Contents

About the Institute ...................................................... 2
Research Overview ...................................................... 4
Research Highlights ..................................................... 6
Education Highlights ................................................... 18
Technology Transfer Highlights .................................... 21
Research Projects ....................................................... 24
Staff, Researchers & Board ......................................... 30
Those using our region’s roadways aren’t as safe as they should be. More than 4,400 people died on Region 5 roads in 2014, while many thousands more suffered life-changing injuries. At the Roadway Safety Institute, we are engaged in many different ways to try and identify both the root causes of road fatalities and serious injuries and the countermeasures that can help to address them.

Technology is one solution that can contribute to safer driving. A good example of a technology likely to make a difference is adaptive cruise control, especially those variations that can also automatically brake and resume from a standstill in stop-and-go traffic. This is now appearing on various car models.

But there is a downside to technology. Driving while distracted has reached epidemic proportions. Even hands-free voice commands and texting while stopped at intersections contribute to the problem, as recent research is showing. The results are disturbing.

In addition to those killed while driving distracted, pedestrians are being killed and injured while looking at their smartphones as they enter an intersection.

Smartphones (which we often forget are but a small package of sensors, wireless communication systems, and computers with a programmable human-machine interface) may themselves provide a solution. RSI researchers are developing systems that use smartphones to warn motorists of work-zone hazards and help pedestrians with visual impairment navigate, among other applications.

Removing the driver from the car is not yet the solution it is made out to be. Filling in for human limitations, such as in our work on an older driver support system, is one approach. We must address those aspects of traveler behavior that contribute to road fatalities and life-changing crashes—and we need to do it soon. By drawing on the safety-related expertise and strengths of all our Institute researchers, we are tackling the problem from all directions.

Finally, the leadership of Minnesota’s Toward Zero Death Program has provided strong support to the Roadway Safety Institute and its researchers for many years. So we are saddened to see Sue Porter step down as Minnesota’s State Traffic Engineer and co-chair of TZD as she takes on a new role at the Minnesota DOT. We wish her well.

Max Donath
About the Institute

The Roadway Safety Institute (RSI) is the Region 5 University Transportation Center (UTC) funded through the federal transportation bill passed in 2012. The region includes Minnesota, Illinois, Indiana, Michigan, Ohio, and Wisconsin.

The Institute conducts activities that further the mission of the UTC program of the USDOT—to advance U.S. technology and expertise in the many disciplines that make up transportation through education, research, and technology transfer activities at university-based centers of excellence.

Our objective is simple: improve safety for those who use the network, regardless of where they live or how they travel on it. To that end, we are working to develop and deploy human-centered transportation systems focused on specific users and on how systematic improvements can affect them and broader groups of travelers.

The consortium is led by the University of Minnesota. Other members are the University of Akron, the University of Illinois at Urbana-Champaign, Southern Illinois University Edwardsville, and Western Michigan University.
Our research is driven by the goal of preventing crashes to reduce fatalities and life-changing injuries. Research concentrates on user-centered transportation safety, addressing both traffic safety system approaches and high-risk road users. Specific projects in our research topic areas include:

**Rail crossing safety**
- Predicting possible railroad crossing incidents through modeling
- Forecasting train arrival times for better emergency response
- Planning and coordinating emergency response to rail incidents

**Tribal safety**
- Collaborating with American Indian communities to learn about their travel risks
- Using GIS to improve traffic safety on tribal lands

**Connected vehicles**
- Facilitating safer freeway merging
- Alerting highway workers to potential hazards
- Creating a testbed for connected vehicles

**Pedestrian and bicycle safety**
- Evaluating pedestrian-activated crossing systems
- Developing a risk model for pedestrian and bicycle travel in urban areas
- Alerting drivers and bikers to potential collisions through a bicycle warning system

**Safety policy**
- Identifying attitudes for and against automated speed enforcement
- Examining the effect of exempting minor speed violations
- Making crash data more accurate and easier to collect
- Uncovering why policymakers support—or oppose—traffic safety countermeasures
Impaired drivers
- Identifying where law enforcement should focus DWI efforts

Driver distraction
- Investigating the effectiveness of in-vehicle safety messages in work zones
- Examining how in-vehicle alerts influence driver behavior

Intersection safety
- Improving left-turn safety at intersections
- Using high-res traffic signal data to estimate traffic conflicts

Safety for design and operations
- Assessing the safety of two-lane roundabouts
- Exploring sensing for high-occupancy vehicle and high-occupancy toll lane enforcement

Vulnerable users
- Exploring how certain medical conditions may affect safety for truck drivers
- Developing smartphone technology to assist blind pedestrians with wayfinding
- Supporting older drivers with a system to help them navigate

Work-zone safety
- Studying how driver attention is affected by automated speed enforcement in work zones
- Improving work-zone safety with connected vehicle technology

Wrong-way driving
- Preventing wrong-way-driving crashes with directional rumble strips

More detailed information on all Roadway Safety Institute projects can be found on pp. 24–28.
With early warning about traffic delays ahead of them, highway drivers can adjust their speeds to keep traffic flowing smoothly and avoid dangerous sudden stops that often result in rear-end crashes. Nationally, the U.S. Department of Transportation has made the development of smart speed harmonization and queue warning systems that can provide these warnings a high priority.

