

ROADWAY SAFETY INSTITUTE

Human-centered solutions to advance roadway safety

Program Progress Performance Report for University Transportation Centers

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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 are being 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.

We are pursuing this objective by meeting the following goals in research, education and workforce development, and technology transfer activities. We are also collaborating with stakeholders across our region and promoting diversity in our educational initiatives.

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 factors and behavior risk metrics, 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 should 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 demonstrating safe driving concepts to students in STEM summer camps; developing a roadway-safety-themed museum exhibit to be displayed at a STEM-related museum; and partnering with WTS's Transportation YOU program to encourage young female students to pursue transportation-related degrees.

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 multiple seminars and webinars; connecting practitioners and researchers to facilitate discussion and encourage implementation; and delivering pedestrian safety workshops to professionals in Region 5 states.

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 are developing versions of research hardware and software that can be deployed through collaboration with state DOTs, public safety agencies, foundations, and the private sector. We are also communicating research findings to the transportation community for their successful implementation, and we have created a consortium website, an electronic newsletter, topical briefs, research videos, and an Institute biennial report.

Collaboration

The Institute brings 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 draws on and expands 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 developing and delivering safety curriculum for the White Earth Summer Camp; hosting tours and demonstrations for students in WTS's high school mentoring program; and identifying ways to support leadership development for female and minority STEM students and faculty.

Accomplishments

Research

Our consortium draws on our members' safety-related expertise and complementary research strengths to achieve measurable gains in safety. The Institute currently has 35 federally funded research projects (23 active, 12 completed) and 33 match projects (4 active, 29 completed). Descriptions of all projects are available on our website, and all active projects have records in the Transportation Research Board (TRB)'s Research in Progress (RiP) database.

Programmatic research accomplishments include:

- The 10 researchers who were selected for funding during last fall's RFP received their funding and started work on their new projects.
- We published 3 final research reports for federally funded projects.

Notable highlights from active research projects:

- *Improving Railroad Grade Crossing Safety: Accident Prediction Models Using Macro- and Micro-Scale Analysis*: Rahim Benekohal updated the zero inflated negative binomial (ZINB) models based on the recent five years of data, which involved developing a methodology to improve the accuracy of crash predictions at railroad crossings using macro- and micro-scale analysis. The results showed that the empirical Bayes approach for considering accident history worked better than the current Federal Railroad Administration (FRA) approach.
- *The Screening Effectiveness of the Commercial Driver's Medical Examination*: Stephen Burks has been working to complete a statistical analysis of the screening effectiveness of the commercial driver's medical examination (CDME) in the pre-registry data and has been writing the first

complete draft of the final paper. The statistical results, now substantially developed, involved several iterations of improving the data set construction process. Burks has acquired a large initial sample of operational data from the participating motor carrier and has some data that is due to be updated from the obstructive sleep apnea service provider but does not yet have new medical insurance or CDME data.

