Minnesota developed the Strategic Highway Safety Plan a decade ago, as the nation set a goal of reducing roadway deaths to less than one person per 100 million vehicle miles traveled. Last year, the nation still hadn’t reached this milestone (1.06 deaths occurred per 100 million miles), but Minnesota had lowered its fatality rate to 0.63 deaths (down from 1.48 deaths 20 years ago).

“When I look at what Minnesota has done over the last 15 years compared to other states, we’re one of the few states that has a pretty consistent downward trend [in fatal crashes],” said MnDOT state traffic engineer Brad Estochen, who gave an update on the highway safety plan during the first event in the Roadway Safety Institute’s fall seminar series. “I think we’re doing some unique things here that have given us these results.” These steps, Estochen says, have included passing a primary offense seatbelt law (seatbelt usage is now above 90 percent), investing in strategic safety infrastructure such as high-tension cable median barriers and focused enforcement of DWI, speed, and seatbelt laws.

To best understand the risk factors for fatal and serious injury crashes, the state combined real-life crash data with input from professionals in engineering, law enforcement, and emergency medical services, as well as everyday road users. The results showed that most crashes in the state involve multiple factors—such as road conditions, driver impairment, and driver age.

Estochen said this approach of analyzing data and gaining stakeholder perspectives provided new insights into the dynamic causes of fatal and serious injury crashes.

In conjunction with the Departments of Health and Public Safety, MnDOT created a highway safety plan aimed at both professional stakeholders and the community that identified critical strategies for reducing serious traffic incidents. It has been updated in 2007 and 2014.

Minnesota’s plan is informing the work of several RSI projects, including those examining policymaker support, or lack of, for safety countermeasures and stakeholder perspectives in deploying automated speed enforcement.

Beyond Minnesota, the Roadway Safety Institute has been working with the safety engineers in the other USDOT Region 5 states—Wisconsin, Michigan, Illinois, Ohio, and Indiana—to identify each state’s top safety needs, aligning with their Strategic Highway Safety
Plans, to create a pooled fund (available on the FHWA website).

Overall, Estochen said one of the best ways to reduce crashes in the state is to promote a culture of traffic safety—something he hopes the highway safety plan contributes to.

“Creating a traffic safety culture has nothing to do with building bigger and better roads,” he said. “It really has to do with making us as a state, as a community, and as individuals responsible for our actions.”

[This article was adapted from a story that first appeared on the Crossroads Minnesota Transportation Research Blog.]

Examine how drivers adapt to safety systems designed to help them

Many technological innovations designed to increase driver safety are already available, and many more are on the way. Some of these safety systems are designed to help drivers make appropriate decisions, while others will initiate decisions themselves if the driver is not capable during safety-critical moments. However, these systems can come with unanticipated effects—causing the driver’s behavior to change or adapt in unforeseen ways that may compromise the potential benefits of a system.

Researcher Linda Ng Boyle aims to make sure the adaptive effects of vehicle safety systems are fully understood. As professor and chair of the Department of Industrial and Systems Engineering at the University of Washington, she has conducted numerous studies that model the effects of drivers’ adaptive behavior on system safety. In October, Boyle delivered a presentation on her work as part of the Roadway Safety Institute’s seminar series.

According to Boyle, behavioral adaptation can have a significant effect on the performance of driver safety systems.

“The idea behind behavioral adaptation is that when you use a driving technology, your performance will initially improve, but over time your performance will level off,” Boyle said. If the system is deactivated, Boyle continued, there may be a positive transfer, where what the driver learned remains to make performance better than before. But the more likely case is that when the system is gone drivers revert to their baseline performance. “There’s also the chance of a negative transfer where your performance actually gets worse when the system is deactivated,” she said.

One specific technology influenced by driver adaptation is adaptive cruise control (ACC), which automatically adjusts a vehicle’s speed to maintain a safe distance from vehicles ahead. In her presentation, Boyle examined how ACC can be used as a case study to show how behavioral adaptation can be studied and modeled using two different approaches: naturalistic studies (using observation and information from a real-world environment) and driving simulation studies.

