators of technologies and products developed by others were noted. Universities help by educating the public and policy makers through forums and conferences, by facilitating dialogues among diverse stakeholders, and by raising the awareness of critical traffic safety issues. University faculty and researchers may also act as facilitators to bring diverse groups together, provide the institutional memory on projects and programs, leverage nontraditional funding, and lead outreach efforts with new groups.
- Agencies and universities have different goals, perspectives, and cultures. Agencies' goals focus on the safe operation of the roadway system. Agencies tend to focus on the current situation, immediate needs, and short-term practical solutions to critical issues. Many participants noted that agencies tend to have a risk-averse culture, while universities have a longer-term view and vision. Universities are interested in innovative approaches that may involve risk. University faculty need to publish

research results in peer-reviewed journals as part of the tenure and promotion process. University faculty also need to support and involve undergraduate and graduate students on research projects. Faculty may have limited time for research during the academic school year and may focus on their research during the summer months. University research institutions typically have full-time researchers who can respond quickly to agency needs.

- Participants identified examples of successful agency–university partnerships associated with roadway safety. Many of these examples were discussed in the general sessions and in the poster session. Many participants suggested that agency–university partnerships were excellent for advancing traffic safety.
- Individual participants identified a number of keys to successful agency–university partnerships. Among them were understanding the roles and needs of both groups, developing and maintaining trust, delivering on promises and meeting commitments, and focusing on common goals. The support of top leadership was identified as a key to successful partnerships. A number of possible contracting mechanisms were identified. They included contracts, project agreements, task orders, memoranda of understanding, memoranda of agreement, cooperative agreements, grants, pooled fund studies, and other methods. Developing joint proposals is another approach. Temporary personnel assignments, student internships, faculty sabbaticals, and agency personnel on loan to universities or on leave obtaining advanced degrees are further approaches. Streamlining contracting methods and providing stable funding were suggested as important elements of viable agency–university partnerships. Identifying and securing ongoing funding were noted as challenges for both agencies and universities.

METHODS FOR ENHANCING PROJECT COLLABORATION AND SYNERGY

The second breakout session focused on enhancing project collaboration and synergy between agencies and universities. Participants discussed key traffic safety stakeholders, the roles of various stakeholders in addressing traffic safety, skill sets needed in agencies and universities to address critical traffic safety issues, and tools and processes to promote collaboration and synergy. The following themes emerged from the breakout group discussions.

- Participants identified a wide range of stakeholders associated with improving traffic safety. In addition to state departments of transportation and other agencies responsible for operating elements of the transportation system, stakeholders included law enforcement agencies, emergency medical services personnel and first responders, policy makers, state and local agencies, hospitals, the medical and public health communities, and K–12 schools. Among other stakeholders were insurance companies, automobile manufacturers, rental car companies, unions, trade associa-

tions, private businesses, the military, trucking firms, the alcohol industry, and the electronic media industry. Many participants noted that while involving all the appropriate stakeholders is important, some groups may play more critical or dominant roles than others. The importance of traffic safety initiatives being inclusive rather than exclusive was noted, as was the need to focus on the benefits to all groups and to share ownership. Determining the appropriate roles, activities, and contributions for the various stakeholders is critical.

- Participants discussed the skill sets needed at agencies and universities for advancing traffic safety. Engineering remains a core skill set, but professionals with expertise in human factors, public policy, planning, psychology, statistics, computer science, advanced technologies, medicine, emergency response, communication, and other disciplines are needed.
- Participants identified numerous tools and processes for promoting collaboration. These suggestions built on the keys to successful partnerships described previously. Leadership support within all groups is a critical factor in advancing traffic safety. Building on existing relationships and developing partnerships with new agencies and groups are important. The local technical assistance program was highlighted as a model of a successful approach for ongoing training and collaboration. Other suggestions were establishing test beds for developing new technologies and creating leadership committees composed of high-level community and business leaders, multiagency working groups, and community and state-level marketing campaigns. Outreach efforts for teenage drivers and children were suggested, including expos, online interactive games, field visits, and safety-related contests. The importance of working across agency silos, as well as silos within agencies, was noted.

MOVING FORWARD AND RESEARCH DIRECTIONS

The third breakout session focused on identifying critical issues in traffic safety, discussing the scope of these issues, and identifying research to help address the most critical issues. Participants also discussed training, technology transfer, workshops, conferences, webinars, and education and outreach activities for advancing roadway safety.

- Developing and maintaining a safety culture within transportation agencies at all levels are important in achieving the overall goals of reducing crashes and achieving zero deaths. Many participants observed that, to be successful, a safety culture requires the support of top agency leadership and needs to permeate all levels of an agency. Documentation of best practice examples, identification of successful approaches for introducing and nurturing a safety culture, and measurement of the benefits of a safety culture were suggested. Examining how safety cultures have been

introduced and sustained in trucking, transit, rail, aviation, shipping, and other industries could be part of the research. The results could be presented in webinars and at meetings and conferences.

• Research topics identified by individual participants to help advance traffic safety included examination of human factors and the interactions of drivers, vehicles, and the roadway. Driver simulators and naturalistic driving studies could be used in these efforts. Partnering with vehicle manufacturers and other private-sector groups on this research may be beneficial. Research examining safety countermeasures, including exploration of new countermeasures, evaluation of countermeasures based on differences in geography and climate, and assessment of the application of new technologies, was suggested. Exploration of methods for reaching high-risk drivers and population groups was identified as another research need. Other research topics focused on examining pavement friction, pavement condition, and safety prediction; analyzing behavioral countermeasures and adjusting them for regional differences; developing and applying safety-related performance measures; and developing and using safety simulation models. Assessing the impact of predictive traveler information on safety and examining how best to provide travel information are other research areas.

• The need to communicate a common theme on traffic safety to all groups was suggested. Communication of the importance of traffic safety and the need for a wide range of safety features and policies to all groups was highlighted. The importance of communication to policy makers at all levels for maintaining funding for key safety programs was noted.

• Developing a peer exchange and mentoring program for state departments of transportation was suggested. The program would match state departments of transportation that have well-developed traffic safety initiatives with those having less robust safety efforts. The program objective would be to help states accelerate traffic safety through mentoring from another state. Possible activities include site visits, meetings, web seminars, staff exchanges, and one-on-one mentoring. All of the states participating in the program could meet periodically in conjunction with a regular conference or event. The American Association of State Highway and Transportation Officials and the TRB annual meetings are possible venues for convening all participating agencies. The meetings could focus on sharing best practice examples concerning traffic safety policies, programs, and activities and on sharing experiences with regard to the most beneficial and productive mentoring activities.

• Developing an ongoing series of webinars, workshops, meetings, and conferences on different aspects of traffic safety might be beneficial. These venues could highlight best practices, share experiences with different approaches, present recent research, and identify further research needs. The status of TZD programs and activities is a focal point for these efforts. The webinars, workshops, and conferences

should include all of the stakeholders involved in reducing traffic fatalities, including state departments of transportation, federal programs, metropolitan planning organizations, transit agencies, emergency medical services, police and other enforcement agencies, universities, health agencies, local communities, private businesses, and other groups.

- Participants discussed the need for enhancing existing university traffic safety courses and developing new courses. Sharing information on existing courses was suggested as a first step. Identifying additional courses and updating information for existing courses with a traffic safety emphasis would help meet the future needs of trained professionals. While civil engineering has been the traditional home for traffic safety courses, coordinating courses offered by other departments could be beneficial. The potential role of junior colleges and technical schools in providing professionals with training in traffic safety–related areas was noted.
- Encouraging more interaction among agency personnel, faculty, and students through course exercises, field trips, guest lecturers, and case study examples was discussed. One suggestion was to use a real traffic safety issue as the major project in a capstone course.
- The development of education and outreach programs focused on grades K–12 was suggested. Guest speakers, field trips, interactive online games, and contests were a few of the methods identified for reaching out to this group.
- Establishment of a certificate program in traffic safety was suggested. A university may offer a certificate in traffic safety as part of a current transportation engineering major, or a professional organization, such as the Institute of Transportation Engineers (ITE) or the American Society of Civil Engineers, could develop and offer a certificate. The ITE professional traffic operations engineer could serve as an example for a traffic safety certification program. Coordinating training with current efforts, including the use of the Safety 101 and the *Highway Safety Manual*, was suggested.
- Developing state-level sabbatical programs modeled after the Federal Highway Administration program is another suggestion. Such programs could provide opportunities for university faculty, researchers, and students to work in university research organizations. A related approach, colocation laboratories with agency and university personnel working together, was suggested by some participants.

APPENDIX A

Poster Summaries

Thirty-seven posters were presented at the conference in an interactive session. The poster authors were available to discuss key elements of the projects and to answer questions. A total of 25 authors prepared and submitted summaries of their posters. The summaries are provided in the order listed in the conference program.

TRAFFIC ASSISTANCE SERVICES FOR KANSAS: PROVIDING QUALITY TRAINING IN HIGHWAY SAFETY SINCE 1980

Robert Stokes,[*] *Kansas State University*
Lynn Berges, *Kansas Department of Transportation*
Thomas Mulinazzi, *University of Kansas*

The Traffic Assistance Services for Kansas (TASK) program is a cooperative highway safety training program funded by the National Highway Traffic Safety Administration and administered by the Kansas Department of Transportation (DOT). The primary objective of the TASK program is to provide training to Kansas public employees with traffic safety responsibilities. The program has been in existence since 1980. The training courses (workshops) are developed and delivered by senior faculty from Kansas State University (KSU) and the University of Kansas (KU). Guidance on the program of courses is provided by the TASK Advisory Committee, which consists of representatives from Kansas DOT, the Federal Highway Administration, and local (city and county) transportation agency personnel. In 2006, the TASK program was incorporated into the technology transfer and education programs of KSU's University Transportation Center (UTC). The program typically offers four or five 1-day workshops per year on topics such as the Manual on Uniform Traffic Control Devices; traffic engineering for technicians; use of traffic control devices to improve highway safety; and bicycles, pedestrians, and traffic calming (a safety perspective). In addition to the scheduled offering of courses, local (city and county) agencies may request "on-demand" courses to be delivered at a date and location best meeting their needs. In recent years, the program has delivered on-site training to approximately 150 local transportation agency personnel per year across Kansas. Participants in the program receive continuing education units or professional development hours from the KSU Division of Continuing Education. In addition, selected TASK courses can

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be used to meet the requirements of the KU Local Technical Assistance Program Center's "Roads Scholar" Program. In 2009, the TASK program received the KSU Division of Continuing Education Award for Excellence in the Provision of Noncredit Programming. The TASK program is a highly successful ongoing highway safety training program involving Kansas DOT, the state's two major universities, and local transportation agencies. The poster presents a brief history of the program, the roles of the various agencies involved in the program, workshop development and delivery methods, and a summary of the program's effectiveness in providing quality training to Kansas public employees who have traffic safety responsibilities.