- *Development of an Automated Vehicles Programming Class:* Under a separate project, Brian Davis purchased an unmanned ground vehicle (i.e., mobile robot) and corresponding equipment that will be used in this project. After specifying the minimum needs of the robot and obtaining quotes from vendors, the robot was received in late August. Davis selected a Clearpath Husky A200 equipped with both lidar and radar sensors. Work has included interfacing with the robot, evaluating available open source software, and beginning to plan for and develop demonstrations for the robot.
- *Driver Behavior in Left-Turn and Other Two-Vehicle Crashes:* Gary Davis's main focus was to test the project's left-turn crash simulation model. The results were a favorable comparison between crash features simulated by the new model and crash features estimated from reconstructed crashes, as well as development of a method to simulate crash modification effects without having to first simulate rates.
- *Scenarios and Justification for Automated Vehicle Demonstration in Rural Minnesota:* Frank Douma's focus is to determine what questions need to be answered to create an effective and thorough proposal for an automated vehicle (AV) demonstration in a small urban or rural area. Thus far, the research team has put together a list of best practices for AV demonstrations. Results to date have shown that shuttles do not operate well during adverse weather conditions; in addition, the current inconsistent U.S. regulatory scheme for AVs has created a legal environment in which individual states and cities have significant power to determine how they want to control AV testing.
- *Developing GPS Antenna Error Models for Improved Centimeter Level Positioning:* Rhonda Franklin collected 48 hours of data from two GPS receivers attached to a pair of high-quality antennas at UMore Park, a research facility at the University of Minnesota. The data analysis thus far showed that complete coverage of the sky was obtained. Franklin also collected radiation pattern data for the Navcom Ant3001 GNSS Rover antenna in the anechoic chamber at the University of Minnesota's Department of Electrical and Computer Engineering.
- *Implementation of a V2I Highway Safety System and Connected Vehicle Testbed:* John Hourdos has succeeded in producing a record number of high-resolution vehicle trajectories as well as the infrastructure for warehousing and accessing data used in a fully functional connected vehicle (CV) testbed.
- *Using GIS to Improve Tribal Traffic Safety:* Thomas Horan developed a series of six prototype applications that could be used by tribes to assist in their transportation safety planning, assessment, and implementation; conducted a series of hot spot analyses on four data sets; and developed a framework for considering GIS-based traffic safety analysis within the context of tribal governance and management for implementing GIS for traffic safety. Feedback from tribal representatives provided confirmation that easy-to-interpret maps of safety trends and conditions could assist in focusing safety information gathering and improvement efforts as well as information sharing of best practices among tribes.
- *Test and Evaluate a Bluetooth Based In-Vehicle Message System to Alert Motorists in Work Zones:* Chen-Fu Liao refined the work-zone alert smartphone app and deployed Bluetooth sensors in two work zones in Hennepin County, Minnesota, to test the reliability of the in-vehicle message system and Bluetooth detection ranges. On average, the work-zone alert system was able to detect the Bluetooth low energy (BLE) tag and announce an associated auditory message when a vehicle was

106 meters (348 feet) ahead of the work zone at the County State Aid Highway (CSAH) 53 site and 167 meters (548 ft) at the CSAH 112 site, indicating the system was capable of providing timely warning messages to alert motorists approaching work zones.

- *Performance Measures for Bicycle and Pedestrian Safety: Methodologies for Monitoring Traffic Volumes and Assessing Exposure to Risk*: Greg Lindsey completed the project's final report, which was published in July 2018. Project results showed that peak-hour counts, or measures of exposure, can be used to model exposure on an entire city-wide street network and that data from statistical models of exposure can be correlated with the probability of bicycle crashes at intersections and along street segments in the network. The project's analyses of exposure at roadway-trail intersections showed that the standard engineering practice of applying warrants for traffic controls using only weekday peak-hour data could miss times when risk is significant, specifically during weekend days when nonmotorized trail traffic is highest. Future studies of the need for traffic controls at roadway-trail intersections should include analyses of weekend traffic volume data.
- *Older Driver Support System (ODSS)*: Nichole Morris recruited 30 older drivers in Minnesota and Kansas to test the RoadCoach app for 12 weeks. The app measured the drivers' normal driving behavior for three weeks, provided feedback for six weeks, and then measured uncoached driving behavior for another three weeks. Data was completed for 28 participants and exit interviews were also completed. While driving performance data is yet to be analyzed, exit interviews resulted in mostly positive feedback from participants, who felt that the app helped them stay more engaged in their driving.
- *Improving Emergency Medical Service Response to Motor Vehicle Crashes in American Indian Reservations*: Kathryn Quick has nearly completed design of an emergency responder survey by searching and reviewing the literature on emergency response systems in American Indian reservations and closely reviewing the data in FHWA's 2016 survey of tribal governments on roadway safety in reservations. From this, Quick developed two short online survey instruments—one for tribal governments and the other for emergency responders with responsibilities in reservation areas—to reveal patterns and address key knowledge gaps.

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.