As part of this national effort, researchers at the Roadway Safety Institute-affiliated Minnesota Traffic Observatory (MTO) are working to establish a testbed for developing and testing connected vehicle technologies and applications, including speed harmonization and queue warning.

“A lot of people in the federal government [and] academia are creating new connected vehicle technologies,” says MTO director John Hourdos, who is leading the project. “They will need a place where they can test them in a real environment—in a very interesting environment.”

The testbed is building on the MTO’s permanent I-94 field lab, which consists of three rooftop locations equipped with surveillance cameras and machine-vision sensors focusing on a high-crash area of I-94 in Minneapolis. “We are very fortunate to be near a very unfortunate site,” Hourdos says, referring to the area that experiences more than 100 crashes annually—the majority of which are rear-end crashes resulting from a failure to stop or too little headway. Since 2003, this lab has been capturing detailed data on hundreds of crashes, including sensor data, video records, and Minnesota Department of Transportation control actions.

This project is adding two basic elements to the current I-94 lab: high-resolution radar sensors, which will allow the researchers to collect vehicle trajectories, and a communication element in the form of roadside units that transmit radio signals compatible with the dedicated short-range communications (DSRC) standard.

So far, researchers have been deploying and testing
the sensors in different locations, allowing them to better gauge radar accuracy and improve speed detection. They are also able to compare the new sensor data with that from existing camera locations for real-time observation. In addition, they’ve upgraded their wireless communication and used the improved sensor data to create and test a new version of the queue warning application. Next steps include deploying additional sensors, conducting live field tests of the infrastructure-based queue-warning application, and developing a vehicle-to-infrastructure (V2I) version of the application.

Ultimately, Hourdos says, the result of this project will be a fully functional connected vehicle testbed uniquely situated to attract freeway safety-oriented V2I and vehicle-to-vehicle safety application development, implementation, and evaluation projects.
Reducing impaired driving and the injuries and fatalities that result from alcohol-related crashes is a major focus of every law enforcement agency and countless education campaigns, but the resources available for those efforts are finite. One question is how to use these limited resources to make the biggest impact.

“Building a better map to identify crash hot spots is essential,” says William Schneider, an associate professor in the University of Akron Department of Civil Engineering. “Law enforcement agencies and motorist education campaigns have a set budget; optimizing hot-spot mapping for these groups allows them to better manage their resources and improves both education and enforcement.”

In a current project for the Roadway Safety Institute, Schneider is building on previous research to identify geospatial trends in alcohol-related crashes to help law enforcement target efforts for preventing them. Traditionally, crash-mapping techniques have either been point-, segment-, or zone-based. Each of these techniques has advantages and disadvantages, and often these basic statistical tools provide only preliminary results.

“By combining traditional crash-mapping techniques into a more advanced analysis, we can overcome many of the weaknesses of these basic analysis methods,” Schneider says. “For example, we are using the exact same crash data but joining both point- and zone-based analysis to improve the accuracy of crash hot-spot identification.”

Most recently, researchers have updated historical crash records, identified movements of crash-related hot spots, and optimized law enforcement patrol routes. In addition, they’ve created maps to compare different counties and types of analyses, including looking at single-versus multiple-vehicle crashes.
Next, the research team will add route optimization between hot-spot areas. “This will provide information on each individual route an officer drives, incorporating the time taken at a traffic stop,” says Schneider. “Additionally, we will project how many traffic stops an officer may make while being able to complete the route in the time allotted.”

Ultimately, better crash mapping will not only lead to more targeted education and enforcement efforts, but also help improve long-term resource allocation for highway safety stakeholders.

“This information can guide decisions about long-term budgeting,” says Schneider. “It will help organizations manage their resource allocation to do more with less and offer a non-biased way to justify why those dollars are being spent in a certain location instead of somewhere else.”
Traveling alone in an unfamiliar environment can be a challenge for people who are blind or visually impaired. For RSI researchers, helping this growing population more easily navigate is a top priority.

“To improve mobility, access, 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 Chen-Fu 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 reliable enough. “Because we provide information to the visually impaired, we cannot afford to provide wrong information [even] one time,” Liao says.

This RSI-sponsored work is aiming to improve the app’s accuracy and reliability by developing a “self-aware” infrastructure—one that can monitor itself and ensure the information it’s providing is up to date, even in a
GPS-unfriendly environment (such as indoor or “urban canyon” conditions). Liao and his team have developed a standalone Bluetooth Low Energy (BLE) smart system integrating commercial off-the-shelf BLE beacons. The system can detect when any of its beacons are not functioning—due to a loss of power or vandalism, for example.

Since these BLE beacons are primarily designed to be detected and not communicate with each other, the researchers are integrating them with the necessary interface elements to sense other BLE devices within their range, Liao says. The BLE beacons can be placed on traffic barrels, barricades, signs in work zones, or in other locations. Then, using a positioning and mapping algorithm, 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 the project’s final phase, researchers will integrate the Bluetooth system with the smartphone app and then conduct real-world tests of the new technology.

Chen-Fu Liao tested his app on the University of Minnesota campus.
Recent years have seen a significant increase in trains carrying hazardous materials such as oil, gas, and ethanol. Rail safety is a critical issue in Midwestern states such as Illinois, Wisconsin, and Minnesota because many of these trains pass through those states’ major population centers on the journey to East Coast refineries.