CASE STUDY OF A UNIVERSITY–TRANSPORTATION AGENCY PARTNERSHIP: ASSESSING TRAFFIC SAFETY CULTURE INITIATIVES IN IOWA

Chris Albrecht,[*] *Iowa State University—InTrans*
Konstantina Gkritza, *Iowa State University—InTrans*
Dimitrios Bilionis, *Iowa State University—InTrans*

Vehicle crashes rank among the leading causes of death in the United States. In 2006, the American Automobile Association Foundation for Traffic Safety made a long-term commitment to address the traffic safety culture of the United States by launching a sustained research and educational outreach initiative. Since that time, efforts to improve safety culture have been undertaken in several states. In Iowa, the initiative to produce a culture of safety includes the Iowa Comprehensive Highway Safety Plan. The Iowa plan "engages diverse safety stakeholders and charts the course for the state, bringing to bear sound science and the power of shared community values to change the culture and achieve a standard of safer travel for our citizens."

Despite Iowa's ongoing efforts in highway safety, 445 deaths on the average and thousands of injuries occur on Iowa's public roads each year. Iowa DOT and the Institute of Transportation at Iowa State University conducted a research project that revisited the concept of safety culture from the perspectives of several disciplines, including public health, education, enforcement, public policy and advocacy, social psychology, and civil engineering.

The research project included four major tasks. Task 1 was the establishment of a technical advisory committee. The members of the committee were identified in consultation with representatives of Iowa DOT's Office of Traffic and Safety. The next step was a literature review that summarized best practices and effective laws for improving traffic safety culture (Task 2). The practices and laws were based on local, regional, national, and international resources. The basis for categorizing the policy areas was the traditional "four E's" that are used to describe highway safety: education, engineering, enforcement, and emergency medical services.

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During the next phase of the project, the research team conducted interviews to solicit the opinions of additional experts on improving the traffic safety culture in Iowa (Task 3). Candidate experts were knowledgeable persons in a variety of areas: public health, education, public policy, social psychology, enforcement, and engineering. Interviews were conducted as part of a focus group session, during discussions at the Iowa Traffic and Safety Alliance meeting in February 2010, and by telephone. The critical issues that the interviewees pointed out, each from a different perspective according to the interviewee's discipline, can be easily categorized by using the "four E's" and are discussed next.

Most of the experts emphasized the importance of education. Some of the issues that were discussed include the entry-level age to drive in Iowa, the minimum number of driving hours required by the state in driver education courses, and the need for continuing education and safety training. Continuing education for senior citizens was discussed. Experts in motorcycle and commercial vehicle advocacy pointed out the inadequate rider training and the reluctance that commercial drivers show for reporting any medical (or fatigue) conditions that would raise questions concerning their ability to drive. An issue mentioned by most of the interviewees was the overall attitude of the public toward traffic safety. Lack of personal responsibility, risk tolerance, acceptance of death resulting from a crash, and distracted driving were at the top of the list. Many experts paid special attention to the role of parents in keeping their children safe both as passengers in a vehicle and as responsible drivers.

With regard to engineering, a major issue noted was the lack of public understanding of the benefits of safety countermeasures such as roundabouts, rumble strips, and median cable barriers. Gravel roads, conspicuity of farm vehicles, and rural lighting were also identified. A need for stronger enforcement of graduated driver's licensing laws and laws concerning distracted driving, use of seat belts, and driving under the influence, especially during the night and in rural areas, was indicated. Finally, the lack of emergency medical service infrastructure was a major concern. The main cause of this problem is that emergency medical service is not a required service in Iowa, and thus the majority of providers are not compensated and cannot cover the extent of emergency calls, especially in rural areas.

It was apparent from the expert input that special attention should be given to rural driving safety. Rural driving culture and the driving environment are different from those in urban areas: use of seat belts is lower; there are differences in driving on gravel roads; and there is a lack of relevant education, adequate enforcement, and emergency medical services in rural areas.

After the safety culture issues identified through the focus group meeting and the interviews were compiled and aggregated, a list of 11 high-level goals was created (Task 4). With input from the experts, these goals were discussed in greater

detail, and actions to meet the objectives were identified for each goal. The actions summarize what experts believe would be most important in addressing the higher-level goals. The goals are as follows: improve emergency medical services response, toughen law enforcement and prosecution, increase seat belt use, reduce speeding-related crashes, reduce alcohol-related crashes, improve commercial vehicle safety, improve motorcycle safety, improve young-driver education, improve older-driver safety, strengthen the teenage licensing process, and reduce distracted driving.

This poster summarizes the findings from the interviews and presents the 11 high-level goals, with specific actions to support each goal's achievement.

COLLABORATING TO IMPROVE ROAD SAFETY IN LOUISIANA: THE LOUISIANA TRANSPORTATION RESEARCH CENTER AND THE LOUISIANA HIGHWAY SAFETY RESEARCH GROUP

Marie Walsh,* *Local Technical Assistance Program, Louisiana Transportation Research Center*
Cory Hutchinson, *Louisiana Highway Safety Research Group*

The process of developing the initial Louisiana Strategic Highway Safety Plan (SHSP) in 2005 identified the need for engaging a more extensive and active core group of stakeholders dedicated to reducing traffic-related deaths in the state. While many challenges exist in the efforts to meet the SHSP vision of "destination zero deaths," Louisiana has achieved a significant reduction in fatalities in the past years, and work on identifying and eliminating the primary causes of serious crashes continues. Central to the success of many of Louisiana's efforts are the products of the collaboration among Louisiana State University (LSU), the Louisiana Department of Transportation and Development (DOTD), and other key stakeholders. The two primary university-based organizations of this university–safety stakeholder collaboration are the Louisiana Highway Safety Research Group (LHSRG) and, to a growing extent, the Louisiana Transportation Research Center (LTRC). The activities conducted by these groups include research, training and outreach, project and program management, data collection and analysis, and program evaluation. The tasks are conducted in support of state- and local-level safety efforts in Louisiana and contribute to national safety efforts.

LHSRG is funded by Louisiana DOTD to collect, store, and analyze crash data reported by Louisiana's law enforcement agencies. LHSRG is a division of the Information Systems and Decision Sciences Department within the E. J. Ourso School of Business on LSU's Baton Rouge campus. Central to LHSRG's operations is implementation of LACrash, Louisiana's electronic crash reporting system for law enforcement. Training, technical assistance, and continuous improvement have resulted in LACrash being widely implemented by Louisiana's law enforcement community.

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Data timeliness, consistency, quality, and accessibility continue to improve. LHSRG also leads the Louisiana Traffic Records Coordinating Committee, which is working to improve the timeliness, quality, and connectivity of all crash and related traffic data from the various sources.

The data generated by LHSRG provide the foundation for the SHSP and for the data-driven safety improvement efforts in the state. LHSRG continues to provide innovative solutions and services to the law enforcement community and other safety stakeholders. Recent products include digital dashboards and geographic information systems projects to make data more meaningful to practitioners and decision makers. Further improvements using "business intelligence" strategies have resulted in prototypes designed to provide sophisticated data analysis techniques and results presented in understandable formats for practitioners.

LTRC is a research, technology transfer, and training center administered jointly by Louisiana DOTD and LSU. LTRC provides a setting in which the thresholds of technology can by explored and applied in practical ways. Its facilities and expertise address the rapidly evolving challenges in the transportation field. LTRC's contributions to the implementation of Louisiana's SHSP include the Local Road Safety Program (LRSP), traffic and roadway safety training, implementation of the *Highway Safety Manual*, safety research, communication and outreach, and direct assistance to Louisiana DOTD's Highway Safety Office and to the Governor's Highway Safety Office.

The Louisiana Local Technical Assistance Program (LTAP) located within LTRC plays a major role in DOTD's safety efforts, including development and implementation of the LRSP and management of the local road safety improvement projects funded by the High-Risk Rural Roads Program and the Highway Safety Improvement Program. LTAP represents LTRC on the *Highway Safety Manual* Lead State Implementation Team, the SHSP Implementation Team, the Traffic Records Coordinating Executive Committee, the Operation Lifesaver Board of Directors, and regional safety coalitions. Under a contract with the Governor's Highway Office, LTAP has coordinated and presented a highly successful annual series of impaired driving workshops for law enforcement officers. The LTAP connection with the local transportation community, elected officials, and other potential safety stakeholders enhances ongoing safety outreach and SHSP implementation activities.

Workforce development for current and future highway safety professionals is a familiar topic of discussion at professional safety meetings around the country. The Standing Committee on Highway Safety of the American Association of State Highway and Transportation Officials has issued a resolution supporting an aggressive effort to educate and train a multidisciplinary workforce of transportation professionals in road safety principles and techniques. LTRC has collaborated with Louisiana DOTD for years in hosting a series of training programs for DOTD and other safety

stakeholders on a variety of topics. Among them are road safety audits, *Highway Safety Manual* implementation, SafetyAnalyst, speed management, roundabout design and implementation, work zone safety, low-cost safety improvements, and fundamentals of road safety. LTRC and DOTD have cosponsored a pilot of the National Cooperative Highway Research Program (NCHRP) product Road Safety 101 and the NCHRP–Federal Highway Administration (FHWA) *Highway Safety Manual* training. LTRC supports DOTD and other stakeholders in professional development efforts such as the biannual Louisiana Safety Summit, other regional and national conference implementation, and peer exchanges. A recent local road safety peer exchange among the Southern states was a collaborative effort between the Louisiana LTAP, Louisiana DOTD, LTRC, and the Louisiana FHWA division.

LTRC implements an extensive research program each year. In 2011, three of the top-rated research projects were related to safety: Development of a Strategic Research Program for Louisiana, Implementation and Calibration of the *Highway Safety Manual*, and Development of a Tool to More Effectively Implement and Track Intersection Improvements. A team, including the LTAP director and a new road safety engineer staff member, has been identified to manage implementation of these research projects.

The partnership between Louisiana DOTD, LHSRG, and LTRC highlights the benefits of collaboration. The safety stakeholders benefit directly from the products and outreach provided by the university groups, and the university uses the opportunity to fund students and research. LHSRG routinely recruits students from various university departments to meet the needs of the project work. This expands the available technical and knowledge base available to LHSRG and exposes students to the highway safety field. LTRC works with other Louisiana university systems to implement research and is investigating how to recruit more students into traffic safety by expanding research and educational opportunities.

APPLICATION OF ADVANCED TOOLS TO ACHIEVE COST-EFFECTIVE TRAFFIC SAFETY MANAGEMENT

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Chuck Reider, *Nevada Department of Transportation*

The poster presentation will illustrate the projects that the University of Nevada, Reno, has conducted in partnership with the Nevada Department of Transportation. In particular, we present projects in which advanced tools have been developed and applied for better management of safety data. One major project is related to beta testing of the SafetyAnalyst software. We used geographic information system tools to merge data from various sources to create a data set for the SafetyAnalyst software

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that was based on the Reno–Sparks area transportation network. Another project is related to studying pedestrian crashes at unsignalized intersections. A web-based tool was developed to display pedestrian crashes graphically so that pedestrian concentrations can be inspected visually.