- The Spring 2018 RSI Seminar Series came to a close with four events in April and May. The events drew roughly 130 in-person and online attendees, including the seven University of Minnesota students who took the course "Advanced Transportation Technologies Seminar" for credit.
- Seventy-five middle school and high school students were fortunate to be able to interact with RSI researchers during three separate University of Minnesota summer camps in July and August. During the National Summer Transportation Institute, Nichole Morris gave 25 students a tour of the HumanFIRST Laboratory and delivered a presentation called "What is Human Factors?" John Hourdos gave a tour of the Minnesota Traffic Observatory to 25 ninth-grade girls as part of the Eureka! Program, a camp put on by the College of Science & Engineering (CSE) at the University of Minnesota and the Minneapolis YWCA. Finally, the Institute arranged an afternoon focused on bicycle and pedestrian safety for Discover STEM, a week-long summer camp also offered by CSE. About 25 students in grades 11 and 12 participated in the session, which began with a demonstration of a bicycle collision-avoidance system being developed by mechanical engineering professor Rajesh Rajamani. Then, Humphrey School professor Greg Lindsey led the students in a discussion focused on bike and pedestrian safety and how science is used in urban planning.

- Over the summer, the Institute placed an undergraduate intern in MnDOT's Traffic Engineering Office. The student, Manik Maharjan, developed a guidance document regarding temporary barriers in work zones. He also worked on updating the office's Intelligent Work Zone toolbox.

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 disseminated 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:

- In June, the University of Minnesota hosted the 2018 CUTC Summer Meeting in Minneapolis. The event gave RSI researchers the opportunity to share their work and facilities with participants: Greg Lindsey shared his expertise while leading a bike tour of Minneapolis; John Hourdos gave a tour of the Minnesota Traffic Observatory; and Nichole Morris demonstrated her driving simulator in the HumanFIRST Laboratory.
- Max Donath gave a presentation to representatives from Polaris Engineering Management about Institute activities, including a potential Connected and Autonomous Vehicle instructional course for undergraduate engineering students. The concepts presented would provide students with a lab experience using technologies that are presently components of the autonomous vehicles being developed and tested by major vehicle manufacturers.
- This summer, Nichole Morris participated in two popular Twin Cities summer events and interacted with the public around pedestrian safety and driver fatigue. In June, she staffed the St. Paul Public Works' Pedestrian Safety Education Booth at Grand Old Day, an annual festival that attracts over 200,000 people. Morris and other knowledgeable volunteers led child-friendly activities and distributed information to passing visitors. In August, Morris collected data for a driver fatigue project at the Minnesota State Fair; interested fairgoers participated in a related vision test and shared their attitudes on automation and drowsy driving with Morris and her team.
- The Institute's communications staff wrote and submitted an article for *Roads & Bridges* magazine's supplemental *Safety Today* publication in June 2018, allowing us to reach a national audience. The article highlighted an RSI research project focused on creating a system for road crew workers to report work-zone intrusions.
- Kathy Quick and Guillermo Narváez participate regularly in meetings of the tribal Safety Management Systems Steering Committee and TRB's ABE80 committee on Native American Transportation Issues. They share research updates periodically through both groups.
- To share our work as widely as possible, we continue to maintain a news feed on the Institute's blog and home page and maintain our RSI Facebook, Twitter, LinkedIn, and YouTube accounts. Highlights from this reporting period include 23 new subscribers and more than 2,100 video views (totaling more than 21,600 minutes of watch time) on our YouTube channel.

Collaboration

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

- During this reporting period, Max Donath discussed potential cooperative programs with two University of Minnesota departments. Both Fleet Services and Parking & Transportation Services are interested in supporting connected and automated vehicle research by offering university roads and vehicles for testing. The programs could also support the testing of driver-assist systems.

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.

- In April, Nichole Morris gave a talk called "Human Factors and Roadway Safety" to 15 high school girls as part of the WTS TransportationYOU program.
- See the research accomplishments section for an update on the tribal safety research being conducted by Tom Horan and Kathy Quick.

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.

- RSI researchers received several local and national media mentions for their safety-related work. Of particular note: Nichole Morris's work on pedestrian safety in St. Paul was covered by seven local media outlets over the summer. For a full list of media stories, please visit roadwaysafety.umn.edu/about/news/.
- The Institute's website is the primary vehicle for distributing information to stakeholders. In this period, the site received approximately 1,925 site visits and 3,688 unique page views. The most popular pages were the home and seminar series pages.

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, 2018–March 30, 2019).

