

# ROADWAY SAFETY INSTITUTE

Human-centered solutions to advance roadway safety

## Program Progress Performance Report for University Transportation Centers

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## CONTENTS

Accomplishments .....	1
Major goals and objectives of the program .....	1
Accomplishments .....	2
Opportunities for training and professional development .....	6
Dissemination .....	6
Plans for next reporting period .....	6
Products .....	10
Publications, conference papers, and presentations.....	10
Websites or other Internet sites .....	11
Technologies or techniques .....	12
Inventions, patent applications, and/or licenses .....	12
Other products .....	12
Participants and Other Collaborating Organizations .....	12
Organizations that have been involved as partners .....	12
Other collaborators or contacts.....	12
Impact .....	13
Impact on the development of the principal discipline(s) of the program.....	13
Impact on other disciplines.....	14
Impact on physical, institutional, and information resources.....	14
Impact on transportation workforce development and human resources .....	15
Impact on technology transfer .....	15
Impact on society beyond science and technology.....	15
Changes/Problems .....	16
Changes in approach and reasons for change.....	16
Actual or anticipated problems or delays and actions or plans to resolve.....	16
Changes that have significant impact on expenditures.....	17
Significant changes in use of care of human subjects, vertebrate animals, and/or biohazards .....	17
Change of primary performance site location from that originally proposed .....	17

## ACCOMPLISHMENTS

### Major goals and objectives of the program

The Roadway Safety Institute (RSI) draws on highly innovative researchers located across Region 5 to focus on targeted research, education, and technology transfer activities aimed at determining and delivering the next wave of transportation safety improvements.

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, user-centered transportation systems will be developed and deployed to focus our work on specific users of the system and on how systematic improvements can affect both key user groups and broader groups of travelers.

This objective will be accomplished by meeting the following goals in research, education and workforce development, and technology transfer activities as well as through collaboration and diversity.

#### *Research*

The Institute is focusing on traffic safety system approaches by researching design- and operation-related safety solutions that reduce fatalities and life-changing injuries across the nation. In addition, the Institute is addressing the following MAP-21 priorities to improve highway safety: rural road safety measures, human factor studies and measures, data collection and analysis, and safety policy studies. The Institute is also focusing on high-risk road users by addressing key safety issues for these groups through research and by examining public engagement strategies to help improve safety on tribal lands.

Countermeasures are effective tools for practitioners to use to improve roadway safety, and our research is working to develop strategies that can be put to use. In addition, our research is investigating methodologies and metrics, in particular related to pedestrian and bicycle travel. Results of this work will provide practitioners with tools for better decision making, ultimately improving safety for those roadway users.

#### *Education and workforce development*

The Roadway Safety Institute is developing a variety of activities targeted to primary and secondary students throughout Region 5 that raise awareness of transportation safety topics and identify exciting career opportunities in related fields. Goals include leveraging WTS's Transportation YOU mentoring program to encourage young female students throughout our region to pursue transportation-related degrees; demonstrating safe driving concepts to students in STEM summer camps; and developing a roadway-safety-themed museum exhibit to be displayed at science, children's, or transportation museums throughout Region 5.

We will continue to demonstrate a commitment to workforce development through activities that engage both practicing professionals and students. For practitioners, we are providing continuing education through a seminar series; developing training programs with the Local Technical Assistance Programs in our region; and delivering pedestrian safety workshops to professionals in all Region 5 states. The Institute is also adapting our transportation internship program to connect students to safety-related internships.

## ***Technology Transfer***

We are working to expand our existing partnerships to foster research innovation and deployment that includes increasing public agency and private sector partners, and we will continue to pursue patents and license agreements with the private sector. We are also communicating research findings to the transportation community for their successful implementation. We have created a consortium website and electronic newsletter and plan to create policy briefs, research videos, and an Institute summary report. In addition, the Institute is leveraging numerous channels to exchange information among partners and provide resources to practitioners, researchers, agencies, and other stakeholders in Region 5. Specific efforts include communicating information at regional conferences, seminars, and workshops and through presentations and social media outlets.

## ***Collaboration***

The Institute is bringing together the diverse strengths, knowledge, and experience of our consortium members to work toward the shared goal of reducing fatalities and injuries on our roadways. Through collaboration, RSI will draw on and expand our many successful partnerships with public, private, academic, and not-for-profit entities. Our goal is to advance the roadway safety knowledge base, address critical workforce needs, implement research activities, and transfer research findings using our established relationships.

## ***Diversity***

We are working to broaden participation and enhance diversity in the transportation sector by supporting female and minority STEM faculty, leveraging the existing Transportation YOU programs in our region, and expanding STEM opportunities for American Indians. Efforts include connecting with tribal middle and high schools in Region 5 to engage students in STEM-related activities, and identifying ways to support leadership development for female and minority STEM graduate students and faculty.

## **Accomplishments**

### ***Research***

Our consortium draws on our members' safety-related expertise and complementary research strengths to achieve measurable gains in safety.

Programmatic research accomplishments include:

- All 18 Institute-funded projects now have peer-reviewed work plans and executed contracts. Descriptions of all active projects are available on our website as well as in the Transportation Research Board (TRB)'s Research in Progress (RiP) database.
- Fifteen RSI researchers have submitted peer-reviewed Nine-Month Progress Reports and subsequently received a second year of project funding.
- We have identified 17 projects at the Institute funded by the Minnesota Department of Transportation (MnDOT) to be used as match funding. The projects, all of which focus on issues related to roadway safety, are worth a combined \$2,345,859.

Highlights from active research projects:

- *Exploring Links Between Medical Conditions and Safety Performance in Tractor Trailer Drivers:* Stephen Burks completed the process of matching cases of truck drivers diagnosed with obstructive sleep apnea to controls based on their months of insurance enrollment. Burks has derived statistical results for medical insurance claims and sent the first complete draft of a paper reporting the analysis to co-authors for review.