DRIVING WITHOUT DISTRACTION: MEASURING THE IMPACT OF ADDITIONAL DRIVER TASKING AND INFORMATION DELIVERY AND ITS MITIGATION BY DESIGN

Gregory Thomas,[*] Paul Atchley, Chris Depcik, Ronald Dougherty, Lance Rake, and Michael Eckersley
University of Kansas

The Driving Without Distraction team is taking an analytical approach to evaluation of the attempts of automobile makers to "personalize" the vehicle to make driving more of an entertainment-oriented experience. Automobile makers have layered the complexities and increased the multitasking of the operator. With the comprehensive study of the numerous media impacts on driving, the additional aspect of designing a "smarter" dashboard console was undertaken by a collaboration of University of Kansas faculty and students. The purpose of the collaboration between experts in engineering, design, and cognitive science was to develop a new class of adaptive information displays that can intelligently assess road and driver conditions and adjust the driver's in-car experience to anticipate needs and demands for safety. The emphasis is directed to maximization of the amount of eye-to-road contact by the heuristic (and tailored) design of instrument clusters and their usage. The project is a study and analysis of the amount of media distractions (inclusive of cell, text, music, and navigation) and their impairment of the driving function by instrument ergonomics and increasing interactive tasking. The design problem focused on the concept of new console configurations that enable multitiered information delivery, consolidation of instrument and information clusters, and simplification of information delivered.

"Keep your eyes on the road" has been the mantra of every driver education teacher and nervous parent. However, we do not keep our eyes on the road at all times. That is not to say that we engage in dangerous behavior, such as texting or changing radio stations, while driving—we briefly avert our eyes to aid the driving experience. We refer, of course, to the dashboard display.

The term "dashboard" originated during horse and buggy days and referred to a piece of wood that protected the buggy's passengers from mud and slush. By the 1930s, though, cars started coming with gauges, and by the mid-1930s all cars included what has been termed the "idiot light," a warning light indicating that something is wrong with the vehicle. Even in the present day, manufacturers are tinkering with the

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instrument panel, moving it to the center of the dashboard or packing it full of technology that may make keeping eyes on the road harder than ever.

In 2008, 5,870 people died and an estimated 515,000 people were injured in motor vehicle crashes that involved at least one form of driver distraction, according to the National Highway Traffic Safety Administration. "Driver distraction" is a catchall term that includes using cell phones, texting while driving, eating, drinking, talking with passengers, and using in-vehicle technologies and portable electronic devices.

In 2009, more than 135 billion text messages were sent or received in a 1-month period nationwide, an 80 percent increase over 2008, according to the National Highway Traffic Safety Administration. A driver will glance away from the road for about 2.6 seconds when texting compared with 1.1 seconds when the driver is not.

As though texting and cell phone distractions were not enough, Transportation Secretary Raymond LaHood recently said, "In recent days and weeks we've seen news stories about carmakers adding technology in vehicles that lets the drivers update Facebook, surf the web, or do any number of other things instead of driving safely."

A coalition of University of Kansas professors representing various areas of research has been formed to address what we perceive as technology in search of a safer application environment. The automobile industry continues to develop standard instrument clusters that have had little modification with the exception of some customization. Except for the ability to create personal preference color consoles, important information concerning the car's performance, operating diagnostics, climate control, Global Positioning System navigation, and music management continue to be independent modules. By failing to integrate all components into an easier-to-read, more ergonomical console, the industry continues to add to the safety issues relating to distractions.

Individual drivers have different levels of skill and cognitive capacity because of differences in training and ability. In addition, roadway conditions change and place different demands on the attention of the driver from moment to moment. The purpose of the current collaboration between experts in engineering, design, and cognitive science is to develop a new class of adaptive smart systems that can intelligently assess road and driver conditions and adjust the driver's in-car experience to anticipate needs and demands for safety.

Students in mechanical engineering and in industrial and interaction design worked together in teams to study vehicular information and develop a new prototype for its delivery. This involves the inclusion of information design. Where the data are complex or unstructured, a visual representation can express the meaning more clearly to the viewer. The emphasis was on maximizing the amount of eye-to-road contact by the heuristic (and tailored) design of instrument clusters and their us-

age. The instrument information could change size and shape and even disappear or become prominent depending on input from the Global Positioning System, sensors, and other tracking and monitoring devices.

The University of Kansas team's goal was to investigate the competing information sources, account for varied driver and vehicle abilities, examine possible innovations, and then determine how best to meet driver needs while maximizing safety for the driver and surrounding vehicles. Drivers are continuously bombarded with information, and the team is investigating how best to manage this information and keep the driver focused on the main task—driving.

The complementary backgrounds of the team members are anticipated to foster innovative solutions for the problems associated with today's driving environment.

ESTABLISHING A CONNECTICUT CRASH DATA REPOSITORY

Eric Jackson,[*] John Ivan, and Gerald Klein III
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Analysis of highway safety is probably the most data-intensive activity carried out by highway and transportation agencies. It requires more than just archiving police accident reports. To be effective, information recorded on the accident reports must be captured in a searchable database. Furthermore, roadway inventory, traffic volumes, and even land use information are all critical for evaluating the safety of any road segment or intersection, and other safety analysis exercises such as demographic or behavioral studies require driver licensure, motor vehicle registration, and other institutional databases.

Connecticut has two disparate large-scale crash data repositories (CDRs): one at the Department of Public Safety and one at the Department of Transportation. In addition, numerous small-scale repositories are retained at local police departments throughout the state. However, these CDRs are not easily linked to roadway information, traffic volumes, or land use data. These other databases are maintained by other state agencies and require significant manual reformatting to combine the crash data and roadway information. The nonhighway information is maintained by agencies such as the Department of Motor Vehicles or the Department of Public Health. Compiling and linking these data require additional steps, especially contacting multiple offices. Assembling the information from all of these databases into a single data repository would reduce duplicative effort on the part of state agency employees and researchers on projects funded by the state.

Historically, a Centralized Accident Records System served as the state's records repository. However, Connecticut's crash data had to be hand-entered from crash

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forms submitted by law enforcement agencies. The move to electronic crash report generation provides the opportunity to create a centralized single data repository for Connecticut.

The first phase of Connecticut CDR development was focused on designing and building a CDR for PR-1 files. The repository developed in Phase 1 will serve as the foundation for more advanced versions of the data repository. The development of the base CDR established a repository that can allow law enforcement agencies across the state to submit crash information via Extensible Markup Language (XML) specification standards. In return, their crash data will be available for analysis through web tools developed in later phases of this research. The first phase of the Connecticut CDR development (*a*) designed the structure and foundation for the CDR database; (*b*) developed the data entry, query, and analysis tool set program; and (*c*) developed a secure web portal that will allow users to display and analyze, export, and print crash records. The current repository can be accessed at http://www.ctcrash.uconn.edu.

The purpose of Phase 2 is to enhance the CDR, data query, and analysis tool set created in the first phase. The overall project goal is to provide members of the traffic safety community with timely, accurate, complete, and uniform crash data. The repository designed at the University of Connecticut compiles data from agencies in Connecticut that capture PR-1 accident data and provides users access to these data. The system is designed to allow users access to two individual data repositories. The first is collected from the Connecticut Department of Public Safety, and the second is generated from accident data processed by the Connecticut Department of Transportation. Phase 2 of this project is intended to (*a*) add functionality to the web portal of the repository, (*b*) incorporate more local police department crash reports (electronic XML) into the repository, and (*c*) integrate other roadway and traffic information databases into the repository.

A potential Phase 3 of this research could be to link or merge the patient care reporting software to the CDR. This would allow users access not only to crash data but also to medical reports detailing the care provided to and the severity of the injuries of crash victims. However, the addition of patient care information increases the level of security and complexity needed for meeting Health Insurance Portability and Accountability Act requirements. This phase would also require the current CDR to be updated to include personal identifiers for those involved in each crash.

The development of the CDR will allow for unprecedented public access to individual crash data without disclosing personal information. The public, researchers, public safety officials across the state, and anyone around the world could view and analyze Connecticut crash data.

IMPLEMENTING TRAFFIC SAFETY EVALUATIONS TO IMPROVE LOCAL ROAD SAFETY

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Improving roadway safety is an ongoing priority for transportation agencies. However, addressing safety issues in rural areas is difficult for local governments because of the limited resources available for maintenance and improvement projects. The North Dakota Department of Transportation reports that 88 percent of fatal and injury crashes occurred on rural roads between 2005 and 2009. Among non-Interstate rural roads, the High-Risk Rural Roads Program (HRRRP) group, which includes the lowest population–traffic density roads, accounted for 56 percent of the fatal and injury crashes over the past 5 years. Most of the HRRRP group crashes, 91 percent, are attributed to the local road system, and the other 9 percent are attributed to the major collector system.

Traffic safety evaluations (TSEs) have emerged as a proven and proactive tool for identifying and addressing roadway safety issues. TSEs are founded on the same principles as the Federal Highway Administration–proved strategy of road safety audits, with a format and process designed to fit the rural roads community. According to the Federal Highway Administration, road safety audits noticeably improve the safety performance of roadway facilities. Several benefits can be achieved through the implementation of road safety audits, such as identification of low-cost, high-value improvement opportunities; promotion of the awareness of safe design and maintenance practices; and provision of a means of tailoring the resources of an agency to meet specific problems.

This project used the case study research approach. Researchers developed supporting materials and resources and documented experiences in two TSEs to demonstrate the methodology and its application to agencies in North Dakota. The demonstration has led to additional TSEs in the state and an expanding partnership in promoting this proven safety countermeasure.

IDENTIFYING FACTORS THAT PREDICT TEEN DRIVER CRASHES

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Reducing crashes, in particular those resulting in injury or fatality, is an ongoing struggle. An ability to predict such crashes would allow agencies to develop interventions targeting the behavior of the drivers and could ultimately reduce the number

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of crashes. Teen drivers are ideally suited for this type of intervention for several reasons. They are overrepresented in crashes—teens account for only 4 percent of the driver population but for 10 percent of crashes. In addition, a large share of teen crashes occurs within the first year after licensure because of a lack of driving experience. Finally, the learning curve is still steep at this point in their driving history, which makes them more susceptible to interventions.

In an attempt to predict these crashes, North Dakota driver licensing data and crash data were used to develop a sample of 20,392 drivers between ages 14 and 17. Within the first year after licensure, these drivers sustained 317 crashes that resulted in an injury or death. The resulting logistic regression model identifies gender, traffic convictions, place of crash (rural or urban), geography, and involvement in previous property damage only (PDO) crashes as markers that are significant in predicting injury and fatal crashes. According to the model, living in an urban area increases the risk of being in an injury or fatal crash within the first year after attaining a license by 2.5 times compared with living in a rural area. Drivers involved in a previous PDO crash are 25 times more likely to be involved in an injury or fatal crash than those not involved in a previous PDO crash. These results can be used in a driver improvement program. One application may be an advisory or warning letter targeted to teen drivers suggesting additional training or guidance for those who exhibit the above markers. This may alter their behavior and reduce their likelihood of being involved in an injury or fatal crash.