To make local communities safer, researcher Yanfeng Ouyang is leading a project to develop ways to better prepare for and respond to a potential emergency.

“Railroad-related incidents involving hazardous materials can cause severe consequences and pose significant threats to safety, public health, and the environment,” says Ouyang, an associate professor of civil and environmental engineering at the University of Illinois at Urbana-Champaign.

In addition to determining the optimal deployment of emergency response resources, this work will also provide tools and guidance to help local officials reach multijurisdictional collaborations that maximize coverage and minimize response time in case of an emergency, Ouyang explains.

One particular challenge is the “probabilistic nature of risks,” he says. “These [incidents] are random. How do we capture the probability and even the correlation among incidents in multimodal networks as well as the potential disruption to the first responders? We really should touch on all the possibilities that may happen randomly.”

To that end, the research team is creating mathematical models and techniques that enable systematic analysis of the emergency response system. The research considers the vulnerability of the emergency response system itself, such as the risk of blocked crossings or other disruptions for first responders. The result will provide operations guidelines and practical tools to policymakers to encourage systems that support safe and efficient railroad industry operations.
Though still under way, this project is already generating significant interest, with one article published and another under review by a leading journal in the field. Ouyang says his efforts are among the first to develop a new framework for analyzing and modeling network disruptions from railroad incidents and for planning reliable emergency response systems toward preventing these disruptions.

In the next phase of this project, the researchers will produce a model that can be used to coordinate emergency response to rail incidents among multiple jurisdictions, including those from different states and the private sector. “For example, a railroad is generally privately owned in this country, so who owns the responsibilities is a big issue,” Ouyang says.

In addition, the researchers are pursuing opportunities to develop a case study using real-world context and data that could be used by practitioners. For example, Ouyang is in touch with one of the Class-I railroads and the Illinois Fire Service Institute on developing potential case studies.
The motor vehicle crash fatality rate is higher for American Indians than for any other ethnic or racial group in the United States: the number of fatal motor vehicle crashes decreased in the nation as a whole from 1975–2002, but increased by 52 percent on tribal lands.

In an RSI-sponsored project, assistant professor Kathryn Quick and research associate Guillermo Narváez at the University of Minnesota’s Humphrey School of Public Affairs are collaborating with American Indian communities to better understand the transportation safety risks on tribal lands and develop strategies to mitigate these risks.

The researchers are focusing on gathering on-the-ground knowledge about the nature of roadway risks and options to improve safety on reservations in Minnesota.

“We’re also actively and intentionally trying to build and sustain relationships with tribal communities to address these kinds of issues over the long term,” Quick says.

Recent project accomplishments include reviewing crash data, selecting case study sites, and developing collaborations with four tribal governments—the Red Lake Band of Chippewa, Leech Lake Band of Ojibwe, Fond du Lac Band of Lake Superior Chippewa, and Mille Lacs Band of Ojibwe—to conduct the case studies. In addition, researchers have interviewed more than 100 key stakeholders from tribal governments and adjacent jurisdictions, including specialists in road engineering and maintenance, law enforcement, emergency response, and injury prevention. They have also gathered data from more than 200 professional drivers and reservation residents so far. “These interviews are producing rich data about what local experts know regarding the sources of risk, how they manage those risks, and what they recommend to improve data,” Quick says.

Preliminary findings suggest that tribal transportation safety problems may not be so different from rural safety.
problems across the nation, with the exception being an elevated concern for pedestrian safety. Many reservation residents, by choice or necessity, travel on foot in the roadway as a way to get around, and several tribal governments are actively promoting walking, jogging, and biking for their recreational and health benefits. However, people feel unsafe because of narrow road shoulders, poor lighting, vegetation, or wildlife.

In the next phase of the project, researchers will begin data collection and consultation at four study sites based on the agreements they have with the tribal governments and complete a detailed analysis of the data.

“Our findings will provide a much more nuanced, ground-level picture of the nature of safety risks on tribal lands in the upper Midwest,” Quick says. “We’ll also be able to help identify policies and investments to address those concerns while building long-term relationships with tribal governments around transportation issues to support ongoing collaborative research with the tribes.”
In recent years, manufacturers have begun equipping many new cars with collision-prediction systems that warn drivers of possible collisions and help them take evasive action. Now RSI researchers are investigating the development of similar technology for bicycles.

This project is working to develop a sensor system for a bicycle that can predict imminent crashes and provide an audio warning to both the bicyclist and motorists.

More than 48,000 bike–car crashes occur in the United States each year, notes Rajesh Rajamani, professor of mechanical engineering at the University of Minnesota (U of MN) and the lead investigator on the project. This research is focusing on three of the most common types of crashes: rear-end collisions, right-turn collisions, and side collisions while the bicycle is riding across an intersection.

Rajamani and doctoral student Woongsun Jeon are currently developing sensor systems and collision-prediction algorithms and testing these algorithms in simulations and experiments.

“Previous projects on vehicle tracking have been developed only for cars and have mostly focused on highway scenarios,” Rajamani says. “This is perhaps the first research project where tracking of vehicles at a traffic intersection has been developed and also the first project for a bicycle collision-warning system that goes beyond rear or straight-frontal collisions.”