During the past five years, Boyle has conducted several studies to help shed light on the adaptive effects of ACC. For example, a naturalistic study analyzed real-world data to determine the likelihood of drivers manually braking when the ACC system began braking or slowing down the vehicle. A second study used a driving simulator to test how experienced ACC drivers used the driving technology, how often they engaged or disengaged the ACC, how many warnings the ACC system issued, and how much drivers trusted their ACC system.

“We found that though the group of drivers was pretty homogenous in terms of age, they all used ACC very differently,” Boyle said. She believes that the best way to effectively model drivers’ adaptive behavior is to use a balanced approach that takes into account both naturalistic and simulation studies.

“You need a range of different techniques and an understanding of how to bring them together,” Boyle said. “In this way, we’ll be able to learn how to design better systems that can reduce the risk and enhance the safety of everyone using the transportation network.”
Helping people with visual impairment find their way

Traveling alone in an unfamiliar environment can be a challenge for anyone, but especially for people who are blind or visually impaired. More than 3.4 million Americans 40 years and older are legally blind or visually impaired—and according to some estimates, that number will double by 2030. For RSI researcher Chen-Fu Liao, helping this growing population to more easily navigate is a top priority.

“In order to improve mobility, accessibility, and confidence in the transportation system, it is important to remove not only the physical barriers but also the information barriers that can impede mobility for people who are visually impaired,” says Liao, a senior systems engineer at the Minnesota Traffic Observatory who is leading research in this area.

In previous work, Liao developed the Mobile Accessible Pedestrian System, or MAPS, which uses smartphone technology to provide location and signal timing information to visually impaired pedestrians. Liao collaborated with Vision Loss Resources (VLR), Minnesota’s largest provider of rehabilitation services for people with vision loss, throughout development of his system.

Kate Grathwol, president and CEO of VLR, explains that the agency teaches blind and visually impaired people how to cross streets, where to catch light rail, how to use the bus—skills that give them independence—but then the world changes, and there’s road construction, or a sidewalk closed,” she says. Since pedestrians with vision impairment are unable to read signs giving directions, they may need to ask for help. “That’s not a bad thing, but nobody else has to—they can see. The real impact of this app is that it allows the same access for the blind and visually impaired that sighted people have,” she says.

Although MAPS received positive feedback from testers, Liao discovered the GPS technology was not as reliable as it needed to be. “Because we provide information to the visually impaired, we cannot afford to provide wrong information [even] one time,” Liao says.

“Smartphone GPS can usually provide good guidance in open areas. However, in indoor or ‘urban canyon’ conditions GPS receivers encounter interference and the positioning results often become inaccurate,” says Liao. “We realized the need for a self-aware infrastructure that can self-monitor and make sure the information it provides is always correct, even in a GPS-unfriendly environment.”

Liao’s team is currently developing a system that uses a standalone Bluetooth smart device to provide trustworthy information to people with visual impairment. Researchers began with commercially available Bluetooth low-energy (BLE) beacons, such as the kind that can be used to locate a misplaced purse or keychain. These beacons, however, are primarily designed to be detected or discovered and do not typically communicate with each other. To develop the new smart system, the team is integrating these commercial off-the-shelf beacons with the necessary interface elements to sense other BLE devices within their range of communication, he says.

The BLE beacons can be placed on traffic barrels, barricades, or signs in work zone applications or at decision locations such as store entrances. Then, using a positioning and mapping algorithm, the smart system creates a local map of the unfamiliar or hazardous environment. The BLE smart beacons remember and check with other BLE smart devices within their communication range to ensure the local map is correct and provide accurate positioning information in areas where GPS signals are unavailable. The system can estimate a user’s location based on nearby Bluetooth signals, share information among nearby devices, and inform the system administrator if any information has changed. For example, the system can detect when any of its beacons are not functioning—due to a loss of power or vandalism, for example.

“Our goal is to provide reliable situation awareness and navigation information to assist with way-finding for people who are visually impaired,” says Liao. The team’s mapping methodology, he says, will ensure that correct audible information, such as signal timing and intersection geometry, is provided to users at the correct location.

For the project’s final phase, researchers will integrate the Bluetooth system with the smartphone app and then conduct real-world tests of the technology.
Researcher Spotlight: Daniel Work

RSI researcher Daniel Work is an assistant professor in the Department of Civil and Environmental Engineering and the Coordinated Science Laboratory at the University of Illinois at Urbana-Champaign. His research focuses on the control, estimation, and optimization of transportation systems, mobile sensing, inverse modeling, and data assimilation.