The North Dakota Department of Transportation, the American Automobile Association–North Dakota, the North Dakota Highway Patrol, and the Federal Highway Administration–North Dakota District supported this project during the competitive process used for Mountain–Plains Consortium research project selection. In addition, these partners worked with the American Association of Motor Vehicle Administrators to try to secure funding for a pilot project. The North Dakota Department of Transportation was instrumental in providing data needed to complete the research.

COLLABORATION BETWEEN UTAH DEPARTMENT OF TRANSPORTATION AND LOCAL GOVERNMENTS TO IMPROVE SIGN MANAGEMENT

Kevin Heaslip,* *Utah State University*

The *Manual on Uniform Traffic Control Devices* (MUTCD) specifies minimum retroreflectivity requirements that include an obligation for agencies to develop a strategy for maintaining compliance. With a deadline of January 1, 2012, for implementation of a management plan, there has been an emphasis on sign asset management. Budget considerations make it important that a transportation agency implement an

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assessment and management plan that is efficient and provides compliance with the standards required by the MUTCD. The development of an efficient plan requires knowledge of the overall condition of an agency's assets and unique considerations with regard to their performance.

Through a review of previous data collection efforts, this paper details the development of a data collection strategy for assessing the performance of traffic signs maintained by the Utah Department of Transportation. Agency operations, site selection, and attribute collection were all considered during development of a collection plan for an agency whose inventory and installation data were limited. Retroreflectivity measurements were taken for 1,433 department signs. The sample provided a snapshot of current compliance and assisted in the selection of an asset management plan for maintaining sign retroreflectivity. The study showed that the department's signs were well over 90 percent compliant with the MUTCD standards, and preliminary management strategies were presented to address vandalism and other damage.

PEDESTRIAN ACCESS MANAGEMENT AT MODERN ROUNDABOUTS

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The following is based on material appearing in the 2011 TRB Annual Meeting Online website. Since the 1990s, modern roundabouts have burgeoned in many states and municipalities of the United States. The keen interest in modern roundabouts can be attributed for the most part to their success in some countries of Europe and Oceania. In geometrics, a modern roundabout is an unsignalized intersection that includes a central island encircled by a single- or multiple-lane roadway. Vehicles entering the roundabout must yield cautiously to those already navigating on the circulatory lanes. Its appeal can be ascribed to substantiated safety benefits, strengthened circulation efficiency, reduced maintenance cost, and aesthetic impact. A large number of roundabouts are under construction or in the planning phase in North America. Simultaneously, the emergence of modern roundabouts has kindled a debate over the pedestrian access issue. The *Access Management Manual* prescribes major transportation actions, including multimodal streets with sidewalks and adequate pedestrian refuges, without addressing the pedestrian access issue at roundabouts.

In 2002, the United States Access Board published "Draft Guideline for Accessible Public Rights-of-Way, Roundabout," which proposes pedestrian signals at all roundabout crosswalks. In 2005, the access board released a revised draft to call for the provision of "a pedestrian-activated traffic signal . . . for each segment of

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the crosswalk" at multilane roundabouts to ensure safe access for vision-impaired pedestrians. Operationally, this provision induces an interruption of the vehicular flow continuity that is originally intended in roundabout design. Another issue is the enhanced likelihood of the yielding queue spilling back into the circulatory lanes. Only a few roundabouts have been signalized for pedestrians in North America, and there is little literature documenting the theme of signalizing roundabouts to improve pedestrian access. Although roundabouts are rarely signalized for pedestrian access in the United States, the call from the access board and the absence of roundabouts in the *Access Management Manual* require the access management community to have more practice-oriented research endeavors with regard to roundabout accessibility for pedestrians.

This study was aimed at quantitative evaluation of the performance of four pedestrian signals [pedestrian actuated, high-intensity activated crosswalk (HAWK), pedestrian light controlled, and pedestrian user-friendly interface (PUFFIN)] experimentally installed at typical single- or double-lane modern roundabouts where three crosswalk geometric layouts (conventional, offset, and distant) and two signal installation schemes (one-stage and two-stage) varied under a range of traffic conditions. The objective was to provide the access management community with an objective basis for identifying crosswalk treatments that could improve roundabout accessibility especially for children, seniors, and the visually impaired or disabled while maintaining adequate multimodal traffic mobility. From an operational perspective, this study investigated how specific crosswalk treatments, which result from variations in three dimensions (signalization options, geometric layouts, and installation schemes), affect multimodal performance measures under varied traffic conditions at typical roundabouts. It is almost infeasible to scrutinize the performance of these treatments in a real-world context because of disruptions and hazards posed to smooth and safe circulation if traffic control strategies change on site. Instead, a simulation platform rendered a valid surrogate means by which treatments can be implemented and evaluated in a quantifiable fashion.

The study results suggest a nonmonotonic relationship between the signalization effects and all levels of vehicle volumes. Vehicle delays appeared to be the largest as traffic volumes approached the roundabout capacities. The following could also be concluded:

1. A two-stage installation scheme is much more operationally efficient than the one-stage counterpart.
2. There are no significant differences among the three geometric layouts if they are used in conjunction with the two-stage scheme. When the one-stage scheme is used, the distant layout, in comparison with the "conventional" layout, can reduce vehicle delays and queue lengths because of the enlarged vehicle storage space at the exit lanes.

3. HAWK poses the least delay to vehicles for most study scenarios, while PUFFIN generates minimum pedestrian delays for all scenarios. These two signals are promising for roundabout signalization, while PUFFIN is believed to provide a better balance between pedestrian crossing safety and traffic movement efficiency.

4. The addition of pedestrian signals to double-lane roundabouts is operationally beneficial for roundaboutwide vehicle circulation when vehicular inflows are in a saturated state.

The study findings should be useful to transportation policy makers, planners, and practitioners in the access management community who face the challenge of improving roundabout accessibility for pedestrians, especially those with impaired vision or mobility.

USING PEER INFLUENCE TO PREVENT TEEN DRIVER CRASHES

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What Is "Teens in the Driver Seat"?

The Teens in the Driver Seat Program is America's fastest-growing peer-to-peer safety program for young drivers. Developed in 2002 by the Texas A&M Transportation Institute to combat the leading cause of injury and death for young people in the United States, the program is distinct from other programs in three important ways. First, the program focuses on all of the major risks faced by young drivers and highlights those that teens and their parents are least familiar with (driving at night; speeding; and distractions such as cell phones, texting, and other teen passengers). Second, the program relies on teens to help shape and deliver safety messages to each other. Third, it is the only traffic safety program in the nation that engages young people starting in junior high school and continuing all the way through the college years.

Teens in the Driver Seat has brought a fresh approach to the teen driver safety problem. Extensive data analysis demonstrates its effectiveness in fighting the number 1 killer of teenagers in America.

How Widely Is the Program Used?

More than 500 schools in Texas now have active Teens in the Driver Seat programs, and it has become active in Georgia, Connecticut, North Carolina, and California. At least 500,000 young people have been directly reached through the program, with many thousands more reached via free downloadable materials from the program website, http://www.t-driver.com.

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How Successful Is the Program?

A national review of crash data determined that the number of teen drivers involved in fatal crashes in Texas has declined at a rate significantly higher than the national average in the years since the program has been active in the state (2003 to the present). In addition, Texas has been the only state in the nation to experience a decline in its teen driver fatal crashes for 8 consecutive years. Findings suggest that the trends are largely attributable to a combination of the state's graduated driver's license (GDL) law and the program, which, by design, reinforces and augments the GDL law. The steady decline in Texas is particularly noteworthy in view of the safety obstacles faced by the state:

1. Texas is one of only a few states permitting teen drivers to secure a license through parent-taught driver education. Parent-taught teen drivers are nearly three times more likely to be involved in a fatal crash, according to a 2007 study performed for the National Highway Traffic Safety Administration.
2. The GDL law in Texas (until 2009) was rated as only "fair" by the Insurance Institute for Highway Safety, while 33 states had laws rated as "good." In other words, Texas is doing better in the face of stiffer competition, because states with stronger GDL laws should expect those laws to have a more positive effect on the frequency of crashes and fatalities.
3. Until 2009, Texas did not require an on-road driving test for novice drivers seeking a license. Again in this case, Texas is doing better in the face of stiff competition, because states that require an on-road test should expect it to have a positive effect on crash frequency—the test helps to ensure that novice drivers are kept off the roads until they have demonstrated basic driving skills.

In addition, a comprehensive case study illustrated the effectiveness of Teens in the Driver Seat in Garland, Texas, where the program was initiated in all of the community's seven high schools in 2006. In the 4 years before implementation, 12 teens died in vehicle crashes, compared with only one death in the years since the program began there. In addition, teen involvement in all crashes dropped from 28 percent before implementation to 16 percent after the program began. Field studies showed a 30 percent decrease in teen driver wireless device use and a 14 percent increase in seat belt use at program schools.

The program has also contributed to changes in public policy in Texas. By serving as expert resources, staff members contributed directly to efforts by the state legislature to strengthen the Texas GDL law (in 2009) and to increase the amount of training required of new teen drivers. Recent GDL modifications were the most significant since the law became effective in January 2002, and the actions resulted in the state's GDL law being upgraded from "fair" to "good" in ratings by the Insurance Institute for Highway Safety.

The program has also effectively positioned teen driver safety as a public health issue. The work with the Texas legislature resulted in a partnership with the House Public Health Committee, the chairwoman of which held a press conference declaring teen driver crashes to be "one of the most serious public health crises faced by our state." Teens in the Driver Seat has received a pledge of support from the chairwoman of the Senate Health and Human Services Committee. In addition, the Texas Transportation Institute has established a formal partnership with the Pan American Health Organization (PAHO), in part to apply the Teens in the Driver Seat program model to other populations within PAHO's region.

What About Other Young Drivers (and Passengers)?

Teens in the Driver Seat—Junior High was developed to help predrivers learn information and develop skills to be responsible passengers and, in many cases, positively influence older siblings who are behind the wheel. Building on the dramatic success of Teens in the Driver Seat, the developers of the program have produced a component for the college-age audience named "U in the Driver Seat." Although the mix and frequency of risk factors for college-age individuals is slightly different, the challenges and dangers they face are virtually the same as those faced by their younger counterparts. Like Teens in the Driver Seat, this newest form of the program depends on peer influence to reduce the number of crash injuries and fatalities for young people.