Research

- We anticipate the publication of at least 12 final reports: 9 from federally funded projects and 3 from match projects.
- Stephen Burks will work to complete the statistical analysis of the screening effectiveness of the commercial driver's medical examination (CDME) in the pre-Registry data and finish writing the first complete draft of the final paper. Burks will also continue to acquire initial data batches from some of the data providers and finalize negotiations with others to begin data transmission. (*The Screening Effectiveness of the Commercial Driver's Medical Examination*)
- Brian Davis plans to finalize and complete development of a curriculum, laboratory exercises, and demonstrations for the automated vehicles programming workshop. He will then solicit feedback from a small number of MnDOT and county transportation professionals attending the workshop and document in a final report the content of the workshop, laboratory exercises and demonstrations, participant feedback, and potential future improvements. (*Development of an Automated Vehicles Programming Class*)

- Frank Douma will engage with potential host communities and work with them to develop a realistic plan for a one-year automated vehicle (AV) demonstration on their streets. The first step will be to outline what characteristics an ideal community should possess and then reach out to stakeholders within communities that best fulfill these criteria. The research team also expects to have a demonstration proposal completed for rural or small urban communities across Minnesota to use as a template for bringing AV technology to their communities. (*Scenarios and Justification for Automated Vehicle Demonstration in Rural Minnesota*)
- John Hourdos will look for funding opportunities to analyze the data collected for a fully functioning connected vehicle testbed. (*Implementation of a V2I Highway Safety System and Connected Vehicle Testbed*).
- Chen-Fu Liao will deploy the in-vehicle message system at a third construction site on state highway 65 in East Bethel, Minnesota, to test the system and evaluate its performance. (*Test and Evaluate a Bluetooth Based In-Vehicle Message System to Alert Motorists in Work Zone*)
- Albert Luo and Hugo Zhou will finalize implementation details with vendors and engineers from the Alabama Department of Transportation and Illinois Department of Transportation—including installation locations, time schedule, and directional rumble strips (DRS) materials—and conduct before-and-after studies at sites. Luo and Zhou will also develop general guidelines of DRS for implementation guides. (*Field Implementation of Direction Rumble Strips for Deterring Wrong-Way Entries*)
- Nichole Morris plans to create defined parameters for instructed driver behavior and programming measurement parameters to give performance feedback to drivers in three simulated driving environments. The team will modify the distracted driving module to be used in driver education training programs to educate professional/commercial drivers about the dangers of distracted driving. (*HumanFIRST Driving Simulation Educational Development*)
- Daniel Work will complete the estimated arrival time (ETA) prediction accuracy evaluation of random forest regression models on grade crossing prediction for larger areas of the CSX freight rail network. Work will also complete an evaluation of well-studied optimization-based computer dispatching techniques with respect to their quantification for real-world freight rail performance and finalize the end-of-project report. (*Improving Railroad Grade Crossing Safety: Accurate Prediction of Train Arrival Times for Emergency Response Management and Driver Decision Support*)

Education and workforce development

- In December, the Institute will host an RSI Seminar featuring Curtis Hay of General Motors. Hay’s expertise lies in GPS and mapping in relation to connected and autonomous vehicles. The presentation, titled “Making Autonomous Vehicles a Reality: Precise Localization Using Precise GPS, Map, and Perception Sensors,” will also be streamed as a webinar.
- We will grant the annual Outstanding Student of the Year award.

Technology transfer

- We will distribute one issue of the RSI e-newsletter. We will also complete an RSI end-of-grant summary report, which will include research, education, and technology transfer highlights.

Collaboration

- Nothing to report.

Diversity

- Kathy Quick will continue her work with tribal governments on roadway safety needs.