- *Identifying and Reconciling Stakeholder Perspectives in Deploying Automated Speed Enforcement*: Frank Douma completed a literature review of automated speed enforcement and developed a hypothetical stakeholder map. He also interviewed 16 stakeholders from law enforcement, public health, and other government entities.
- *Impact of Exempting Low-Level Speed Violations*: Frank Douma completed this project examining the impacts of Minnesota's Dimler Amendment (Statute 171.12, Subd. 6), which keeps certain speeding violations off a driver's record. Douma's findings question the efficacy of the law, in that the public appears to be unaware of it and an exemption in the law may allow repeat offenders to keep their driver's license when they would otherwise be revoked or suspended.
- *DSRC-based Warning System for Workers' Safety*: Imran Hayee developed and field tested the proposed system and found that it can successfully show the presence of workers around a construction vehicle on an Android-based tablet with acceptable distance and direction accuracies. Further, the results show that the equipment can post a variable speed limit based on the presence of a worker.
- *Performance Measures for Bicycle and Pedestrian Safety: Methodologies for Monitoring Traffic Volumes and Assessing Exposure to Risk*: Greg Lindsey completed two research case studies in Minneapolis, data collection in Grand Marais, and mapping historic bike counts in Duluth and Bemidji. He also acquired computer tools for estimating network measures needed to model bicycle traffic volumes in Bemidji, Duluth, and Grand Marais.
- *Directional Rumble Strips for Reducing Wrong-Way-Driving Freeway Entries*: Albert Luo completed literature reviews on transverse rumble strips, conducted initial field tests to estimate vibrations for the vehicle and passengers, and submitted a technical paper on the preliminary results to the Transportation Research Board's 2016 meeting. He also conducted a national survey to collect ideas on directional rumble strip design and feasibility from transportation professionals.
- *Computerized Crash Reports Usability and Design Investigation*: Nichole Morris successfully conducted thorough beta testing of an electronic crash report built by technology company Appriss Inc. Morris recommended three distinct interfaces, which were tested extensively to give fast-paced feedback to spur important improvements to the reports, which will be used by Minnesota law enforcement beginning in 2016.
- *Older Driver Support System (ODSS) Usability and Design Investigation*: Nichole Morris completed interviews and focus groups aimed at gathering information about older drivers with and without technology experience. She also created an interface display survey and awaits institutional review board approval to commence research activities.
- *Collaborating with American Indians to Re-Interpret and Strategize About Transportation Safety Risks in Tribal Lands*: Kathy Quick and Guillermo Narvaez have selected several case study sites, written a review of the literature, executed the contract, and completed institutional board review of protocols. They also initiated and strengthened relationships with key collaborators that include tribal traffic safety leaders and four tribal governments, as well as visited seven tribal governments and conducted 35 interviews with 30 unduplicated study participants.
- *Novel Collision-Avoidance System for Bicycles*: Rajesh Rajamani conducted a series of simulations for a bicycle traveling through an intersection that utilized a custom laser sensor to track moving vehicles. Initial results indicate that the collision-warning system is able to estimate vehicle position and orientation well for the two scenarios tested (rear collision and right-turning vehicle).
- *Alcohol-Related Hot Spot Analysis and Prediction*: William Schneider updated historical crash records, identified spatio-temporal movements of crash-related hot spots, and optimized law enforcement patrol routes. He also created hot spot maps comparing counties and different methods of analysis.

- *Improving Railroad Grade Crossing Safety: Accurate Prediction of Train Arrival Times for Emergency Response Management and Driver Decision Support*: Daniel Work completed a literature review on train travel-time-delay studies and collected data on 282 Amtrak trains from 2011 through 2013. He also developed two classes of algorithms to apply to the dataset, which includes more than 100,000 trips. The work was accepted for publication at one conference and presented in five settings.

### **Education and workforce development**

During this reporting period, the following initiatives helped us meet our goals of attracting and preparing future transportation professionals and expanding the knowledge of current practitioners.

- Planning continues for our upcoming safety-themed exhibit at The Works 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. The focus groups' findings informed a July 2015 meeting with those same staff and RSI researcher and human factors psychologist Nichole Morris. The goal of the finished exhibit—slated to open in June 2016—is to teach kids how to make safe decisions, especially regarding visibility.
- In September 2015, we held the first three events of the Fall 2015 RSI Seminar Series, drawing 116 attendees. These events are open to the public and streamed online. They are also available as a one-credit course at the University of Minnesota; 11 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. Dates and speakers have been secured for the remaining events, which will run through December.
- In July 2015, the Institute participated in the University of Minnesota's National Summer Transportation Institute, a two-week summer camp that introduced 30 middle school students to careers in transportation. Over the course of the camp, RSI staff member Colleen O'Connor Toberman presented a session on retroreflectivity; RSI researcher Nichole Morris led a session on human factors and gave a tour of the HumanFIRST driving simulator; and MnDOT senior research analysis specialist Katie Fleming led a session on crash data analysis. The Institute also sponsored a lunch for the students.
- In July 2015, Morris's graduate assistant presented her human factors curriculum at the College of Science & Engineering's Discover STEM camp, which introduced approximately 20 incoming 11<sup>th</sup>- and 12<sup>th</sup>-grade students to science careers.
- In March 2015, Daniel Work and staff members from his research lab participated in the University of Illinois Engineering Open House, a two-day event for middle and high school students that is the largest of its kind in the country. During the open house, Work demonstrated traffic sensing technologies to the participants.
- Over the summer, University of Minnesota undergraduate student Caitlin Nuce completed an Institute-secured internship at MnDOT's Office of Traffic, Safety & Technology. MnDOT has asked Nuce to stay on as an intern for the academic year.

See the Diversity section for further updates related to education and workforce development.