DEVELOPMENT OF TRAFFIC SAFETY–TECHNICAL ASSISTANCE CENTER IN MASSACHUSETTS

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The societal costs of traffic safety have been well documented, yet the issue remains critical. In Massachusetts, the toll of crashes on roadways can be quantified not only in terms of injuries and fatalities but also in terms of cost. Although the various safety stakeholders have both independently and collectively established programs and countermeasures aimed at improving safety, a need for an analytical support mechanism for transportation safety remains. The primary objective of this research was to establish a Traffic Safety–Technical Assistance Center (TS/TAC) with the intent of providing an analytical support system to enhance approaches to traffic safety analyses in Massachusetts. The goal of the TS/TAC was to provide a dynamic source for general data analysis and support; program evaluation for initiatives; access to unique transportation data sets (i.e., linked data); and as appropriate, the collection of additional data. There is a need for research tools like these. To that point, the

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Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users, the current federal transportation legislation, requires transportation agencies to be more data-driven in their approach to programming and to expand accountability and reporting. By all accounts, the forthcoming transportation bill will likely increase the demand for funding to be tied directly to quantifiable performance measures. This emphasis translates into an increased demand for high-quality, accurate safety data and analyses to justify safety expenditures, a high-priority area of the forthcoming legislation.

The University of Massachusetts Traffic Safety Research Program (UMassSafe) is a multidisciplinary traffic safety research group housed in the University of Massachusetts Transportation Center in the College of Engineering at the University of Massachusetts Amherst. At UMassSafe, we seek to reduce the frequency and severity of crashes through the rigorous examination and analysis of safety-related data to improve understanding of crashes, driver behavior, and related factors. The TS/TAC serves to meet the immediate data analysis needs of safety shareholders; the information provided is useful for problem identification, program evaluation, accountability reporting (including benefit–cost analysis), and analytical comparisons across the United States.

The safety analysis is completed by using safety data available in the UMassSafe Traffic Safety Data Warehouse. The data warehouse includes "administrative" data sets collected by state agencies and other organizations, including crash, citation, roadway inventory, and hospital data. Fourteen such data sets are housed in the UMassSafe Traffic Safety Data Warehouse. The analysis includes linked data sets created by using the aforementioned administrative databases. Crash, citation, hospital, death certificate, and roadway inventory data have been linked through the use of advanced statistical methodologies to create a single data set that allows analysts to consider the comprehensive crash experience, including driver behavior, crash characteristics, roadway environment, and crash outcomes such as injuries and costs. The data and associated analyses are used to assist state agencies via the TS/TAC.

ROAD SAFETY AUDITS: ASSISTING LOCAL COMMUNITIES IN NEW JERSEY THROUGH COOPERATION

Andrew Kaplan,* *Center for Advanced Infrastructure and Transportation, Rutgers University*

The Transportation Safety Resource Center (TSRC), part of the Center for Advanced Infrastructure and Transportation (CAIT) at Rutgers University, has implemented a road safety audit (RSA) program for local agencies. TSRC employs a diverse staff

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of engineers, data analysts, and education specialists to provide safety resources and services to agencies statewide. A cornerstone of TSRC, the RSA program provides towns and counties with no-cost, data-driven engineering support that identifies long- and short-term countermeasures fitting within each budget.

An RSA is a Federal Highway Administration–supported safety performance evaluation conducted by an independent, multidisciplinary team on existing or future roads and intersections. In a traditional road or intersection safety review, situational factors and issues are not part of the safety assessment, but the TSRC team—led by staff engineers—conducts an RSA that examines and identifies issues that could be hazardous not only to motorized traffic but also to all road users, including pedestrians and bicyclists.

TSRC has been instrumental in implementing a statewide RSA program aligned with the Federal Highway Administration goals and objectives of enhancing local road safety through a data-driven process and providing a benefit to the local stakeholders. Site visits are a vital part of the RSA process, which relies on keen safety observation and data analyzed before evaluation. These elements allow TSRC to recommend short- and long-term countermeasures to the towns and counties receiving RSAs.

Recommendations, site visits, and data do not solve traffic issues by themselves. When a local public agency implements countermeasures recommended by the RSA, postevaluation data from national statistics suggest that crashes can be reduced by up to 40 percent in urban areas and by up to 60 percent on rural roads, where crashes tend to be more severe.

Successful RSAs conducted by CAIT's TSRC involve the bringing together of local officials and organizations such as police officers, municipal and county engineers, planners, public works employees, safety-oriented community organizations, school transportation companies, hospitals, and fire departments with experts from organizations such as the Federal Highway Administration, New Jersey Transit, New Jersey DOT, the Voorhees Transportation Center of Rutgers University, the New Jersey Local Technical Assistance Program, TSRC, the Rutgers Pavement Resource Program, transportation management associations, and metropolitan planning organizations.

JOURNAL OF TRANSPORTATION SAFETY AND SECURITY: LEVERAGING RESEARCH PARTNERSHIPS WORLDWIDE

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Stephen H. Richards, *University of Tennessee, Southeastern Transportation Center*
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Lindsay Allen, *Taylor and Francis Group, LLC*
Julie Sikora, *Taylor and Francis Group, LLC*

Across the globe, commerce, economic development, and the security of nations depend on safe and secure transportation systems. Until recently, outlets for publishing research in the areas of comprehensive transportation safety or transportation security were limited. However, in 2009 the Southeastern Transportation Center, a regional center in the U.S. DOT UTC program, launched the *Journal of Transportation Safety and Security* (JTSS). The journal fills that gap by publishing original research emphasizing multimodal transportation safety issues such as highway, transit, ridesharing, and pedestrian and bicycle modes as well as rail, water, and aviation. JTSS is a quarterly, peer-reviewed, academic journal that is the product of an international partnership between the Southeastern Transportation Center, the University of Tennessee, Beijing Jiaotong Transportation University in China, and the London-based academic publisher Taylor and Francis Group, LLC.

The journal is supported and directed by an international editorial board. In creating the board, the editors sought renowned experts worldwide in all modes of transportation safety. The researchers and practitioners represent China, Australia, Hong Kong, Canada, and all regions of the United States. The aims and scope of JTSS are broad and multidisciplinary. They include the safety aspects of infrastructure design, driver behavior and human factors, traffic control and traffic operations, crash data collection and analysis, crashworthiness, safety information and communication systems, advanced and emerging vehicle and network technologies, and safety policy and planning. JTSS is also interested in security issues of transportation systems and networks, as well as emergency and incident planning and response.

The journal's mission is to disseminate research results and engineering experience to educators, researchers, practitioners, and policy makers to enhance transportation safety with comprehensive and integrated solutions. The journal succeeds in reaching an international audience: published authors are from universities in Italy, France, Spain, the United Arab Emirates, China, Egypt, the United Kingdom, China, and Russia, while international subscriptions are growing at a healthy rate. In 2009, the journal was featured in the Research and Innovative Technology Administration's *Points of Pride* publication as an outstanding example of a successful UTC initiative.

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Taylor and Francis Group publishes scores of engineering, science, and medical journals, including many of the world's top academic journals. According to its publication staff, JTSS is one of its most successful journal start-ups, if not the most. The success in large part is a result of the vision and unique contributions of the journal partners and the initial support and increased exposure afforded by the UTC program.

Something important has been achieved through our partnership with an international academic publisher, Taylor and Francis Group, and an international university. This partnership may be unique. It involves a joint copyright agreement between the University of Tennessee, representing the Southeastern Transportation Center, and Taylor and Francis. It enjoys international editorial support from Beijing Jiaotong Transportation University. To represent the concept visually, we will answer these questions:

- What inspired the partners to create the journal? What need does JTSS meet?
- What have we achieved?
  - Fulfilling research needs by publishing peer-reviewed transportation security research.
  - Covering diverse areas such as highway, transit, ridesharing, and pedestrian and bicycle modes as well as rail, water, and aviation.
  - Supported by an international editorial board filled with renowned experts.
  - Relevant to educators, researchers, practitioners, and policy makers.
- Who are the beneficiaries? This refers not only to those who read the research but also to the contributing authors, reviewers, libraries, faculty, students, and those who use transportation worldwide.
- How do we measure our success?
- What impact do we have now and where do we envision it will reach?
- Given where we started, where are we now and what is our future?
- How could someone else achieve this sort of success?

IMPROVING RURAL ROADWAY SAFETY PROGRAMS THROUGH A UNIVERSITY–PUBLIC SCHOOL COLLABORATION

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Over a period of 2 days in March 2011, a team of five graduate student researchers from the University of Tennessee–Knoxville (UTK) hosted 71 teenagers from two rural Tennessee schools for a pilot test of a rural driver education project. The goals of the Rural Teen Driver Education Program (RTDEP) are to develop methods for making teens more conscientious and safe while driving by focusing on distracted driving and seat belt use and to teach the participants to be safer drivers by using the basics of

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science and engineering. The program served as a leadership development platform for the graduate student researchers and instructors who created and implemented the project. In addition, the program received widespread local news coverage. The pilot test program showed promising results. Phase II of the program emphasizes observational data collection to analyze short- and long-term program impacts on teen driver safety behaviors.

On arrival at UTK, the high school students participated in a classroom lecture, which examined the stopping sight distance formula and explored its relationship to distracted driving. The teens also faced an emergency driving scenario on the university's driving simulator while talking and texting on a mobile phone. Additional classroom exercises explored Tennessee Department of Safety crash data and statistics (specific to their county of origin) to learn the numbers of crashes "close to home" and their respective causes. Several weeks later the graduate researchers returned to the partner schools to discuss the results of the simulator exercise. The teens were shown the stopping distance and lane position data indicating their diminished driving capabilities. The results of a self-reporting survey given to the students during the initial visit were also discussed, with a focus on the participants' low seat belt use responses. Basic mathematics and physics were used to show the teen participants the risks they were taking by not using occupant protection.

Teen driver safety issues are a nationwide concern. Rural teen drivers face challenges different from those of their urban peers. Rural roads often have higher design speeds and lower adherence to design standards. Medical response times are often significantly longer in rural areas. Distracted driving is receiving an increasing amount of coverage in the media. Not surprisingly, the RTDEP received widespread coverage in the local media. Each of the three local television stations produced feature stories, as did one partner school hometown newspaper. The graduate researchers were interviewed by local radio and by Iowa State University's online transportation magazine for teens, *Go! Transportation*.

The project was developed and implemented entirely by graduate students at the University of Tennessee. The initial funding was secured by winning first place in a contest hosted by the URS Corporation for student engineering clubs at UTK. The Tennessee Section of the Institute of Transportation Engineers provided additional funding, and the Southeastern Transportation Center matched all private funding.

The initial results showed large decreases in self-reported willingness to use portable electronic devices while driving. Phase II of this project is under way (fall 2011); researchers will return to one of the partner schools and continue these educational efforts with a 4-day minicourse. Roadside data will be collected before and after the students participate in the course to determine the impact the course may have on seat belt use and the use of portable electronic devices while driving. Additional

project goals are to evaluate the short- and medium-term impacts of the program on driver behavior and safety while exposing students to transportation engineering–related principles and attracting a future generation of transportation professionals.

PLAN4SAFETY

Evan Bossett* **and Amir Rezvani,** *Center for Advanced Infrastructure and Transportation, Rutgers University*

Developed by the Transportation Safety Resource Center (TSRC) at Rutgers University's Center for Advanced Infrastructure and Transportation and funded by New Jersey DOT, Plan4Safety is a web-based, comprehensive crash analysis software application that provides decision support for New Jersey safety engineers, police officers, planners, researchers, and educators.