So far the researchers have implemented the rear-collision-avoidance component, based on rear laser sensors, and the side-collision-avoidance system, which uses a custom sonar sensor consisting of one transmitter and two receivers. The configuration allows researchers to estimate both the lateral distance to a car and the orientation of that car.

Researchers have tested a bicycle equipped with the warning system on the U of MN campus—and seen...
promising results. Preliminary experiments have shown that the sensor suite on the bicycle can accurately estimate vehicle position and orientation for scenarios involving vehicles approaching cyclists from behind and vehicles turning right at intersections.

Upcoming plans include enhancing the bike’s instrumentation by adding multiple laser sensors and a video camera for recording during potential collisions, developing a system to monitor multiple vehicles at an intersection using front laser sensors, and extensively testing the bike at real-world intersections.

Rajamani says the system is self-sufficient in that it doesn’t depend on cars having any special technology: “All the technology that is needed is on the bicycle.” If the final results demonstrate that the system works reliably and performs effectively, it could be commercialized into an inexpensive product sold to bicycle riders, he says. In addition, the technology has the potential to be extended to motorcycles in the future.
In June 2015, the Institute sponsored one day of a two-week summer camp program for 40 White Earth Nation youth in grades 4 to 8 in northwestern Minnesota. The program focuses on hands-on learning and uses American Indian culture and heritage as a vehicle for studying math, science, and engineering.

RSI staff taught several classes about safe travel in a variety of modes. Students experimented with reflectivity to understand safe pedestrian and bike travel and studied GIS mapping. The dangers of distracted driving and walking were also demonstrated by testing students’ reaction time. Connections to students’ heritage included Ojibwe vocabulary lessons and discussions of local animals’ travel patterns and traits and associating them with GIS maps.

Through these interactive lessons, students deepened their science and math skills while learning practical information about being safe travelers. Local engineers and a 3M representative also participated, sparking students’ desire to pursue higher education and STEM careers.

RSI staff and White Earth Nation summer campers discussed safe travel concepts.
Exploring new options for pedestrian safety

In June 2014 and November and December 2015, Western Michigan University’s Ron Van Houten, with assistance from RSI staff, delivered pedestrian safety workshops in Minneapolis, Columbus, Indianapolis, and Milwaukee for planning and engineering professionals. In the workshops, Van Houten shared innovative treatment options to serve pedestrians in a wide variety of walking environments and participated in small-group discussions with attendees.

One goal of the workshops was to identify specific problems in each area that could potentially be addressed by Institute researchers. Attendees at the November and December workshops also watched a video demonstration of RSI researcher Chen-Fu Liao’s smartphone application for warning distracted pedestrians of potential hazards. A total of 113 planners, engineers, and others interested in traffic safety attended the workshops.

The Institute will be producing a summary document in early 2016, which will be available at roadwaysafety.umn.edu.

Moving ahead with museum exhibit

Planning continues for our upcoming pedestrian-safety-themed exhibit at The Works Museum, a hands-on science and technology museum, in Bloomington, MN. In May 2015, Institute and museum staff visited Bancroft Elementary School in Minneapolis and led a focus group for fourth- and fifth-grade students on safe travel and road behavior. Findings from the focus groups, as well as input from RSI human factors researcher and cognitive psychologist Nichole Morris, were used to narrow down options to four potential exhibit topics. The topics are now being further refined with our selected fabricator to determine the final exhibit. The goal of the finished exhibit—slated to open in June 2016—is to teach kids how to make safe travel decisions and to introduce them to transportation career concepts.

Nichole Morris
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 University of Minnesota–Twin Cities, participated in the 2015 Summer Transportation Internship Program. RSI 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.
In May 2015, the Roadway Safety Institute held a one-day event featuring the latest work by our researchers. Greg Winfree, USDOT Assistant Secretary of Transportation for Research and Technology, opened the Roadway Safety Showcase: Safety Innovations for Today and Tomorrow, which was held in St. Paul, MN, in conjunction with the University of Minnesota’s Center for Transportation Studies annual Transportation Research Conference.

The Institute’s goal is to prevent crashes that reduce fatalities and life-changing injuries—which fits well with the USDOT’s vision for the future of transportation safety, according to Winfree. “The first 50 years of transportation safety focused on occupants surviving crashes,” Winfree said. “The next 50 years will be about avoiding those crashes altogether.”

Researchers from three U of MN campuses and other RSI member institutions—the University of Illinois at Urbana-Champaign, University of Akron, and team of Auburn University/Southern Illinois University Edwardsville—shared updates on projects related to tribal nation road safety, connected vehicle technology, bicycle and pedestrian safety, wrong-way driving, automated speed enforcement, alcohol-related hot-spot analysis, a decision-support system for older drivers, and commercial vehicle driver safety.

Max Donath, the USDOT’s Amy Stearns and Greg Winfree, and John Hourdos toured the I-94 field lab in conjunction with the Safety Showcase.
Seminars address Institute research and beyond

Featuring leading roadway safety researchers, the Roadway Safety Institute seminar series provided updates on research related to high-risk road users and traffic safety systems in a wide range of disciplines. Presenters were both RSI researchers and researchers from other institutions across the U.S. For out-of-state researchers, the Institute facilitated networking meetings with U of MN faculty as well as state and local transportation practitioners.