### *Technology transfer*

Roadway users will be safer when our research findings are put into the hands of those who can use them to reduce fatalities and injuries. Toward that goal, we spread this information in varied ways to reach both specific groups and broad audiences—from conference presentations to social media. During this reporting period, we engaged in the following technology transfer activities:

- Institute staff developed a new one-page handout, “Rail Crossing Safety Research.” We also distributed our existing handouts, “Roadway Safety Institute Overview” and “Tribal Safety Initiatives,” at the LTAP/TTAP National Meeting in July. All three documents are available for download on the Institute’s website.
- We distributed two issues of our e-newsletter, one in May and one in September 2015. Since the last reporting period, we have grown our subscriber base from 1,492 to 1,593, and the average open rate has stayed steady at 23.5 percent.
- To share our work as widely as possible, we continue to maintain a news feed on the Institute’s blog and home page, as well as regularly update our RSI Facebook, Twitter, and LinkedIn accounts. Our Twitter account (@RoadwaySafetyIn) has shown notable growth; between April and September, we increased our Twitter impressions from 420 to 5,500.
- Greg Winfree, USDOT Assistant Secretary of Transportation for Research and Technology, opened the Roadway Safety Showcase: Safety Innovations for Today and Tomorrow, a one-day event highlighting the latest work by researchers from the Roadway Safety Institute. The May 21 showcase was held in St. Paul and featured researchers from 16 RSI-funded projects. Approximately 85 people attended the event.
- On April 1, 2015, RSI staff member Gina Baas presented on roadway safety issues at a public meeting hosted by Representative Rick Nolan of Minnesota’s 8th Congressional District. The meeting at Isanti Community College attracted about 40 attendees that included citizens, safety professionals, and local elected officials.
- Max Donath spent the summer presenting on the Institute’s research and educational initiatives to a variety of important audiences, including Ford, General Motors, 3M, and AASHTO (Please refer to the “Products” section for a full list of Donath’s presentations).
- On August 28, 2015, Greg Lindsey’s bicycle and pedestrian counting research was highlighted at an exhibit at the Minnesota State Fair. The booth not only featured a poster on Lindsey’s findings, but also demonstrated the infrared sensors he uses to monitor trail traffic. A similar display was created for a September 2015 “Open Streets Minneapolis” event.
- When Daniel Work (UIUC) traveled to Minneapolis to speak at the RSI Seminar Series, he met with Brian Kary, MnDOT’s Freeway Operations Engineer, and toured MnDOT’s Regional Transportation Management Center, which coordinates the state’s response to freeway incidents. During his visit, Work also received a tour of the Minnesota Traffic Observatory from fellow RSI researcher John Hourdos and met with Alireza Khani, a new civil engineering faculty member at the University of Minnesota.

### *Collaboration*

Solving the problem of roadway injuries and fatalities requires multiple approaches from multidisciplinary perspectives. To help the Institute meet this challenge:

- The RSI Advisory Board met on May 28, 2015, on the University of Minnesota’s campus in Minneapolis. The board consists of 14 transportation professionals from Region 5 and the federal government. During the meeting, Kathy Quick and Guillermo Narvaez presented on their RSI research project, which led to a productive discussion on initiatives to increase roadway safety on tribal lands.

- The RSI University Partners Committee, made up of researchers from all five partner universities, gathered at the Roadway Safety Showcase in May 2015. The night before the conference, committee members attended a dinner with Greg Winfree, Assistant Secretary of the USDOT's Office for Research and Technology. The dinner included a round robin during which the researchers shared their research interests and areas of expertise with the group.
- We moved closer to our goal of engaging Region 5 DOTs in a safety-related pooled fund project. After several productive conference calls in the spring, a number of regional state safety engineers identified two potential research areas and approved a solicitation to be posted on the Transportation Pooled Fund Program website. The solicitation was posted on September 1, 2015.

### ***Diversity***

The Institute is committed to broadening participation and enhancing diversity in the transportation sector through all our activities. Here are some ways we're working to increase participation by groups currently underrepresented in STEM fields.

- On June 16, 2015, the Institute provided one day of curriculum for the White Earth Summer Camp, which is the product of a longstanding partnership between the White Earth Nation and the University of Minnesota Extension Office. In sessions facilitated by RSI staff, 40 students in grades 4–8 studied GIS mapping, reaction time and distracted driving, and reflectivity and pedestrian visibility. Local engineers and a 3M representative participated in the lessons designed to spark students' desire to pursue higher education and STEM careers.
- On June 15, 2015, we hosted a two-hour session for 10 Red Lake Summer Camp students in 7<sup>th</sup>–11<sup>th</sup> grade. Chen-Fu Liao introduced students to the world of traffic engineering through his STREET project (<http://street.umn.edu/>) and by demonstrating his Gridlock Buster game. Following his presentation, the students toured the Minnesota Traffic Observatory (MTO) and learned about current transportation-related research.
- Please refer to the Research Accomplishments section for an update on Kathy Quick's project, which focuses on roadway safety in tribal lands.

### **Opportunities for training and professional development**

Accomplishments are reported in the Education and Workforce Development section.

### **Dissemination**

For the results of Institute work to effect positive change—specifically, safer roadways—they must be delivered to those who can effectively implement them in everyday practice. We strive to communicate this information broadly and purposefully through the following activities.

- The Institute's website is the primary vehicle for distributing information to stakeholders. In this period, the site received 3,105 visits and 11,569 views of individual pages. The most popular pages were the home, seminars, and research pages.
- Six PIs and two research facilities from our consortium captured media attention in stories highlighting work in roadway safety. For a full list of media stories, please visit <http://www.roadwaysafety.umn.edu/about/news/>.

### **Plans for next reporting period**

There have been no changes to the Roadway Safety Institute's approved application plans. We anticipate the following activities will take place in the next reporting period (October 1, 2015 – March 30, 2016).