Through a partnership with the Bureau of Safety Programs of the New Jersey State Police and New Jersey DOT, Plan4Safety's comprehensive database allows the most accurate data available to be distributed at the local, county, and state levels to improve safety throughout the state's roadway network. Every reported crash in New Jersey from 2003 onward, more than 1 million crash records, is included in the Plan4Safety program. Working with TSRC, a Bureau of Safety Programs team is assigned to data collection and entry, with multiple fact-checking resources and state-of-the-art comparison software.

Because of the reliability of the data, New Jersey organizations use Plan4Safety to display various aspects of traffic and crash data. In particular, the Brain Injury Association of New Jersey uses Plan4Safety data to display the many types of teenage crashes on a geographic information systems map to inform parents and teenagers in New Jersey of the dangers and of the precautions that should be taken before a teenage driver takes the wheel.

The "red light running automated enforcement" initiative, an operational New Jersey pilot program designed to test the effectiveness of traffic light cameras, uses Plan4Safety as its primary data resource in eight of the 12 pilot municipalities: Jersey City, Edison, New Brunswick, Linden, East Brunswick, Roselle Park, Piscataway, and Stafford.

Other Plan4Safety user organizations include metropolitan planning organizations; New Jersey DOT; and state, county, and local enforcement and planning agencies. The High-Risk Rural Roads Program operates on a federally approved methodology and uses Plan4Safety's ranking feature to identify and ultimately improve high-risk rural roads, which typically experience more severe crashes.

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Finally, Plan4Safety allows TSRC engineers to participate with local, county, and state engineering and law enforcement offices to provide data for field assessments, or road safety audits, which identify safety issues that can be improved.

TRANSPORTATION SAFETY RESOURCE CENTER: ONE-STOP SAFETY SHOPPING

Mitra Ammar-Fetrat,* *Center for Advanced Infrastructure and Transportation, Rutgers University*

Obstacles can hinder attempts to address traffic safety issues by providing vital information and educational and technical resources from the state level to local and county agencies. Since its inception in 2004, the Transportation Safety Resource Center (TSRC) at the Center for Advanced Infrastructure and Transportation at Rutgers University has served as a statewide resource center for technical assistance, training, data analysis, and traffic safety programs. Through a collaborative approach with stakeholders, TSRC provides support to state and local transportation and law enforcement agencies and officials, including New Jersey DOT, the Federal Highway Administration's New Jersey Division, state police, metropolitan planning organizations, county engineers, municipal administrators, and others.

Serving in a cooperative partnership with New Jersey DOT, TSRC provides safety programs and initiatives that address issues for all facets of traffic safety—enforcement, education, engineering, and emergency response.

Examples are assistance to the New Jersey Division of Highway Traffic Safety and more than 400 police officers and engineers from local and county agencies via the TSRC-developed Plan4Safety crash data and analysis software, participation with public agencies in the analysis of data, written update and distribution of the New Jersey Comprehensive Strategic Highway Safety Plan, improvement of local and county roadways for cost-efficiency and safety maximization via statewide and regional initiatives such as road safety audits, and provision of daylong educational activities for schoolchildren to influence the behavior of future drivers. TSRC works hand in hand with the New Jersey Local Technical Assistance Program to develop and conduct safety-related workshops for practicing professionals, to conduct safety outreach programs, and to provide technical assistance to public agencies.

To consolidate traffic safety efforts and resources, TSRC hosts an annual full-day safety conference—the New Jersey Safety Forum—that offers interactive workshop sessions and panels allowing educators, enforcement personnel, and engineers to discuss transportation safety issues. The forum advances communication between agencies and industry professions and provides a showcase of safety achievements around the industry to educate and inspire all in moving toward zero fatalities on roadways within the state, the country, and the world.

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EVALUATING THE SAFETY IMPLICATIONS OF INNOVATIVE BICYCLE FACILITIES

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The number of cyclists in Portland, Oregon, has increased dramatically over the past 10 years, and the city expects the number to continue to increase over the next two decades. To accommodate current cyclists more safely and to encourage future riders with safe, attractive routes, the Portland Bureau of Transportation (PBOT) has implemented a number of innovative facilities intended to improve cycling conditions, particularly in the downtown area. Since 2008, PBOT, Portland State University (PSU), and the Oregon Transportation Research and Education Consortium (OTREC) have collaborated on the evaluation of a number of these bicycle facilities to determine how they are working, what the safety effect has been, and what improvements can be made. Completed assessments include (*a*) an evaluation of green bicycle boxes installed in 2008 around the Portland downtown core, (*b*) a seven-block cycle track separated from motor vehicle traffic by a lane of parked cars, and (*c*) a couplet of wide buffered bicycle lanes running east–west through the Portland downtown core. A second-phase bicycle box study is under way at PSU, which, as in the initial phase, received matching funding from OTREC and PBOT. For each facility, PBOT collected video of the facility locations before and after treatment, which PSU analyzed for user behavior, interactions or conflicts between users, and other metrics. PSU also conducted surveys of affected user groups to assess how the facilities were being understood, used, and perceived. This poster highlights the facilities that have been evaluated. Brief discussions of key evaluation methods, metrics, and findings are included. Through the evaluations, the city of Portland, PSU, and OTREC have developed a strong collaborative relationship, which has allowed PBOT to explore new approaches to improving cyclist safety in Portland while expanding the base of knowledge about how such facilities operate in an American city. Furthermore, PBOT's commitment to funding bicycle safety research at PSU has allowed the university to hire faculty with transportation safety expertise. Finally, the city of Portland and agencies throughout the United States are taking the findings of these evaluations into account in building the next generation of bicycle facilities designed to provide a safe and comfortable riding experience to increasing numbers of cyclists, and the methodologies developed for these evaluations are informing research examining other innovative bicycle facilities.

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IMPROVING TRANSIT SAFETY IN FLORIDA THROUGH IMPLEMENTING YIELD-TO-BUS LED SIGNS

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Florida DOT sponsored a research initiative in 2004 to explore factors contributing to bus accidents near bus stops. The study found that 47 percent of all crashes between 1998 and 2002 corresponded to vehicles having rear-end collisions with buses. On the basis of these findings, Florida DOT has identified yield-to-bus (YTB) initiatives as one of the key components in increasing transit safety. YTB laws have been in place in many states for years. However, programs promoting YTB compliance have been difficult to fund and justify because of the lack of quantitative information concerning their effectiveness.

To increase highway safety for transit buses, Florida DOT, through the National Center for Transit Research (NCTR), actively pursues the best set of treatments to promote YTB awareness and compliance. Florida DOT, in conjunction with NCTR–Center for Urban Transportation Research, initiated a series of studies to improve transit safety at pullout bays. For the study "Moving the Bus Back into Traffic Safely—Signage and Lighting Configuration Phase I," an initial review of the available treatments and assessment of current YTB initiatives in Florida was performed. In addition, a bus operator survey was performed to obtain additional information on the effectiveness of current YTB treatments. A decal was the most common treatment for promoting YTB in Florida. Some isolated efforts by two agencies included flashing LED signs. Phase I also produced recommendations for roadside signs and lighting configurations for YTB treatments.

Phase II of the study identified and organized the available treatments as in-bus treatments and roadside treatments. It focused on in-bus treatments, specifically YTB LED signs. Phase II also focused on the field evaluation of in-bus treatments on two off-the-shelf YTB LED flashing signs from three participating transit agencies in Florida. The study assessed the safety and operational benefits of installing YTB LED flashing signs on the back of buses versus those of using YTB decals only. Three main performance measures were defined: number of merging maneuvers ending in yield, number of safety conflicts, and reentry time. The study found that the YTB behavior of motorists can be significantly improved by using flashing YTB LED signs. The study found that the YTB LED sign can reduce traffic conflicts.

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Phase II involved active cooperation among safety, operations, and maintenance departments of transit agencies; the research institution; and sign manufacturers. The safety department cooperated with the oversight of the study, identification of potential locations for the study, and bus operator training for the tests. Operations departments assisted in the scheduling of the selected vehicles through the previously identified locations during the selected periods. In addition, only specifically trained bus operators were scheduled for the duration of the study. The maintenance departments played a role in the study by installing the signs and attending to compliance details with regard to flashing and sign activation. In addition, the maintenance departments installed a special camera on the buses looking backwards to collect data on the traffic behind the bus.

In accordance with the recommendations of previous phases, a new project has been initiated through Florida DOT and NCTR with regard to possible roadside treatments and geometric considerations of bus bays in Florida. For this project, several bus bay design configurations and their compliance with the *Accessing Transit Design Handbook for Florida Bus Passenger Facilities* are being evaluated. This project involves cooperation not only with the transit agencies but also with local traffic operations and public works departments. The traffic operations role is related to the selection design of roadside treatments, which include roadside signs, pavement markings, flashing beacons, and smart signs. Where applicable, these designs will be submitted to the Federal Highway Administration for approval for experimentation. The role of public works departments is related to the installation and removal of the selected roadside treatments during the study period. One of the expected outcomes of this project is the design of new roadside safety treatments for transit agencies that can be included in the *Manual on Uniform Traffic Control Devices*. In addition to the roadside treatments, a new safety study of transit-related crashes is being performed under the same project. The new safety assessment will be performed with high-
quality data that will include better geographic information on incident location, roadway features, and traffic volumes.

COLLABORATIVE APPROACHES FOR IMPLEMENTING FHWA's INTERACTIVE HIGHWAY SAFETY DESIGN MODEL

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FHWA's Interactive Highway Safety Design Model (IHSDM) is a suite of software analysis tools for evaluating safety and operational effects of highway geometric design decisions. IHSDM includes six evaluation modules (Crash Prediction,

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Design Consistency, Intersection Review, Policy Review, Traffic Analysis, and Driver/Vehicle) that support decision making in the highway design process. Intended users include federal, state, and local highway agencies, as well as universities. The presentation will highlight university use of IHSDM and university–agency collaboration on IHSDM-related initiatives and will identify potential activities.

University use of IHSDM occurs on several levels: integration of IHSDM with highway design and safety-related courses, IHSDM as the focus of or in support of thesis and dissertation work, agency-sponsored research projects, and technology facilitation (e.g., hosting IHSDM training courses).

Universities and agencies can collaborate in evaluating and tailoring IHSDM for agency use, identifying the most effective and appropriate applications of IHSDM within the project development process, developing an implementation plan for agency use of IHSDM, and developing IHSDM training for universities.