PRODUCTS

Publications, conference papers, and presentations

During this reporting period, RSI researchers and staff gave 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. Presentations included:

- Davis, G. “Driver Behavior in Left-Turn and Other Two-Vehicle Crashes.” Presentation to the MnDOT Metro Managers Group, Roseville, MN, June 11, 2018.
- Dirks, P., and J. Hourdos. “Assessing the Impact of Pedestrian Activated Crossing Systems.” Presentation at the 59th Annual Transportation Research Forum, Minneapolis, MN, April 11, 2018.
- Donath, M. “Driver Assistance Systems to Support Snowplow Operations.” Presentation to MnDOT Operations and Maintenance Group, St. Cloud, MN, April 19, 2018.
- Donath, M. “Driver Assistance Systems to Support Snowplow Operations.” Presentation to the Dakota County Transportation Department, Rosemount, MN, May 31, 2018.
- Hourdos, J. “Building a Freeway Laboratory for Connected Vehicle and Traffic Safety Research and Development.” Presentation for the RSI Seminar Series, Minneapolis, MN, April 19, 2018.
- Hourdos, J. “Continuous Access Priced Managed Lanes – What Have We Learned So Far?” Webinar sponsored by the TRB Standing Committee on Managed Lanes, online, September 20, 2018.
- Hussain, S., M. Faizan, and I. Hayee. “Real-time Relative Lane and Position Identification of Surrounding Vehicles Using GPS and DSRC-Based Vehicle-to-Vehicle Communication.” Presentation at the IEEE Conference on Communications, Kansas City, MO, May 23, 2018.
- Lindsey, G. “Bicycle and Pedestrian Rural Safety.” Minnesota County Engineers Summer Meeting, Minneapolis, MN, June 15, 2018.
- Morris, N. “Effects of In-Vehicle Messaging on Mental Workload During Driving Through Work Zones.” Presentation at the 9th International Driving Symposium on Human Factors in Driver Assessment, Training and Vehicle Design, Manchester Village, VT, June 29, 2018.
- Owen, A. “Implementing Low-Stress Bicycle Routing in Accessibility Evaluation.” Presentation at the Bike/Walk/Places Conference, New Orleans, LA, September 17, 2018.
- Schmit, M., and L. Munnich. “Factors Influencing Policy and Political Leadership in Improving Roadway Safety.” Presentation at the 59th Annual Transportation Research Forum, Minneapolis, MN, April 11, 2018.

RSI researchers published the following papers during this reporting period:

- Barbour, W., J. C. Martinez Mori, S. Kuppa, and D. Work. 2018. “Prediction of Arrival Times of Freight Traffic on US Railroads Using Support Vector Regression.” *Transportation Research Part C: Emerging Technologies* 93: 211-227.
- Craig, C., J. Achtemeier, B. Patzer, and N. Morris. 2017. “Effects of In-Vehicle Messaging on Mental Workload During Driving Through Work Zones.” *Proceedings of the Ninth International Driving Symposium on Human Factors in Driver Assessment, Training and Vehicle Design*, 179–85.

- Gao, J., and G.A. Davis. 2017. “Using Naturalistic Driving Study Data to Investigate the Impact of Driver Distraction on Driver’s Brake Reaction Time in Freeway Rear-End Events in Car-Following Situation.” *Journal of Safety Research* 63: 195–204.
- Hochmuth, J., and R. Van Houten. 2018. “Influence of Advanced Placement of the In-Street Sign Gateway on Distance of Yielding from the Crosswalk.” *Transportation Research Record: Journal of the Transportation Research Board*. Advance online publication.
- Murphy, B., A. Owen, and D. M. Levinson. 2017. “Evaluating the Safety in Numbers Effect for Pedestrians at Urban Intersections.” *Accident Analysis and Prevention* 106: 181–90.
- Van Houten, R., J. Hochmuth, D. Dixon, and C. McQuiston. 2018. “Safety Benefits of the Gateway R1-6 Treatment: An Examination of Effects on Drivers Yielding to Pedestrians, Speed at Crosswalks, and Sign Durability.” *ITE Journal* 88.3: 31-39.

Federally funded and match projects produced the following final reports during this reporting period:

- Davis, G., J. Gao, and A. Mudgal. *Developing and Validating a Model of Left-Turn Crashes to Support Safer Design and Operations*. Roadway Safety Institute report number 18-18.
- Jeon, W., and R. Rajamani. *A Novel Collision Avoidance System for a Bicycle*. Roadway Safety Institute report number 18-06.
- Lindsey, G., J. Wang, S. Hankey, and M. Pterka. *Modeling Bicyclist Exposure to Risk and Crash Risk: Some Exploratory Studies*. Roadway Safety Institute report number 18-15.