“Our nation’s transportation infrastructure is getting old, and to get better performance out of those aging systems, we need to link our physical transportation infrastructure and our computing infrastructure to solve the critical issues in transportation,” Work says. “Computers are getting so much faster and sensors so much cheaper and easier to deploy, it is allowing us as researchers to see more about how those systems work in the real world so we make them better and improve their performance. That’s the big picture of what we’re working on in our lab.”

Work’s diverse professional experience gives him the expertise needed to study the intersection of transportation and technology. In addition to holding a Ph.D. in civil engineering, he spent a number of years at the Nokia research labs developing smartphone apps for traffic estimation and working for Microsoft research on traffic estimation.

Currently, Work is conducting an RSI-sponsored research project to improve rail-crossing safety through the accurate prediction of train times. The project studies train delays to accurately estimate train arrival times at crossings to support in-vehicle driver alerts on personal navigation devices. It will also enable effective management of emergency response resources on the road network when trains at crossings may temporarily disconnect emergency vehicles from parts of the community they serve.

“Just knowing that there is a rail crossing doesn’t mean much—there’s only a very small period where drivers need to be alerted to possible delays or collision risks and possibly rerouted around a crossing,” says Work. “Giving drivers information about when trains might be at those crossings can provide a variety of safety and operational improvements on our road network.”

Work earned his bachelor’s degree from Ohio State University and a master’s degree and Ph.D. from the University of California, Berkeley, each in civil engineering. His awards and honors include receiving the CAREER Award from the National Science Foundation in 2014 and the IEEE Intelligent Transportation Systems Society Best Dissertation Award in 2011.

Researcher Spotlight: Chen-Fu Liao

Chen-Fu Liao is a senior systems engineer at the RSI-affiliated Minnesota Traffic Observatory, a facility of the University of Minnesota’s Department of Civil, Environmental, and Geo-Engineering. Much of Liao’s research focuses on using intelligent transportation system technologies to help people with vision impairment. He has also conducted research in the areas of incident decision-support systems, database management and data mining, and freight performance measures and developed undergraduate and graduate curriculum to support transportation education and training.

Liao’s interest in technology to help the visually impaired stemmed from his volunteer experience with Vision Loss Resources in Minneapolis. Liao worked with the agency and its clients extensively when developing a smartphone system to assist the visually impaired with crossing streets at signalized intersections. In a 2014 project, Liao’s research team also developed a smartphone app that alerts pedestrians with visual impairment to upcoming work zones and helps them navigate those areas safely. Liao is currently working on an RSI-sponsored project building on this earlier research. The project—A Positioning and Mapping Methodology using Bluetooth and Smartphone Technologies to Support Situation Awareness for the Visually Impaired—will create and test a network of Bluetooth modules that can provide reliable situation awareness and navigation information to help these pedestrians with wayfinding when GPS-based information is unavailable. This self-monitoring wireless infrastructure could also be used to warn sighted pedestrians...
when they are distracted by their smartphone and entering a busy intersection, Liao says. Liao’s research will also help combat what he believes is one of today’s most pressing transportation safety issues: distraction. “Distracted drivers and the growing number of distracted pedestrians who are texting or checking messages on their phone while walking or crossing intersections create a serious safety challenge,” says Liao. “Technology can help, but we also need to continue our focus on education and raising awareness of potential danger.”

Liao received his bachelor’s degree in mechanical engineering from National Chunghsing University in Taiwan and a master’s degree in mechanical engineering from the University of Minnesota. Before joining the University of Minnesota, he worked as a product-development engineer specializing in pneumatic linear positioning systems at Tol-O-Matic Inc. He is a member of the Transportation Research Board and the Institute of Navigation, and is also a research scholar with the Center for Transportation Studies at the University of Minnesota.

Seminars share perspectives on Institute research and beyond

This is the second fall semester that the Roadway Safety Institute offered a seminar series featuring leading safety researchers presenting on topics related to our research focus areas of high-risk road users and traffic safety systems.