The IHSDM Crash Prediction Module is a faithful software implementation of the *Highway Safety Manual* (HSM) Part C crash predictive methods. The HSM strongly recommends that agencies calibrate the prediction models "to provide results that are meaningful and accurate for each jurisdiction." The 2011 release of IHSDM includes a calibration utility to assist agencies with data input and processing and calibration factor calculations. Some state DOTs are working collaboratively with universities on model calibration. For example, Kansas DOT provided data to the University of Kansas for calibrating the rural two-lane highway segment prediction model; the University of Kansas used the IHSDM Crash Prediction Module to develop calibration factors and will provide recommendations on the most appropriate level of calibration for Kansas (e.g., one statewide factor versus regional or county-level factors).

Although satisfactory results from the HSM Part C predictive method can be obtained by calibrating the predictive model for each facility type, some agencies may prefer to develop jurisdiction-specific safety performance functions by using their own data. Utah DOT and Brigham Young University partnered to develop state-specific safety performance functions, which can be entered into IHSDM for use in the Crash Prediction Module.

These and other agency–university collaboration activities will support appropriate and effective implementation of IHSDM and, therefore, improved roadway safety.

ACCELERATED SAFETY IMPROVEMENT USING UNIVERSITY–AGENCY–INDUSTRY COLLABORATION

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Crossover crashes, in which a vehicle crosses a divided median and strikes a vehicle traveling in an opposing travel lane in a nearly head-on collision, constitute fewer

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than 2 percent of all crashes on divided highways but account for more than 30 percent of highway-related fatalities. Cable median barriers are used to reduce the frequency of crossover crashes and have reportedly reduced crossover crash risk and fatality rates by as much as 90 percent on divided roadways. However, cable median barriers are a risk to occupants of errant vehicles, since approximately 3 percent of all cable median barrier crashes result in a severe injury or fatality. The current base of cable median barriers is expected to double within the next 5 to 10 years. If the current rate of severe cable median barrier crashes is sustained as cable median barrier mileage increases, within only one decade as many as 500 fatalities and more than 2,500 severe injuries may occur annually because of cable median barrier crashes.

A study was funded through a cooperative grant provided by the Mid-America Transportation Center, Region VII UTC, to evaluate the causes of cable median barrier failures. For this study, a failure was defined as an occupant sustaining serious or fatal injuries. Knowledge of the cause of serious injury and fatal crashes was used to identify barrier design modifications, median construction recommendations, and barrier placement guidelines to improve the state of the art with respect to cable median barrier technology and implementation. The study examined the results of more than 15,000 cable median barrier crashes in 10 states to determine impact conditions leading to increased propensity for barrier failure. Design changes to barriers and installation practice are being pursued. The study is continuing.

The cable median barrier safety improvements study is being conducted at the Midwest Roadside Safety Facility, which is located at the University of Nebraska–Lincoln (UNL). The facility is recognized as a global leader in roadside design for safety and has collaborated extensively with government agencies and private companies. Much of the facility's experience in collaboration with government is based on the Midwest States Pooled Fund program. The program includes 10 state DOTs that pool their research funding for transportation safety. Sixteen state DOTs were contacted to obtain cable median barrier accident records in the form of police-level accident reports, including sketches of scene diagrams and crash narratives, when available. All relevant crash information was compiled into a database, and a statistical description of crashes involving serious injury or fatality was developed. The information and database were then used to develop recommendations concerning optimum cable barrier configuration and placement conditions.

In addition, potential contributors to unsafe vehicle–barrier interaction were identified for further investigation. As transportation research and operations budgets are reduced at the state, national, and local levels, the cooperative pooling of resources and information together with university collaboration enables DOTs to obtain a broader understanding of the inherent risks and benefits associated with roadside treatment options, including cable median barriers. On the basis of the results of this study, changes have been recommended at the federal testing level to evaluate cable median barriers in impact conditions commonly associated with crashes involv-

ing barrier penetration, vehicle rollover, or serious injury or fatality. Recommended changes in federal testing standards would be impossible without the collaboration of state DOTs and without the experience and expertise of the university researchers familiar with these testing standards.

Safence, Inc., a cable barrier manufacturer and subdivision of Blue Systems, Inc., supported this project by providing funding for full-scale crash testing that helped to isolate causes of unsafe barrier performance. The tests and findings from the accident data analysis have been used to provide recommendations for design changes to improve proprietary barrier designs. Private agencies are generally unable to obtain confidential crash data such as those obtained in this study. Thus, the study described here would have been impossible for a private company to undertake without collaborating with a university. Safence representatives hope to improve product performance and address problems in barrier design to make safer and more competitive products. Furthermore, the company has committed to evaluating the performance of its barrier systems under the new crash test conditions identified as commonly associated with serious injury and fatal cable barrier crashes. By incorporating design modifications developed during this study and revising test conditions to reflect impacts associated with barrier failure more accurately, Safence should be able to develop the safest products available anywhere on the globe. Another cable median barrier manufacturer, Brifen, has requested the results of the study and has indicated an intention to evaluate its barrier systems under the new recommended impact conditions.

University collaboration with state DOTs and cable median barrier manufacturers has provided state highway agencies with barrier placement guidelines that should result in significant improvements in safety performance. Barrier design modifications and identification of revised impact conditions that are more representative of crash conditions associated with barrier failures will help barrier manufacturers significantly reduce the number of serious and fatal injury crashes. Participation in this university–government–industry collaboration has helped all parties understand the magnitude of the safety problems associated with barrier design and placement guidelines. This appreciation for the large number of serious and fatal injuries associated with cable barrier crashes will ensure that the states and barrier manufacturers rapidly implement design and testing modifications identified in this study.

The study described here represents the first major effort to compile a large accident database of crashes involving a single barrier type. This approach provides the best possible method for isolating crash conditions and barrier configuration and placement geometries frequently leading to barrier failure. The information is being used by industry to improve its products and by state DOTs to identify the best available barriers and erect them in the regions of the median that can maximize motorist safety. These benefits would not be attainable without industry–university–government collaboration.

TENNESSEE GOVERNOR'S HIGHWAY SAFETY OFFICE AND THE UNIVERSITY OF TENNESSEE TRANSPORTATION CENTER PARTNERSHIP: DRIVING TOGETHER TOWARD SAFER HIGHWAYS

Jerry Everett,* *University of Tennessee Center for Transportation Research*
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This poster describes the partnership between the Tennessee Governor's Highway Safety Office (GHSO) and the Center for Transportation Research at the University of Tennessee, several of the key linkages, and how the partnership promotes highway safety in Tennessee.

Tennessee Traffic Safety Resource Service

The Tennessee Traffic Safety Resource Service (TTSRS) is one of the more enduring aspects of the partnership. TTSRS provides informational, educational, and web services to enhance traffic safety in areas such as safety belt usage, child restraint promotions, drunk driving programs, teen driving issues, and bicycle and pedestrian safety. TTSRS serves as a statewide clearinghouse for educational materials for traffic safety educators, law enforcement personnel, health professionals, safety advocates, and individuals. TTSRS has evolved into a one-stop service center for Tennesseans requiring information concerning traffic safety. The program offers technical assistance related to state highway safety laws and child passenger safety.

TTSRS also serves an important role in keeping state educators and law enforcement personnel abreast of traffic safety training, conferences, special program promotions, and data collection and dissemination for statewide safety education and enforcement campaigns.

Highway Safety Program Administration

In 2000 the Tennessee GHSO awarded a grant to the University of Tennessee's Center for Transportation Research for the creation of seven full-time positions on site at the GHSO offices in Nashville. The employees were tasked with providing assistance in the areas of traffic records, impaired driving, administration, public information, law enforcement, and safe communities.

Since the inception of the partnership, many of those filling the positions have excelled in their duties and evolved into leaders in the highway safety field. Through the support of the university and GHSO leadership, several have earned bachelor's and master's degrees to assist in their management responsibilities, and several have become certified child passenger safety technicians and certified instructors for the Traffic Safety Institute. The staff provides oversight of approximately 375 grants

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totaling more than $15,000,000 annually. Each year the staff provides support for multiple large-scale projects, including the annual Tennessee Lifesavers Conference, which hosts more than 400 traffic safety advocates, and Grant Orientation Workshops for 300 to 400 grantees.

Tennessee Law Enforcement Liaison Program

The partnership between the University of Tennessee and GHSO was enhanced in 2004 when the Tennessee Law Enforcement Liaison (LEL) program was formally established at the Center for Transportation Research. The program now includes a training coordinator, a program administrator, and four full-time LELs, each of whom is responsible for about a 25-county region of the state. The program administrator and LELs are former law enforcement officers and are accredited law enforcement instructors. Members of the LEL team serve as the drug recognition expert state coordinator and the standardized field sobriety testing state coordinator. The LELs organize and oversee the contributions of Tennessee's law enforcement agencies to national campaigns such as Click It or Ticket and Booze It and Lose It.

The National Law Enforcement Challenge is a friendly competition between law enforcement agencies of similar sizes and types. It recognizes and rewards the best overall traffic safety programs in the United States. The LELs administer the challenge in Tennessee. Participating agencies provide documentation of their agency's efforts and effectiveness in officer training, public information, and enforcement efforts to reduce crashes and injuries. This annual contest provides agencies with a chance to win a fully equipped police vehicle and other incentive items related to traffic enforcement.

Safety Campaign Awareness Survey

GHSO has partnered with the University of Tennessee Center for Transportation Research since 2004 to evaluate Tennesseans' awareness of media campaigns and gather their opinions concerning highway safety issues. To date, 40,000 Tennesseans have completed these highway safety surveys. Since 2006, data collection has been scheduled to coincide with major media buys throughout the year. The surveys are designed to provide the National Highway Traffic Safety Administration with the data needed to document exposure to the messaging used in large-scale media campaigns. The campaigns consistently evaluated over the years are Booze It and Lose It, which is evaluated twice in each grant year, and Click It or Ticket, which is evaluated each May.

Click It or Ticket has a recognition rate of 75 percent or higher in Tennessee, and roughly seven out of 10 respondents recognize the slogan "booze it and lose it." The much used older slogan "friends don't let friends drive drunk" is still recognized by more than six out of 10 respondents.

Safety Culture Survey

A telephone survey of 928 Tennessee residents was administered in spring 2011 to measure attitudes and opinions about traffic safety issues and driving habits. The survey instrument was designed to compare Tennesseans' views with those of the remainder of the country by replicating questions included in the third annual Traffic Safety Culture Index conducted by the American Automobile Association Foundation.

The results suggest that Tennesseans are similar to those across the country in their driving habits, attitudes, and beliefs about traffic safety issues. Approximately 75 percent report that they never drive without a seat belt and never text while they are driving. However, the same percentage report that they talk on a cell phone while driving. Texting while driving is a growing concern and is perceived to be as much of a threat to personal safety as drivers who have had too much to drink. The survey results indicate overwhelming support for requiring an interlock device on the car of someone who has received more than one DWI, screening drivers over 75, and banning texting while driving. Drivers were also asked to report on their personal attitudes and the attitudes held by their neighbors with regard to the acceptability of driving behaviors such as driving after drinking and texting while driving. Respondents consistently reported that they found the behaviors to be less acceptable than what they perceived their neighbors thought.