Websites or other Internet sites

The Roadway Safety Institute website (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) 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) 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) 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/) includes information on the research of Imran Hayee.
- The Midwest Tribal Safety website (<http://tribalsafety.maps.arcgis.com/home/gallery.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.
- The Truckers & Turnover Project website (morris.umn.edu/academics/truckingproject) features the research of Stephen Burks, including a link to his recent paper in the journal *Sleep* on crash risk and obstructive sleep apnea among truck drivers.
- The Transportation Research Board website contains a link to the recording of a webinar (trb.org/ElectronicSessions/Blurbs/173634.aspx) given by Kathy Quick and Guillermo Narváez in

February 2016 titled “New Methods for Assessing and Addressing Roadway Safety Priorities in American Indian Reservations.”

Technologies or techniques

Nothing to report.

Inventions, patent applications, and/or licenses

During this reporting period, John Hourdos submitted a full patent application titled “Queue Warning System Utilizing ATM infrastructure.” He had previously submitted a provisional application in 2017. (*Implementation of a V2I Highway Safety System and Connected Vehicle Testbed*)

John Hourdos has sent a technology declaration to the University of Minnesota’s Office of Technology Commercialization and anticipates filing for a provisional patent application. (*Work Zone Mapping and Tag Deployment System*)

Other products

John Hourdos developed a radar database monitoring tool as well as a radar database summary tool that can examine the contents of the database. (*I-94 Connected Vehicles Testbed Operations and Maintenance*)

Greg Lindsey’s bicycle demand models are available for practitioners to use to estimate bicycle demand for use in planning-level studies in Minneapolis and Duluth, Minnesota. (*Performance Measures for Bicycle and Pedestrian Safety: Methodologies for Monitoring Traffic Volumes and Assessing Exposure to Risk*)

Greg Lindsey has made databases of pedestrian and bicyclist exposure to risk available to be used in planning-level studies. (*Pedestrian and Bicycle Safety, Equity, and Street Funding: New Criteria for Prioritizing Multimodal Street Projects in Minneapolis*)

Nichole Morris is developing curricular materials that will be available for use in driver education training programs to educate professional/commercial drivers about the dangers of distracted driving. (*HumanFIRST Driving Simulation Educational Development*)

PARTICIPANTS AND OTHER COLLABORATING ORGANIZATIONS

Organizations that have been involved as partners

The Roadway Safety Institute is actively in partnership with 50 organizations across 11 states and the District of Columbia. For more information on these partners—including their names, locations, and contribution types—please see pages 16 and 17.

Other collaborators or contacts

Nichole Morris recently discussed her “Older Driver Support System” project with representatives from the City and County of San Francisco’s Vision Zero group. The group is interested in using Morris’s technology to measure driver risk in left turning at intersections related to left-turn pedestrian crashes.

In April, Max Donath gave a presentation on his team’s driver assist system (DAS) to MnDOT’s Operations and Maintenance Group, which consists of maintenance superintendents and supervisors across the state. Several members of Office of Maintenance leadership attended as well. The purpose of the meeting was to solicit interest from state districts to deploy the DAS technology on their snowplow trucks.

On May 8, Max Donath met with Brad Estochen, MnDOT’s State Safety Engineer, to discuss potential collaborative projects.

On May 31, Max Donath, Chen-Fu Liao, and Nichole Morris met with representatives from the Dakota County (Minnesota) truck station to discuss outfitting their snowplows with technology developed in the team’s work on driver assist systems.

In June 2018, Max Donath and Nichole Morris met with staff from the Office of Traffic Safety at the Minnesota Department of Public Safety. During the visit, the group discussed several of Morris’s RSI projects, as well as priorities and partnerships around Minnesota’s Towards Zero Deaths initiative.

At the July 2018 Automated Vehicles Symposium in San Francisco, Max Donath presented RSI research and discussed potential collaborations with representatives from FHWA, Caltrans, UC Berkeley’s California PATH Program, and Swift Navigation.

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 the effect of medical conditions on crash risk, improved crash reporting, 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.