Presenters have hailed from our consortium member institutions as well as universities across the country, including the University of Texas at Austin, University of Wisconsin–Madison, University of Washington, University of Massachusetts Amherst, and University of Maine.

Each seminar qualifies for one Professional Development Hour (PDH), and they are also available as a one-credit course at the University of Minnesota; nine students are taking the course for credit. Our researchers are also engaging students at partner universities: in Hugo Zhou’s (Auburn University) research course, students can earn credit by remotely attending the seminars. Albert Luo (Southern Illinois University Edwardsville) is offering the series as an extra credit opportunity in one of his courses.

Highlights from two seminars are featured in this issue of Roadway Safety Institute News, and all seminars are recorded and available for viewing on the RSI website.

Building skills and connections through internship

While some interns spend their days making copies and coffee runs, Caitlin Johnson spent her summer internship working on a research project exploring ways to improve safety in work zones.

Johnson, a fifth-year civil engineering student at the U of MN Twin Cities, participated in this year’s Summer Transportation Internship Program. Roadway Safety Institute staff facilitated Johnson’s placement within MnDOT’s Office of Traffic, Safety, and Technology (OTST). Johnson says her internship at MnDOT gave her the opportunity to study a topic that hasn’t been explored in-depth in the past and present those findings to industry professionals, including staff from the Federal Highway Administration.

“I’ve been finding things that people weren’t really expecting,” Johnson says. “And it might change the way that we go about making work zones safer.”

Johnson’s time with MnDOT didn’t end when the summer did; she’s continuing to work for the OTST during the 2015–16 school year.

Institute presents at Tribes and Transportation Conference

On October 13, 2015, the Institute participated in the Minnesota Tribes and Transportation Conference, held in Morton, Minnesota. The theme of this year’s conference, which drew more than 150 attendees representing tribal, state, and federal agencies, was “Technology and Innovation in Tribal Transportation.” Among those attendees, nine of the eleven federally recognized tribes were represented.
RSI Program Director Stephanie Malinoff provided an overview of the Institute’s education and workforce development initiatives intended to engage the next generation of the transportation workforce. “The conference offered the opportunity to foster connections with tribal transportation leaders from throughout the state, which will help us grow the initiatives we’ve put in place so far, especially the summer camps and programs for tribal youth,” Malinoff says.

RSI researchers Kathy Quick, Guillermo Narváez, and Tom Horan presented on their research aimed at better understanding transportation safety risks on tribal lands through collaboration with American Indian communities in Minnesota. Quick and Narváez are reviewing crash data, collaborating with the Advocacy Council on Tribal Transportation, and conducting interviews with key stakeholders. “This is producing rich data about what local experts know about the sources of risk, how they manage those risks, and what they recommend to improve data,” Quick said. Horan gave an overview of a set of new GIS applications that could assist tribes with transportation safety planning. During the presentation, audience members gave feedback on the prototype applications’ potential usefulness and benefits to tribal safety.

The Institute was also a sponsor of this year’s event.

**Workshops highlight options for pedestrian safety**

On November 19, the Roadway Safety Institute held the first of three pedestrian safety workshops. RSI researcher Ron Van Houten of Western Michigan University (WMU) discussed innovative treatment options to improve pedestrian safety at the workshop in the Waukesha/Milwaukee, WI, area. Forty attendees consisting of planners, engineers, and others interested in traffic safety joined in a group discussion after Van Houten’s presentation. One goal of the workshops is to identify specific problems in the area that could potentially be addressed by RSI researchers. Attendees also viewed a video demonstration of RSI researcher Chen-Fu Liao’s smartphone application for warning distracted pedestrians of potential hazards.

Van Houten is a professor in the Department of Psychology at WMU and a behavior analysis expert in the areas of traffic safety, pedestrian safety, intelligent transportation systems, traffic calming, bicycle safety, seat belt use, and reducing impaired driving. His specific projects have included conducting research on bicycle lanes, participating in the development of shared use bicycle marking, and completing a number of large-scale studies on reducing nighttime pedestrian crashes. Many of these projects included social norming elements to target shifts in the safety culture.

Additional workshops were held in early December in Columbus, OH, and Indianapolis, IN, attracting 21 and 27 attendees. The Institute is producing a summary of the workshops that will be available on our website in early 2016.