SCOPING STUDY FOR IMPLEMENTATION OF THE *HIGHWAY SAFETY MANUAL* IN ALABAMA

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The University Transportation Center for Alabama (UTCA) and the Center for Advanced Public Safety (CAPS) at the University of Alabama initiated a project in 2010 to develop a plan for Alabama DOT to implement the new *Highway Safety Manual* (HSM) methodologies into its day-to-day activities. The project is under way and is based on 10 primary work tasks, each of which addresses a major aspect of implementation planning. Many of the tasks will be conducted in parallel, saving time and allowing better coordination. The final task will be the development of a proposed work plan and a schedule for implementation. Each of the tasks is described below.

Task 1 is intended to foster interaction among UTCA and CAPS researchers and safety professionals in other states working to integrate the HSM into their practices (e.g., attending lead state workshops and NCHRP-sponsored training). The second task maps HSM-related needs and outcomes to various transportation safety provid-

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ers throughout the state including Alabama DOT, city and county officials, planning commissions, and consultants. The results of this project task will be a technical memorandum detailing when, why, and how the various end users can expect to use the HSM and related tools. The document will also identify data-related and training needs for each group to maximize the benefits of implementing the HSM. The preparation and circulation of this document to obtain concurrence early in the project will ensure that the project team is on track moving forward. The third and fourth tasks are intended to assess data and other needs required for using SafetyAnalyst and the Interactive Highway Safety Design Model (IHSDM), respectively, for safety-related studies in Alabama. Both tasks include efforts to identify data needs for the software packages and map them to data sources within Alabama DOT and other organizations involved in traffic safety work in Alabama. The capabilities and demands of the software packages will be examined in light of end user needs and capabilities by way of traditional strengths–weaknesses–opportunities–threats analysis. The result of this analysis will be a recommendation concerning the feasibility and evaluation of SafetyAnalyst and IHSDM and whether or how the systems provide benefits or logical coordination with the HSM in Alabama. Task 5 is an effort to identify any gaps in the data available from Alabama DOT and related agencies and to develop a plan to collect (where not currently available), maintain, and manage the necessary data for successful HSM implementation in Alabama. At the conclusion of this task, Alabama DOT will have a plan and process for collecting data needed for optimum operation of the HSM. This plan can serve as a guide for collecting data in other bureaus, or Alabama DOT may elect to include the HSM data generation in a larger project that addresses all of the department's data needs. The sixth task is an effort to integrate the existing traffic safety analysis tools currently used in Alabama into a new HSM-based approach. The CAPS-developed Critical Analysis Reporting Environment (CARE) has an embedded component that can find hot spots for any type of crash according to specified criteria (high rates, statistical outliers, etc.). Other criteria such as empirical Bayesian approaches could easily be added to CARE. Cost–Benefit Optimization for the Reduction of Roadway-Caused Tragedies (CORRECT) has been used by Alabama DOT since the early 1980s. CORRECT encompasses the entire process of field investigation of hot spots by using data generated during the hot spot determination procedure. It includes the data generated by crash location investigations from which costs and benefits of recommended improvements are determined and methods for ensuring that the maximum benefits are obtained given the funds allocated to an overall program. It has been continuously improved and now takes the critical locations obtained by CARE along with the standardized reports of specific crash information for each location and synthesizes the results into an optimal set of roadway improvements. It does this by maximizing the number of lives saved and the number of injuries avoided within the budget that is available for a given program. The seventh task

is an attempt to determine whether default safety performance functions (SPFs) in the HSM are applicable to local conditions in Alabama and, if not, how new Alabama-specific SPFs can be developed. Task 8 will synthesize the results of previous tasks aimed at assessing the feasibility of using SafetyAnalyst and IHSDM to perform traffic safety analyses in Alabama. At the conclusion of Task 9, Alabama DOT will receive the draft implementation plan, which will include work plans for each of the major implementation efforts (research, software development, integration of components, training, data collection, SPF development, calibration, etc.). A time frame and estimated costs will be included in the plan. Finally, Task 10 will allow for additional scoping exercises between Alabama DOT, UTCA, and CAPS to identify future efforts to further the partnership and continue the implementation of HSM into safety practices in Alabama.

This poster will present the planned activities associated with each task, progress to date, and other issues related to the execution of the partnership between UTCA and Alabama DOT.

IMPLEMENTING PEDESTRIAN SAFETY COUNTERMEASURES THROUGH UNIVERSITY AND GOVERNMENT PARTNERSHIPS: CASE STUDY FROM LAS VEGAS, NEVADA

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This poster summarizes a program aimed at enhancing pedestrian safety and improving pedestrian mobility in the Las Vegas, Nevada, metropolitan area, and its outcomes. The lead sponsor of this research, implementation, and evaluation program was the Federal Highway Administration, which provided about 75 percent of the funding. Five state and local government agencies were cosponsors and collectively provided about 25 percent of the funding. The five state and local agencies were the Clark County Department of Public Works, the City of Las Vegas Department of Public Works, Nevada DOT, the Nevada Office of Traffic Safety, and the Regional Transportation Commission of Southern Nevada. The efforts were led by researchers at the Transportation Research Center, University of Nevada, Las Vegas. The program was conducted in conjunction with similar efforts in the Miami–Dade County area in Florida and the city of San Francisco in California.

The program included identification of appropriate pedestrian safety countermeasures for deployment in Las Vegas that are potentially transferable to other areas in the United States, deployment of the countermeasures, and evaluation of their effectiveness. High-pedestrian-risk locations were identified on the basis of spatial and

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temporal characteristics of pedestrian crash data and crash rates, demographic characteristics, land use characteristics, and traffic characteristics. The countermeasures installed were signs, markings, signals, and other devices, and they were categorized broadly as follows: engineering based, intelligent transportation systems (ITS), and others. Appropriate measures of effectiveness (MOEs) were used in evaluating the effectiveness of the countermeasures. Field observations were used to quantify the MOEs. More than 18,000 pedestrians were observed in the field. The analyses include before-and-after studies as well as a comparative evaluation of MOEs across deployment sites and control sites. Parametric and nonparametric statistical tests were used to support the analyses.

Results of the analyses can be summarized broadly on the basis of relative effectiveness (high, medium, or low) and the relative costs [low (L), medium (M), or high (H)] of the countermeasures. The following were highly effective countermeasures: advanced yield markings (L), in-roadway knockdown signs (L), pedestrian countdown signals with animated eyes (M), Danish offset (H), median refuge (H), portable speed trailer (H), and pedestrian-activated flashing yellow (H). The following were moderately effective countermeasures: pedestrian call buttons that confirm—press visible/audible confirmation (L), turning vehicles yield to pedestrians (L), ITS no-turn-on-red signs (M), and automatic pedestrian detection devices (H). The following countermeasures had low effectiveness: warning signs for motorists (L), high-visibility crosswalk treatment (M), pedestrian channelization (H), and smart lighting (H).

The program produced information on critical issues related to coordination, scheduling, and procurement, especially when multiple administrative jurisdictions and vendors are involved, and on issues associated with changes in key personnel at each of these organizations. Other considerations include the significant time and effort required for permitting, procurement, and construction processes; legal aspects; and liability-related concerns posed by public agencies. Effective communication with various stakeholders and the user community is critically important. Involving a broad group of partners and stakeholders from inception yields significant benefits. Their perspectives, insights, and ingenuity were invaluable in various phases of the program.

STATISTICAL ANALYSIS OF MOTORCYCLE CRASHES IN MARYLAND

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Commuting and recreational motorcycle use in the United States has been on the rise since the mid-1990s, with motorcycle registrations increasing by 61 percent between 1996 and 2005. As the number of motorcyclists increases, the safety issues associated

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with this mode of travel need to be addressed. Motorcycle riders and passengers are much more vulnerable to injury in crash situations. While crash fatalities decreased from 1990 to 1997, fatalities in the United States have increased every year for the past 10 years.

Motorcycle crashes are becoming more and more frequent in Maryland. Although some studies have examined various aspects of motorcycles crashes in Maryland, a comprehensive data set and analysis of the road-related factors of motorcycle crashes have never been undertaken. This study identifies recurring or common road characteristics of motorcycle crashes in Maryland from 1998 to 2007.

The research project had three objectives:

- To perform a comprehensive statistical analysis of motorcycle crashes in Maryland,
- To identify crash and injury patterns (including areas with the highest crash rates, common issues of crash locations, the relationship between crash rate and volume, the relationship between rural and urban areas and crashes, difficulties in reporting and collecting crash data, and the types of roadways where most crashes have occurred), and
- To determine any increase or trend in motorcycle registrations and volumes and their relationship to crashes and injuries.

Motorcycle crash data were obtained from the National Highway Traffic Safety Administration's Crash Outcome Data Evaluation System, and road inventory data were obtained from the Maryland State Highway Administration. A geospatial joint was performed on the two data sets to have a comprehensive database of crashes and characteristics of the roads where the crashes occurred.

The preliminary data analysis indicated that most motorcycle crashes occurred on state roads with no access control and speed limits of 40 to 55 mph. They were mostly undivided, two-way roads with two through marked lanes and no auxiliary lanes—urban other principal arterials, urban minor arterials, and urban collectors. The crashes typically occurred during the day when weather conditions were sunny or cloudy and the road surface was dry. The majority of crashes were single-vehicle collisions in which the motorcycle was moving straight at a constant speed far from an intersection. The drivers, who were mostly men between 20 and 45 years old, were in normal condition and wore helmets. Prince George's County, Baltimore County, Baltimore City, Anne Arundel County, and Montgomery County had the highest percentage of the motorcycle crashes.

Fault tree analysis was implemented to find the variable combination responsible for the most motorcycle crashes. Categorical principal component analysis (CATPCA), which is factor analysis for categorical data, quantifies categorical variables while reducing the dimensionality of the data. CATPCA was used to group the variables and reduce the number of variables in the regression model. Most of the data

variables were ordinal and categorical. Because the probability distribution of the dependent variable within each road class fit the gamma function, a generalized linear model was used to estimate the crash rate (number of crashes per mile) for all roads in Maryland and each road type (freeway, arterial, and collector or local).

The important factors in motorcycle crashes were government control, shoulder type, road type, area type, and median width.

- Government control: County- and agency-controlled roads had a lower probability of motorcycle crashes than did state-controlled roads.
- Shoulder type: There was a higher probability of motorcycle crashes on roads without any shoulder or curbs than on roads with concrete or bitumen shoulders. The crash probability was also higher on roads with curbed shoulders than on roads with concrete or bitumen shoulders. However, there was a lower probability of motorcycle crashes on roads with gravel-stabilized shoulders than on roads with concrete or bitumen shoulders.
- Road type: Collector and local roads and arterials had a higher probability of motorcycle crashes than did freeways.
- Area type: More motorcycle crashes occurred on urban roads than on rural roads.
- Median width: The wider the median, the lower the probability of motorcycle crashes.

Engineers and safety officials can use this study's results to develop solutions to reduce the probability of motorcycle crashes.

APPENDIX B

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