Each seminar qualified for one Professional Development Hour, and nine students took the course at the U of MN for credit. Additionally, in Hugo Zhou’s (Auburn University) research course, students earned credit by remotely attending the seminars, and Albert Luo (Southern Illinois University Edwardsville) offered the series as an extra credit opportunity in one of his courses.

The seminars, which were held in the fall of 2014 and 2015, were open to the public, broadcast live on the web, and recorded for later viewing. The 12 fall 2015 seminars attracted 137 attendees in person and 659 viewers watching online.

Institute research in the news

RSI researchers and facilities captured media attention in numerous newspaper, television, and radio news stories highlighting our work. Among the headlines:

- **U study questions Minnesota speed laws** *(Minnesota Daily)*: Researcher Frank Douma shared results of his study on an amendment to a state law exempting low-level speeding tickets from driver’s records—results that found an exemption in the law may allow repeat offenders to keep their license when they would otherwise be revoked or suspended.

- **The Drive: Why we don’t have more flashing yellow arrows** *(Minneapolis Star Tribune)*: Gary Davis’s work on flashing yellow arrows, which permit motorists to turn left after yielding to oncoming traffic and pedestrians, was highlighted.

- **Driving too fast? Your cell phone will text your mom** *(Minnesota Public Radio News)*: HumanFIRST researchers described a cell phone app that monitors teens’ driving habits in real time and alerts their parents when they break the rules of the road.

- **Is V2V soon to be a reality?** *(KMSP TV)*: MTO director John Hourdos and researcher Frank Douma commented about connected vehicle technology and the testbed under development along Interstate 94.
Connecting to the wider world through:

- **Our website: roadwaysafety.umn.edu**
  - 11,091 visits

- **Roadway Safety Institute News**
  - 7 issues
  - 1,593 subscribers

- **Social media**
  - RSI Facebook
  - Twitter @RoadwaySafetyIn
  - LinkedIn

- **Research project briefs on**
  - Bike and pedestrian safety
  - Tribal safety initiatives
  - Rail crossing safety
  - Lidar scanning

Our blog
- [https://roadwaysafety.instituteblog.wordpress.com/](https://roadwaysafety.instituteblog.wordpress.com/)

Read, subscribe, or download at roadwaysafety.umn.edu/publications.
The following active projects include those funded by the Institute as well as those funded through match. For more details on these projects, visit roadwaysafety.umn.edu/research.

**Accident Prediction Models Using Macro- and Micro-Scale Analysis**  
Principal investigator: Rahim Benekohal, UIUC  
Funding: RSI  
This project is developing a methodology for analyzing crashes at a micro level to discover trends at a single railroad crossing or a series of crossings along a corridor or a region, and to improve the accuracy of crash predictions by incorporating the findings from microscopic analyses and studying the regional trends that emerge in this analysis.

**Exploring Links Between Medical Conditions and Safety Performance in Tractor Trailer Drivers**  
Principal investigator: Stephen Burks, UMN–Morris; co-investigator: Jon Anderson, UMN–Morris  
Funding: RSI  
This project is exploring the relationship between medical conditions, particularly obstructive sleep apnea, and safety performance for commercial motor vehicle operators.

**Developing and Validating a Model of Left-Turn Crashes to Support Design and Operations**  
Principal investigator: Gary Davis, UMN; co-investigator: Abhisek Mudgal, UMN  
Funding: RSI  
This project is investigating left-turn gap acceptance, the trajectories followed by left-turning drivers, and classification of left-turn crash types, as well as developing and validating a simulation model of left-turn crashes to help transportation engineers identify when to use permitted left-turn treatments versus a protected left turn.

**Estimation of Traffic Conflicts at Signalized Intersections Using High-Resolution Traffic Signal Data**  
Principal investigator: Gary Davis, UMN  
Funding: MnDOT  
This project is using high-resolution traffic signal data directly collected from existing loop detection systems to build and calibrate a crash-prediction model for traffic engineers to evaluate traffic safety performance at signalized intersections.
Safety Study of I-35W Improvements Done Under UPA Project  
Principal investigator: Gary Davis, UMN; co-investigator: John Hourdos, UMN  
Funding: MnDOT  
This project is using an interrupted time-series approach to test for changes in safety effects (e.g., crash experience) before versus after the Urban Partnership Agreement project (a package of interventions aimed at improving travel on the I-35W corridor) to inform the potential implementation of these interventions in other corridors.

Identifying and Reconciling Stakeholder Perspectives in Deploying Automated Speed Enforcement  
Principal investigator: Frank Douma, UMN; co-investigator: Nichole Morris, UMN  
Funding: RSI  
This project is examining the perceptions of affected stakeholders in selected states in Region 5 in order to understand the causes for the continued conflict around deploying automated speed enforcement.

Impact of Exempting Low-Level Speed Violations  
Principal investigator: Frank Douma, UMN  
Funding: MnDOT  
This project is examining the impacts on public safety, frequency of speeding, crash rates, travel time efficiency, travel time reliability, and data privacy of Minnesota’s Dimler Amendment (Statute 171.12, Subd. 6), which keeps certain speeding violations off a driver’s record.