## Research

- Three more PIs will submit their Nine-Month Progress Reports in an effort to secure continued funding for their projects. We will also verify the eligibility of 15 additional projects that may count as match.
- A process will be developed and implemented to identify additional research using our Year 3 funds.
- Rahim Benekohal will develop a methodology to conduct a microanalysis at individual railroad crossings, along corridors, and for regional studies. He will also incorporate results from the microanalysis into his macro model (*Improving Railroad Grade Crossing Safety: Accident Prediction Models Using Macro and Micro Scale Analysis*).
- Stephen Burks will prepare the initial draft of his paper on the sleep apnea status and medical cost differences among tractor-trailer drivers for journal submission. He will also continue to develop the legal and contractual conditions for new data to flow from the project's participating motor carrier and its medical service providers (*Exploring Links Between Medical Conditions and Safety Performance in Tractor Trailer Drivers*).
- Gary Davis will reconstruct a sample of left-turn crashes from NHTSA's National Automotive Sampling System/Crashworthiness Data System database. He will also compare characteristics of simulated crashes to those of reconstructed crashes and modify the simulation if needed (*Developing and Validating a Model of Left-Turn Crashes to Support Safer Design and Operations*).
- Frank Douma will articulate points of contention from his original interviews and identify opportunities for addressing them. Further, he will conduct a quantitative comparison of speed violations in Minnesota vs. states with automated speed enforcement (*Identifying and Reconciling Stakeholder Perspectives in Deploying Automated Speed Enforcement*).
- Imran Hayee will conduct multiple-vehicle field tests using three dedicated short-range communication devices on three vehicles. He will also work on the algorithm to process the relative trajectories of multiple vehicles in real time (*Acquisition of Real-Time Relative Vehicle Trajectories to Facilitate Freeway Merging Using DSRC-based V2V Communication*).
- Tom Horan will conduct interviews with tribal safety representatives and experts to develop a process for implementing prototypes in tribal communities. He will also finalize a procedure for implementing geographic information system (GIS) tools and applications at individual and institutional levels. Further, he will identify potential outcomes of increased use of GIS prototypes and conduct preliminary GIS analysis of data to identify characteristics potentially associated with tribal safety concerns (*Using GIS to Improve Tribal Traffic Safety*).
- John Hourdos will deploy the full complement of sensors, test the infrastructure-based Q-Warn application, and develop the V2I version and demonstrate its operation with one test vehicle (*Implementation of V2I Highway Safety System and Connected Vehicle Testbed*).
- Chen-Fu Liao will integrate the Bluetooth low energy and smartphone subsystems and conduct tests to verify and validate the system (*A Positioning and Mapping Methodology Using Bluetooth and Smartphone Technologies to Support Situation Awareness and Wayfinding for the Visually Impaired*).
- Greg Lindsey will continue to coordinate with MnDOT, the Minneapolis Department of Public Works, the Minneapolis Park and Recreation Board, and other agencies interested in potential outcomes of the study (*Performance Measures for Bicycle and Pedestrian Safety: Methodologies for Monitoring Traffic Volumes and Assessing Exposure to Risk*).

- Albert Luo will analyze data from tests of three concept designs to identify final draft design patterns for further field testing. He will also wrap up a national survey and summarize the results to optimize the directional rumble strip design and field testing (*Directional Rumble Strips for Reducing Wrong-Way-Driving Freeway Entries*).
- Nichole Morris will complete an interface display survey, begin programming for a simulation study, and complete a driving video test (*Older Driver Support System (ODSS) Usability and Design Investigation*).
- Lee Munnich will conclude interviews with stakeholders in six Midwest states, re-engage the technical advisory committee, and incorporate additional information and feedback into the draft report. He will also complete a nine-month progress review, plan and initiate policy roundtables, circulate a final report for review, and revise the report to include final analysis and conclusions (*Assessing Factors Affecting Policy Leadership in Adopting Road Safety Countermeasures*).
- Yanfeng Ouyang will develop a set of non-cooperative game-theoretic models to study how railroad hazmat stakeholders and public agencies collectively determine management decisions. He also plans to develop solution methods based on relaxation, decomposition, transformation, and approximation modeling schemes (*Improving Railroad Grade Crossing Safety: Positioning, Planning, and Operation of Emergency Response Resources and Coordination Between Jurisdictions*).
- Andrew Owen will collect the necessary data and calculate accessibility and network metrics for biking. These metrics will help Owen to create a risk model for pedestrian and bicycle travel in urban areas (*Safety in Numbers? Accessibility, Traffic, and Safety of Non-motorized Travelers*).
- Kathy Quick and Guillermo Narvaez will conduct detailed data analysis of transportation safety issues on tribal lands. They will also continue to cultivate existing relationships with tribal transportation leaders and determine methods to reduce traffic injuries and promote transportation safety programs and policies. In addition, they will present findings at several conferences (*Collaborating with American Indians to Re-Interpret and Strategize About Transportation Safety Risks in Tribal Lands*).
- Rajesh Rajamani will install multiple laser sensors and a video camera system for recording potential collisions on the test bicycle. He will also implement the model predictive controller for real-time tracking of vehicles using angular control of the laser sensors on the bicycle and will undertake experimental work at real-world intersections (*Novel Collision Avoidance System for Bicycles*).
- William Schneider will add route optimization between hot-spot areas to provide information on individual routes a police officer drives, incorporating the time taken at a traffic stop. He will also incorporate failure probability based on the maps, projecting how many stops an officer may make while still completing the route in the allotted time (*Alcohol-Related Hot Spot Analysis and Prediction*).
- Daniel Work will continue creating an online regression model for train-delay estimation and will explore the use of both historic and online estimation models on datasets provided by transportation corporation CSX (*Improving Railroad Grade Crossing Safety: Accurate Prediction of Train Arrival Times for Emergency Response Management and Driver Decision Support*).

### *Education and workforce development*

- To prepare for the opening of our exhibit at The Works Museum in June 2016, we will spend the next reporting period finalizing contracts, designing the prototype, and planning for the construction of the finished product.
- We will deliver the remaining nine events in the RSI Seminar Series.
- In November and December 2015, Institute staff will work with Western Michigan University's Ron Van Houten to deliver pedestrian safety workshops in Columbus, Indianapolis, Lansing, and Milwaukee. During the workshops, Van Houten will present a number of practical treatment options for pedestrian crossings; participants will also watch a video demonstration of Chen-Fu Liao's smartphone application to warn distracted pedestrians as they approach an intersection. The workshop will end with a facilitated discussion with attendees.
- We will work with Iowa State University and LTAP/TTAP directors in our region to identify a training topic for a roadway safety course aimed at maintenance workers.
- We will select and distribute an Outstanding Student of the Year award as well as provide TRB travel awards to students. We will also award a student travel stipend for attendance at the WTS Central Region conference.