Development and Demonstration of Merge-Assist System Using Connected Vehicle Technology  
Principal investigator: M. Imran Hayee, UMN–Duluth  
Funding: RSI  
This project aims to acquire real-time relative trajectories of vehicles traveling toward a merging junction using DSRC-based vehicle-to-vehicle communication.

DSRC-Based Warning System for Worker Safety  
Principal investigator: M. Imran Hayee, UMN–Duluth  
Funding: MnDOT  
This project aims to develop a DSRC-based worker safety system that can provide construction vehicle operators and drivers passing by a work zone more situational awareness about the presence of workers.

Using GIS To Improve Tribal Traffic Safety  
Principal investigator: Thomas Horan, CGU; co-investigator: Brian Hilton, CGU  
Funding: RSI  
This project is investigating the potential of new advances in geographic information systems (GIS) to enhance the collection, availability, and use of transportation-safety-related information.

Assessing the Impact of Pedestrian-Activated Crossing Systems  
Principal investigator: John Hourdos, UMN  
Funding: MnDOT  
This project is integrating results from a prior crash-record-based safety study with direct, long-term, and staged observations of
pedestrian-vehicle interactions at crosswalks with particular safety treatments to determine their effects on pedestrian crashes.

Evaluation of Safety and Mobility of Two-Lane Roundabouts
Principal investigator: John Hourdos, UMN; co-investigator: Stephen Zitzow, UMN
Funding: Minnesota Local Road Research Board
This project aims to collect observations of all undesirable driving maneuvers on 2x2 roundabouts (two entering through-lanes crossing two exiting through-lanes) in Minnesota and relate the frequency of each individual type to specific design features.

Implementation of a V2I Highway Safety System and Connected Vehicle Testbed
Principal investigator: John Hourdos, UMN; co-investigator: Stephen Zitzow, UMN
Funding: RSI
This project aims to capitalize on the already extensive instrumentation available at the Minnesota Traffic Observatory’s I-94 field lab to develop a connected vehicle testbed specifically for the implementation and testing of speed harmonization and queue warning systems.

A Positioning and Mapping Methodology Using Bluetooth and Smartphone Technologies to Support Situation Awareness and Wayfinding for the Visually Impaired
Principal investigator: Chen-Fu Liao, UMN
Funding: RSI
This project is developing a system (integrating commercial off-the-shelf Bluetooth devices) that can self-monitor and ensure the information provided to visually impaired pedestrians through a navigation app is accurate and up to date.

Investigate the Effectiveness of Using Bluetooth Low Energy Technology to Trigger In-Vehicle Messages at Work Zones
Principal investigator: Chen-Fu Liao, UMN
Funding: MnDOT
This project is investigating the effectiveness of using in-vehicle messages to calibrate drivers’ understanding of work zones to reduce risky behavior associated with distraction—specifically, examining an inexpensive technology based on Bluetooth Low Energy tags deployed in or ahead of work zones.

Performance Measures for Bicycle and Pedestrian Safety: Methodologies for Monitoring Traffic Volumes and Assessing Exposure to Risk
Principal investigator: Greg Lindsey, UMN
Funding: RSI
This project aims to develop protocols and methodologies for estimating bicycle and pedestrian traffic volumes that can be used to inform assessments of exposure to risk.

Directional Rumble Strips for Reducing Wrong-Way-Driving Freeway Entries
Principal investigator: Albert Luo, SIUE; co-investigator: Huaguo Zhou, Auburn University
Funding: RSI
This project is developing a new countermeasure (directional rumble strips) for mitigating wrong-way-driving incidents.
Computerized Crash Reports Usability and Design Investigation  
Principal investigator: Nichole Morris, UMN  
Funding: MnDOT  
This project aims to design and create an electronic crash report interface that improves the accuracy, speed, reliability, and meaningfulness of crash report data entry by law enforcement personnel.

Examination of Driver Performance and Distraction with In-Vehicle Signing  
Principal investigator: Nichole Morris, UMN  
Funding: MnDOT  
This research is exploring how well drivers perform in a driving simulator using a smartphone interface to project in-vehicle alerts.

Examining the Impact of ASE in Work Zones on Driver Attention  
Principal investigator: Nichole Morris, UMN  
Funding: MnDOT  
This project is examining driver attentional patterns as motorists travel through work zones and the impact that automated speed enforcement may have on driver attention.

In-Vehicle Work-Zone Messages  
Principal investigator: Nichole Morris, UMN  
Funding: MnDOT  
This project aims to design and evaluate auditory, in-vehicle messages presented by a smartphone to catch drivers’ attention, especially those who might be already engaged in smartphone use.

Older Driver Support System (ODSS) Usability and Design Investigation  
Principal investigator: Nichole Morris, UMN  
Funding: RSI  
Through interviews, an interface display survey, a usability test, and a controlled field study with older drivers, this project aims to better outline the needs of those drivers and to prepare the Older Driver Support System prototype for a field operational test.