### *Technology transfer*

- We will develop two new fact sheets for distribution at events and on our website. The first, to be completed this fall, will feature bicycle and pedestrian research initiatives. The second, slated for Spring 2016, will focus on connected vehicle technologies.
- We will distribute two issues of our e-newsletter, in November 2015 and February 2016. E-announcements will be sent as appropriate, and we'll continue to update our safety news feed, social media outlets, and other communication channels.
- We will write and produce a report highlighting progress to date, which we will distribute at the TRB Annual Meeting in January 2016. The goal of the report will be to share the Institute's research portfolio and initiatives with federal and state agency professionals, policymakers, and other interested stakeholders.
- Similarly, we will start work on two video projects highlighting our researchers' work and communicating the value of the UTC program to a broad audience. The first video, which is scheduled to be completed during the next reporting period, will provide a programmatic overview of the Roadway Safety Institute, focusing specifically on the positive future impacts of the research. The second video, to be completed during spring 2016, will focus more narrowly on a specific research area.
- We will explore the possibility of partnering with Iowa State University (Region 7) and North Dakota State University (Region 8) to develop a new webinar series focusing on research implementation. Iowa State is the lead institution for the Region 7 UTC, while NDSU is the lead for Region 8.
- In October 2015, the Institute will sponsor and have a presence at the Minnesota Tribes and Transportation Conference. Program Director Stephanie Malinoff will provide an overview of our education and workforce development initiatives, while Kathy Quick, Guillermo Narvaez, and Tom Horan will present on their research.
- The remainder of the RSI Seminar Series events will feature six out-of-state speakers. During their visits, networking meetings will be facilitated with University of Minnesota faculty as well as state and local transportation practitioners.
- Max Donath and others working on the Teen Driver Support System—a smartphone app that alerts teen drivers and their parents when a driver engages in risky behavior—will evaluate the

commercial deployment of apps for both iPhone and Android platforms. In addition, the project team will identify national foundations to potentially sponsor the app to reduce its cost to customers.

### **Collaboration**

- The RSI Advisory Board will meet on October 15, 2015, to discuss bicycle and pedestrian research initiatives.
- The RSI University Partners Committee will convene via conference call on November 2, 2015.
- We will engage the Region 5 state safety engineers and start the project selection process for the safety-related pooled fund.

### **Diversity**

- On October 8, Linda Boyle, director of the Human Factors and Statistical Modeling Lab at the University of Washington, will give a presentation for the RSI Seminar Series on transportation safety with regard to driving behaviors. Her visit meets our goal of supporting female faculty in STEM disciplines as well as sparking interest among female students to pursue transportation safety careers.
- On October 27, 2015, Institute staff will plan and deliver a program for WTS Minnesota's Transportation YOU program. About a dozen female high school students will take a transportation-focused tour of the University of Minnesota campus and meet with Institute researchers to learn about their work and career paths.
- We will start developing a "curriculum toolbox" to be shared with Region 5 WTS chapters. Over the past year, we have developed tools, relationships, and activities that may be useful to others who aim to support and encourage women to enter the transportation field.

## **PRODUCTS**

### **Publications, conference papers, and presentations**

During this reporting period, 21 RSI researchers and staff gave 40 presentations to local, regional, and national audiences. The settings, ranging from national conferences to local meetings, introduced a wide variety of stakeholders to our work. For a full list of presentations, please visit [http://www.roadwaysafety.umn.edu/publications/ostr/documents/pppr4\\_presentations\\_list.pdf](http://www.roadwaysafety.umn.edu/publications/ostr/documents/pppr4_presentations_list.pdf).

RSI researchers published the following papers during this reporting period:

- Chatterjee, I., and G. Davis. 2014. "Use of Naturalistic Driving Data to Characterize Driver Behavior in Freeway Shockwaves." *Transportation Research Record: Journal of the Transportation Research Board* 2434: 9–17.
- Davis, G. 2015. "A Comparison of Bayesian Speed Estimates from Rollover and Critical Speed Methods." *SAE Technical Paper* 2015-01-1434.
- DeLaere, G., R. Van Houten, and J. Shurbutt. 2015. "Countdown Pedestrian Signals and Low Vision Pedestrians." *Transportation Research Record* (forthcoming).
- Douma, F., A. Lari, and I. Onyiah. 2015. "Self-Driving Vehicles and Policy Implications: Current Status of Autonomous Vehicle Development and Minnesota Policy Implications." *Minnesota Journal of Law, Science & Technology*.