Assessing Factors Affecting Policy Leadership in Adopting Road Safety Countermeasures  
Principal investigator: Lee Munnich, UMN  
Funding: RSI  
This project is analyzing various aspects of state highway safety plans and approaches tied to the Toward Zero Deaths program, focusing on garnering a better understanding of why certain roadway safety provisions have or have not been adopted in the six Midwestern study states.

Positioning, Planning, and Operation of Emergency Response Resources and Coordination Between Jurisdictions  
Principal investigator: Yanfeng Ouyang, UIUC  
Funding: RSI  
This project seeks to develop methods and guidance for strategically positioning and allocating emergency responders and resources in anticipation of potential crashes in a region that may be impacted by rail incidents.
Safety in Numbers? Accessibility, Traffic, and Safety of Nonmotorized Travelers
Principal investigator: Andrew Owen, UMN; co-investigator: David Levinson, UMN
Funding: RSI
This project is developing a risk model for pedestrian and bicycle travel in urban areas that reflects the cross-modal interactions produced by varying levels of nonmotorized and motorized travel on individual road segments or intersections.

Sensing for HOV/HOT Lane Enforcement
Principal investigator: Nikos Papanikolopoulos, UMN; co-investigator: Vassilios Morellas, UMN
Funding: MnDOT
This project is developing a system involving emerging technology and software algorithms to automatically estimate the occupancy of passenger vehicles in high-occupancy vehicle and high-occupancy toll (HOV/HOT) lanes.

Collaborating with American Indian Communities to Re-Interpret and Strategize About Transportation Safety Risks in Tribal Lands
Principal investigator: Kathryn Quick, UMN; co-investigator: Guillermo Narváez, UMN
Funding: RSI
This project aims to better characterize and improve strategies to address the unusually high rates of fatalities and severe injuries from transportation-related crashes among American Indians in the United States.

Novel Collision-Avoidance System for Bicycles
Principal investigator: Rajesh Rajamani, UMN
Funding: RSI
This project is developing a sensor system for a bicycle that can predict imminent bicycle-motorist crashes and provide an audio warning of the bicycle’s presence to the motorist.

Alcohol-Related Hot-Spot Analysis and Prediction
Principal investigator: William Schneider, Akron
Funding: RSI
This research is identifying geospatial trends in alcohol-related motor-vehicle crashes to help law enforcement target efforts for preventing them.

Accurate Prediction of Train Arrival Times for Emergency Response Management and Driver Decision Support
Principal investigator: Daniel Work, UIUC
Funding: RSI
This project is studying train delays to accurately estimate train arrival times at grade crossings to support in-vehicle driver alerts on personal navigation devices.
Key Staff

Max Donath
Director, Roadway Safety Institute
Professor, Dept. of Mechanical Engineering
University of Minnesota
612-625-2304; donath@umn.edu

Stephanie Malinoff
Program Director, Roadway Safety Institute
University of Minnesota
612-624-8398; malinoff@umn.edu

Brenda Thomas
Director of Coordinated Research, Roadway Safety Institute
612-625-8401; bkthomas@umn.edu

Dawn Spanhake
Associate Director, Development and Finance Center for Transportation Studies
University of Minnesota
612-626-1536; spanh001@umn.edu

Researchers

Jon Anderson
Professor of Statistics, Div. of Science and Math
University of Minnesota Morris
320-589-6306; anderson@morris.umn.edu

Rahim Benekohal
Professor, Dept. of Civil & Environmental Engineering
University of Illinois at Urbana-Champaign
217-244-6288; rbenekoh@illinois.edu

Stephen Burks
Professor of Economics and Management, Division of Social Science
University of Minnesota Morris
320-589-6191; svburks@morris.umn.edu

Brian Davis
Research Fellow, Intelligent Vehicles Laboratory, Dept. of Mechanical Engineering
University of Minnesota
612-625-0323; davis862@umn.edu

Gary Davis
Professor, Dept. of Civil, Environmental, & Geo- Engineering
University of Minnesota
612-625-2598; drtrips@umn.edu

Frank Douma
Director, State & Local Policy Program
Humphrey School of Public Affairs
University of Minnesota
612-626-9946; douma002@umn.edu

M. Imran Hayee
Professor, Dept. of Electrical Engineering
University of Minnesota Duluth
218-726-6743; ihayee@d.umn.edu

Brian Hilton
Clinical Associate Professor, Center for Information Systems & Technology
Claremont Graduate University
909-607-8209; brian.hilton@cgu.edu

Thomas Horan
Professor and Director, Center for Information Systems & Technology
Claremont Graduate University
909-607-9302; tom.horan@cgu.edu

John Hourdous
Director, Minnesota Traffic Observatory Adjunct Assistant Professor, Dept. of Civil, Environmental, & Geo- Engineering
University of Minnesota
612-626-5492; hourd001@umn.edu

David Levinson
Professor, Dept. of Civil, Environmental, & Geo- Engineering
University of Minnesota
612-625-6354; dlevinson@umn.edu

Greg Lindsey
Professor, Humphrey School of Public Affairs
University of Minnesota
612-625-0669; linds301@umn.edu
Chen-Fu Liao  
Senior Systems Engineer, Minnesota Traffic Observatory  
University of Minnesota  
612-626-1697; cliao@umn.edu

Albert Luo  
Distinguished Research Professor, Dept. of Mechanical Engineering  
Southern Illinois University Edwardsville  
618-650-5389; aluo@siue.edu