- Douma, F., S. Peck, L. Fatehi, and A. Lari. 2015. “The SDVs Are Coming! An Examination of Minnesota Laws in Preparation for Self-Driving Vehicles.” *Minnesota Journal of Law, Science & Technology* (forthcoming).
- Fees., C.A., D. J. Torbic, R. Van Houten, K. M. Bauer, N. Roseberry, and J. LaPlante. “Design Guidance for Bicycle Lane Widths.” *Transportation Research Record* (forthcoming).
- Levinson, D. 2015. “Climbing Mount Next—The Effects of Autonomous Vehicles on Society.” *Minnesota Journal of Law, Science & Technology* (forthcoming).
- Lindsey, G., K. Nordback, and M. Figliozzi. 2014. “Institutionalizing Bicycle and Pedestrian Monitoring Programs in Three States.” *Transportation Research Record: Journal of the Transportation Research Board* 2443:134–142.
- Lindsey, G. 2015. “Validation of Bicycle Counts from Pneumatic Tube Counters in Mixed Traffic Flows.” *TRB 94th Annual Meeting Compendium of Papers*, paper no. 15-5258.
- Morris, N. L., J. I. Creaser, C. J. Edwards, and M. Donath. 2015. “Are Cellular Phone Blocking Applications Effective for Novice Teen Drivers?” *Journal of Safety Research* (forthcoming).
- Morris, N. L., J. I. Creaser, and B. Swanson. 2015. “The Role of Parent Feedback and Vehicle Status on Supervised Driving in the Minnesota Teen Driver Study.” *Driving Assessment* (in press).
- Munnich, L., N. Nguyen, and F. Douma. 2015. “Closing the Gap in Rural and Urban Road Deaths: Transportation Issues, Policies and R&D.” In *Road and Traffic Safety: Practices, Role of Human Behavior and Effective Programs*, edited by Daniel Hughes, 1–22. New York: Nova Science Publishers.
- Ouyang, Y. 2015. “Calibration of Car-Following Laws for Traffic Oscillation Prediction.” *TRB 94th Annual Meeting Compendium of Papers*, paper no.15-1018.
- Schneider, W. “Contributing Factors to Fatal Single Unit Motorcycle Crashes.” *TRB 94th Annual Meeting Compendium of Papers*, paper no. 15-3356.
- Schneider, W. “A Preliminary Investigation of Contributing Circumstances of Fatal Crashes Involving Law Enforcement Officers.” *TRB 94th Annual Meeting Compendium of Papers*, paper no.15-3221.
- Xie., S, X. Li, and Y. Ouyang. 2015. “Decomposition of General Facility Disruption Correlations via 4 Augmentation of Virtual Supporting Stations.” *Transportation Research Part B* 80: 64–81.
- Van Houten, R., J. Shurbutt, and J. F. Morgan. 2015. “Countdown Pedestrian Signals Legibility and Comprehension Without Flashing Hand.” *Transportation Research Record* (forthcoming).

### Websites or other Internet sites

The Roadway Safety Institute website ([roadwaysafety.umn.edu](http://roadwaysafety.umn.edu)) includes information on research activities, events, news, and key personnel. Each active research project has a web page that includes both the research project description and a downloadable UTC Project Information Form. We will post final research reports on the RSI website as they are completed.

In addition:

- The Institute’s website reaches a wider audience through links to it from the Center for Transportation Studies (CTS) at the University of Minnesota. CTS ([cts.umn.edu](http://cts.umn.edu)) strives to solve persistent transportation problems in innovative ways by convening diverse communities to brainstorm, debate, share, learn, and act.

- The Minnesota Traffic Observatory (MTO) website ([mto.umn.edu](http://mto.umn.edu)) notes its affiliation with RSI on its home page. RSI researcher John Hourdos directs MTO, a facility that is used frequently by other RSI personnel.
- The HumanFIRST website ([humanfirst.umn.edu](http://humanfirst.umn.edu)) features the work of RSI principal investigators who use the laboratory to conduct psychology and human factors research.
- The website of the Connected Vehicles Research Laboratory at the University of Minnesota Duluth ([d.umn.edu/ee/cvrl/](http://d.umn.edu/ee/cvrl/)) includes information on the research of Imran Hayee.
- The Midwest Tribal Safety website ([tribalsafety.maps.arcgis.com/home/organization.html](http://tribalsafety.maps.arcgis.com/home/organization.html)), a product of Tom Horan's research, serves as an online collaborative interface for stakeholders working in tribal transportation safety or with tribal community leaders.

### **Technologies or techniques**

Rajesh Rajamani is currently developing two technologies suitable for bicycles: an inexpensive target vehicle tracking system, and a black box recorder. He may apply for a patent in the next year or two.

### **Inventions, patent applications, and/or licenses**

Nothing to report.

### **Other products**

Andrew Owen has produced a dataset that calculates block-level accessibility to jobs for 50 U.S. metropolitan areas. These data can be used to understand non-motorized traffic volumes in urban areas. The summary data is available at [access.umn.edu/data/index.html](http://access.umn.edu/data/index.html).

Daniel Work has made publically available the source code used to implement the algorithms in his research. The code is available at [github.com/Lab-Work/TrainDelayEstimation\\_IEEEITSC](https://github.com/Lab-Work/TrainDelayEstimation_IEEEITSC).

## **PARTICIPANTS AND OTHER COLLABORATING ORGANIZATIONS**

### **Organizations that have been involved as partners**

Please see the table on page 18 for a list of partner organizations.

### **Other collaborators or contacts**

The following organizations have been in collaboration or contact with the Institute during this reporting period.

- In April 2015, Max Donath met with representatives from Minnesota's Washington County to talk about research opportunities related to in-vehicle curve speed warnings. Specifically, the group is interested in using smartphone technology to warn drivers if they are going too fast approaching a horizontal curve.
- Chen-Fu Liao is in discussions with the City of Minneapolis regarding a pilot implementation of his Bluetooth and smartphone systems. Liao also presented the system to representatives from the New York City Department of Transportation, who have expressed interest in his approach.
- On September 10, 2015, the Institute hosted 10 representatives from 3M, including Pat McGuire, Global Laboratory and Application Engineering Manager. The group discussed potential

collaborations and toured the HumanFIRST Lab and Minnesota Traffic Observatory. Since the meeting, 3M has invited several RSI researchers to help brainstorm potential uses of the University of Minnesota's driving simulator and to demonstrate our LiDAR technology at an upcoming conference.

- Yanfeng Ouyang has been working with the Minnesota National Guard to identify potential collaborators in the emergency response community and opportunities to observe emergency response exercises.
- In September 2015, Kathy Quick and Guillermo Narvaez met with representatives from the newly formed Center for Indian Country Development at the Federal Reserve Bank in Minneapolis to discuss potential collaborations. The Center works on economic and community development in American Indian communities from Michigan to Idaho.
- William Schneider has shared the goals and objectives of his project with the Ohio State Patrol and the California Highway Patrol.