Nichole Morris  
Principal Researcher, HumanFIRST Laboratory  
University of Minnesota  
612-624-4614; nlmorris@umn.edu

Abhisek Mudgal  
Post-Doctoral Associate, Dept. of Civil, Environmental, & Geo-Engineering  
University of Minnesota  
512-814-6803; mudga017@umn.edu

Lee Munnich  
Senior Fellow, State & Local Policy Program  
Humphrey School of Public Affairs  
University of Minnesota  
612-625-7357; lmunnich@umn.edu

Guillermo Narváez  
Research Associate, Humphrey School of Public Affairs  
University of Minnesota  
612-624-2465; gnarvaez@umn.edu

Yanfeng Ouyang  
Associate Professor, Dept. of Civil & Environmental Engineering  
University of Illinois at Urbana-Champaign  
217-333-9858; yfouyang@illinois.edu

Andrew Owen  
Research Fellow, Dept. of Civil, Environmental, & Geo-Engineering  
Director, Accessibility Observatory  
University of Minnesota  
612-626-0024; aowen@umn.edu

Kathryn Quick  
Assistant Professor, Humphrey School of Public Affairs  
University of Minnesota  
612-625-2025; ksquick@umn.edu

Rajesh Rajamani  
Professor, Dept. of Mechanical Engineering  
University of Minnesota  
612-626-7961; rajamani@umn.edu

William Schneider  
Assistant Professor, Dept. of Civil Engineering  
University of Akron  
330-972-2426; whs4@uakron.edu

Ron Van Houten  
Professor, Dept. of Psychology  
Western Michigan University  
269-387-4471; ron.vanhouten@wmich.edu

Guillermo Narváez  
Research Associate, Humphrey School of Public Affairs  
University of Minnesota  
612-624-2465; gnarvaez@umn.edu

Yanfeng Ouyang  
Associate Professor, Dept. of Civil & Environmental Engineering  
University of Illinois at Urbana-Champaign  
217-333-9858; yfouyang@illinois.edu

Andrew Owen  
Research Fellow, Dept. of Civil, Environmental, & Geo-Engineering  
Director, Accessibility Observatory  
University of Minnesota  
612-626-0024; aowen@umn.edu

Kathryn Quick  
Assistant Professor, Humphrey School of Public Affairs  
University of Minnesota  
612-625-2025; ksquick@umn.edu

Rajesh Rajamani  
Professor, Dept. of Mechanical Engineering  
University of Minnesota  
612-626-7961; rajamani@umn.edu

William Schneider  
Assistant Professor, Dept. of Civil Engineering  
University of Akron  
330-972-2426; whs4@uakron.edu

Ron Van Houten  
Professor, Dept. of Psychology  
Western Michigan University  
269-387-4471; ron.vanhouten@wmich.edu

Guillermo Narváez  
Research Associate, Humphrey School of Public Affairs  
University of Minnesota  
612-624-2465; gnarvaez@umn.edu

Yanfeng Ouyang  
Associate Professor, Dept. of Civil & Environmental Engineering  
University of Illinois at Urbana-Champaign  
217-333-9858; yfouyang@illinois.edu

Andrew Owen  
Research Fellow, Dept. of Civil, Environmental, & Geo-Engineering  
Director, Accessibility Observatory  
University of Minnesota  
612-626-0024; aowen@umn.edu

Kathryn Quick  
Assistant Professor, Humphrey School of Public Affairs  
University of Minnesota  
612-625-2025; ksquick@umn.edu

Rajesh Rajamani  
Professor, Dept. of Mechanical Engineering  
University of Minnesota  
612-626-7961; rajamani@umn.edu

William Schneider  
Assistant Professor, Dept. of Civil Engineering  
University of Akron  
330-972-2426; whs4@uakron.edu

Ron Van Houten  
Professor, Dept. of Psychology  
Western Michigan University  
269-387-4471; ron.vanhouten@wmich.edu
Advisory Board

Laurie McGinnis
Chair
Director, Center for Transportation Studies
University of Minnesota

Laura Bloomberg
Associate Dean, Humphrey School of Public Affairs
University of Minnesota

David Brand
County Engineer
NACE Northeast Region Vice-President
Madison County, OH

D. Scott Dibble
Senator
State of Minnesota

Tom DiSalvi
Vice President, Safety & Loss Prevention
Schneider National Inc.
Green Bay, WI

Monique Evans
Director of Safety Research & Development
Federal Highway Administration

Jan Homan
Deputy Chief of Bus Operations
Metro Transit

Mos Kaveh
Associate Dean, College of Science & Engineering
University of Minnesota

Arlene Kocher
Division Administrator
Federal Highway Administration–Minnesota Division

Matthew Langer
Chief
Minnesota State Patrol

Sue Mulvihill
Deputy Commissioner and Chief Engineer
Minnesota Department of Transportation

Dan Murray
Vice President of Research
American Transportation Research Institute

Sue Porter
Director, Office of Traffic, Safety & Technology
Minnesota Department of Transportation

Jean Wallace
Assistant Division Director, Modal Planning & Program Management Division
Minnesota Department of Transportation

Rick West
Public Works Director/County Engineer
Otter Tail County, MN