## IMPACT

### Impact on the development of the principal discipline(s) of the program

The outcomes of our work will give society ways to improve safety and public health for everyone who uses our region's and nation's roadways. By identifying critical areas of focus such as automated speed enforcement, intersections, rail grade crossings, and speeding, our efforts will help prevent fatal and serious-injury crashes for those users who have a greater propensity for risk. Specific guidance will be created to help state and national agencies address these priorities. Our work will also help state departments of transportation and other agencies implement design- and operation-related safety improvements. Specifically, we are focusing on issues that have been inadequately addressed to date through projects that examine policy issues, operational safety, rail grade crossings, and automated speed enforcement.

During this reporting period, the following projects reported impacts:

- *Exploring Links Between Medical Conditions and Safety Performance in Tractor Trailer Drivers:* Stephen Burks foresees an impact on both public policy and managerial economics, possibly leading the Federal Motor Carrier Safety Administration and motor carriers to institute new obstructive sleep apnea screening requirements for motor vehicle operators.
- *Impact of Exempting Low-Level Speed Violations:* Frank Douma's completed project had an impact on speeding laws in the state of Minnesota. His findings questioned the efficacy of the Dimler Amendment, which keeps certain speeding violations off a driver's record
- *Computerized Crash Reports Usability and Design Investigation:* Nichole Morris reports an impact on public safety. In 2016, Minnesota law enforcement agencies will begin using an improved crash reporting interface that's a direct result of Morris's research.
- *Older Driver Support System (ODSS) Usability and Design Investigation:* Nichole Morris anticipates an impact on human factors investigations. Specifically, her work will help researchers better understand the kind of support that older drivers without cognitive impairment may want or need while driving.
- *Improving Railroad Grade Crossing Safety: Positioning, Planning and Operation of Emergency Response Resources, and Coordination Between Jurisdictions:* Yanfeng Ouyang anticipates an

impact on complex transportation systems. His project is the first to address the vulnerability of network systems under correlated disruptions due to disasters.

- *Safety in Numbers? Accessibility, Traffic, and Safety of Non-motorized Travelers*: Andrew Owen anticipates impacts on accessibility analysis and pedestrian safety. His project demonstrates how publicly available data sources can be used to calculate detailed walking and biking accessibility to jobs. In turn, the accessibility data can be used as a tool to estimate pedestrian traffic volumes for safety analysis. Owen's approach will help resolve challenges identified in existing research of non-motorized travel safety.
- Ron Van Houten's work on pedestrian safety influences traffic engineering. He's developed new and effective ways to use the R1-6 sign, as well as shared best practices on using the Pedestrian Countdown Timer, Rectangular Rapid-Flash Beacon, and Pedestrian Hybrid Beacon.
- *Improving Railroad Grade Crossing Safety: Accurate Prediction of Train Arrival Times for Emergency Response Management and Driver Decision Support*: Daniel Work anticipates making an impact on railroad engineering. His proposed method will estimate train arrival times at grade crossings, which will improve safety by enabling effective management of emergency response resources. It will also support driver alerts at unsignalized grade crossings in personal navigation devices.

### Impact on other disciplines

The interdisciplinary nature of our research means outcomes will reach beyond our core focus areas to impact safety approaches in other disciplines.

During this reporting period, the following projects reported impacts:

- *Older Driver Support System (ODSS) Usability and Design Investigation*: Nichole Morris anticipates an impact on gerontology; her work will illustrate how the use of technological assistance can improve older drivers' quality of life.
- *Improving Railroad Grade Crossing Safety: Positioning, Planning and Operation of Emergency Response Resources, and Coordination Between Jurisdictions*: Yanfeng Ouyang's work may influence network optimization. His project will develop new methods to analyze and optimize reliable resource allocation under multiple dimensions of uncertainty.
- *Collaborating with American Indian Communities to Re-Interpret and Strategize About Transportation Safety Risks in Tribal Lands*: Kathy Quick and Guillermo Narvaez anticipate that their project will have an impact on public health. The methods being used in the project are designed to complement previous population-level epidemiological studies of the elevated crash rate among American Indians.
- Ron Van Houten's work affects planning in that the results teach professionals how to use engineering, enforcement, and education to change the driving culture and improve pedestrian safety.

### Impact on physical, institutional, and information resources

Our work's impact on physical, institutional, and information resources will enable stakeholders to access training and better perform their jobs.

During this reporting period, the following projects reported impacts:

- *Implementation of a V2I Highway Safety System and Connected Vehicle Testbed*: John Hourdos's project has greatly enhanced the capabilities of the Minnesota Traffic Observatory, whose facilities

now have greater capacity for data collection and the analysis of vehicle trajectories. Several other projects have already benefitted from the new sensors and software.

- *Safety in Numbers? Accessibility, Traffic, and Safety of Non-motorized Travelers*: Andrew Owen’s block-level jobs accessibility dataset is now available for download and use by other researchers.
- *Improving Railroad Grade Crossing Safety: Accurate Prediction of Train Arrival Times for Emergency Response Management and Driver Decision Support*: Daniel Work’s data and algorithm source codes will be licensed as “open source” and posted on Github, a source code repository, for others to use.

## **Impact on transportation workforce development and human resources**

Our education and workforce development efforts will offer opportunities to engage future transportation professionals in safety-related concepts and careers, enrich the educational experience of university students, and provide professionals with the tools and resources they need to improve roadway safety. The results of these activities will support the development of a diverse transportation workforce.

Sixteen out of eighteen RSI-funded projects have enlisted undergraduate or graduate student assistants. During this reporting period, these jobs provided 40 students with research and practical work experience related to roadway safety. PIs supervising students include Stephen Burks, Gary Davis, Frank Douma, Imran Hayee, Tom Horan, John Hourdos, Chen-Fu Liao, Greg Lindsey, Albert Luo, Nichole Morris, Yanfeng Ouyang, Andrew Owen, Kathy Quick, Rajesh Rajamani, William Schneider, and Daniel Work.

## **Impact on technology transfer**

Our technology transfer activities will lead to the implementation of research results and promote a safer transportation system. Through partnerships, RSI faculty and researchers will be successful in technology transfer.

During this reporting period, the following project reported impacts:

- *Improving Railroad Grade Crossing Safety: Accurate Prediction of Train Arrival Times for Emergency Response Management and Driver Decision Support*: Daniel Work anticipates that the algorithms he develops could be reused by Class I railroads or Amtrak, and notes that open source software codes reduce the burden for private companies to leverage the resulting algorithm. Work’s new collaboration with CSX increases the potential that the technologies developed in this work will be adopted in practice.

## **Impact on society beyond science and technology**

The Institute’s work will result in real-world applications—policy approaches as well as engineering and technology solutions—to mitigate the human and economic toll of traffic crashes and traffic-related fatalities by improving safety.

During this reporting period, the following projects reported impacts:

- *Exploring Links Between Medical Conditions and Safety Performance in Tractor Trailer Drivers*: Stephen Burks’s project has the potential to reduce the rate of heavy truck crashes due to untreated obstructive sleep apnea; it is estimated that between 7 and 20 percent of these crashes result from driver fatigue.
- *A Positioning and Mapping Methodology Using Bluetooth and Smartphone Technologies to Support Situation Awareness and Wayfinding for the Visually Impaired*: Chen-Fu Liao’s project

will help visually impaired pedestrians safely reach their destinations. His smartphone application, which uses Bluetooth low-energy devices to transmit messages, will be especially useful in places with poor GPS coverage, such as skyways and subways.

- *Improving Railroad Grade Crossing Safety: Positioning, Planning and Operation of Emergency Response Resources, and Coordination Between Jurisdictions:* Yanfeng Ouyang's project will generate policy and engineering guidelines that will improve public knowledge and decision-making practices, subsequently improving social welfare through enhanced safety, economic, and environmental conditions.

## CHANGES/PROBLEMS

### Changes in approach and reasons for change

*Exploring Links Between Medical Conditions and Safety Performance in Tractor Trailer Drivers:* Instead of working with a new motor carrier to obtain protected health information and other relevant data, Stephen Burks will work with the currently participating firm. The change stems from the new carrier's concerns about confidentiality.

*Identifying and Reconciling Stakeholder Perspectives in Deploying Automated Speed Enforcement:* While Frank Douma had planned to expand his interviews into other Region 5 states, he has decided to spend the next year focused on solidifying the productive contacts he's made in Minnesota.

*Acquisition of Real-Time Relative Vehicle Trajectories to Facilitate Freeway Merging Using DSRC-based V2V Communication:* Instead of using DSRC devices with different models of GPS receivers, Imran Hayee will only use devices that have similar receivers.

*Using GIS to Improve Tribal Traffic Safety:* Tom Horan has learned that few tribes understand the role of GIS in transportation safety. Instead of canvassing all tribes on the subject, Horan will instead work in-depth with a few tribes to help them understand its use.

*Improving Railroad Grade Crossing Safety: Accurate Prediction of Train Arrival Times for Emergency Response Management and Driver Decision Support:* Because Amtrak denied his data request, Daniel Work will now work with CSX to obtain train-positioning information.

### Actual or anticipated problems or delays and actions or plans to resolve

*Acquisition of Real-Time Relative Vehicle Trajectories to Facilitate Freeway Merging Using DSRC-based V2V Communication:* Because of a malfunctioning Savari S103 DSRC device, Imran Hayee had to delay his vehicle tests. He anticipates that the delay will not impact the overall project schedule.

*Older Driver Support System (ODSS) Usability and Design Investigation:* A slow IRB process has delayed Nichole Morris's data collection; in the future, she will allow more time for the IRB submission process. She anticipates that the delay will not impact the overall project schedule.

*Safety in Numbers? Accessibility, Traffic, and Safety of Non-motorized Travelers:* While Andrew Owen had hoped to apply his model to multiple cities, there has been a delay in data gathering; full application is currently limited to the city of Minneapolis.



**Changes that have significant impact on expenditures**

Nothing to report.

**Significant changes in use of care of human subjects, vertebrate animals, and/or biohazards**

Nothing to report.

**Change of primary performance site location from that originally proposed**

Nothing to report.

## ORGANIZATIONS THAT HAVE BEEN INVOLVED AS PARTNERS

Organization Name	Organization Location	Type of Contribution				
		Financial Support	In-Kind Support	Facilities	Collaborative Research	Personnel Exchanges
Minnesota Department of Transportation	St. Paul, MN	X	X	X	X	X
Vice President for Research, University of Minnesota (UMN)	Minneapolis, MN	X				
College of Science and Engineering, UMN	Minneapolis, MN	X				
Humphrey School of Public Affairs, UMN	Minneapolis, MN	X				
School of Nursing, UMN	Minneapolis, MN				X	X
University of Minnesota Morris	Morris, MN	X				
University of Minnesota Duluth	Duluth, MN	X				
University of Illinois at Urbana-Champaign	Urbana, IL	X				
Southern Illinois University Edwardsville (SIUE)	Edwardsville, IL	X				
University of Akron	Akron, OH	X				
Civil Engineering Department, Auburn University	Auburn, AL			X	X	
Esri Corporation	Redlands, CA		X			
CSX Corporation	Jacksonville, FL		X	X	X	X
Mechanical Engineering Department, SIUE	Edwardsville, IL			X		
Advocacy Council for Tribal Transportation	Greater Minnesota				X	
Arrowhead Regional Development Commission	Duluth, MN		X		X	X
Fond du Lac Band of Lake Superior Chippewa	Cloquet, MN				X	
Headwaters Regional Development Commission	Bemidji, MN		X		X	X
Hennepin County	Minneapolis, MN		X		X	X
Leech Lake Band of Ojibwe	Cass Lake, MN				X	
Mayo Clinic	Rochester, MN				X	X
Mille Lacs Band of Ojibwe	Onamia, MN				X	
Minneapolis Department of Public Works	Minneapolis, MN		X		X	X
Minneapolis Park and Recreation Board	Minneapolis, MN		X		X	X
Red Lake Nation	Red Lake, MN				X	
Region 9 Development Commission	Mankato, MN		X		X	X
Sawtooth Mountain Clinic	Grand Marais, MN		X		X	X