New impacts from this reporting period include:

- *Implementation of a V2I Highway Safety System and Connected Vehicle Testbed:* John Hourdos reports multiple impacts on the discipline of traffic engineering. As part this project, Hourdos and his team have perfected a queue warning algorithm that is being considered for commercialization. The algorithm’s success also prompted the Minnesota Department of Transportation to fund implementations in more locations on Minnesota’s freeway network. In addition, the data collected in the Connected Vehicle Testbed have already shed light on driver behavior and characteristics

such as response time and preferred deceleration, as well as validated existing traffic flow models of shockwave propagation.

- *Older Driver Support System*: This research has impacted the discipline of human factors by demonstrating the power of universal design for serving older drivers and all other driver age groups.
- *Performance Measures for Bicycle and Pedestrian Safety: Methodologies for Monitoring Traffic Volumes and Assessing Exposure to Risk*: Greg Lindsey expects impacts on traffic engineering and transportation planning. This project will provide practitioners with new models for estimating exposure for use in planning-level studies that assess exposure to risk and crash probability.
- *The Screening Effectiveness of the Commercial Driver's Medical Examination (CDME)*: Stephen Burks anticipates impacts on public policy. This project has the potential to influence the likelihood of revision to federal regulations requiring the screening of commercial vehicle operators using the CDME.
- *Test and Evaluate a Bluetooth Based In-Vehicle Message System to Alert Motorists in Work Zones*: This project will have impacts on the discipline of traffic engineering. Based on current test results at two construction sites, Chen-Fu Liao reports that the system is able to trigger in-vehicle messaging reliably using the Bluetooth technology and is effective for vehicles traveling at highway speeds.

Impact on other disciplines

- *HumanFIRST Driving Simulation Educational Development*: According to Nichole Morris, this work has had an impact on human factors education. Specifically, it has impacted the approach to related community education and outreach by investigating other avenues to reach driving populations that could benefit from the research team's expertise and the hands-on experience of the driving simulator.
- *Performance Measures for Bicycle and Pedestrian Safety: Methodologies for Monitoring Traffic Volumes and Assessing Exposure to Risk*: This project will impact urban and transportation planning. Planners can use its results as inputs in studies to assess equity of exposure to crash risk and to address issues such as prioritization of street improvement projects.

Impact on physical, institutional, and information resources

- *HumanFIRST Driving Simulation Educational Development*: This project has supplemented institutional infrastructure investments at the University of Minnesota and improved the HumanFIRST Laboratory's equipment for future use.
- *Implementation of a V2I Highway Safety System and Connected Vehicle Testbed*: This project established a new, unique field lab for the study of connected vehicle technology.
- *Improvement of Driving Simulator Eye Tracking Software*: This project will increase the efficiency with which simulator eye tracking data can be processed and analyzed. This will significantly reduce the amount of human intervention required to process raw eye tracking output into a useful format.

Impact on transportation workforce development and human resources

Our education and workforce development efforts, as described in the Accomplishments section, 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 support the development of a diverse transportation workforce.

During this reporting period, 21 RSI projects enlisted undergraduate or graduate student assistants. These jobs provided 42 students with research and practical work experience related to roadway safety. PIs supervising students include Ray Benekohal, Stephen Burks, Brian Davis, Gary Davis, Frank Douma, Rhonda Franklin, Imran Hayee, Tom Horan, John Hourdos, Michael Levin, Greg Lindsey, Albert Luo, Nichole Morris, Kathy Quick, and Dan 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.

New impacts from this reporting period:

- *Computerized Crash Reports Usability and Design Investigation*: This project led to a follow-up study, “Minnesota Crash Records Audit,” which evaluated the system implemented under the original effort. The new study has demonstrated that the new system has more complete data and fewer errors than its predecessor. Morris expects this work to continue with further iterative design and testing to improve the crash data and accommodate changing national standards for data capture.
- *Implementation of a V2I Highway Safety System and Connected Vehicle Testbed*: As part of this project, research related to queue warnings was transferred to an actual deployed system operated on I-94 by the Minnesota Department of Transportation.
- *Long Term Effects of Gateway R1-6 Treatment on Yielding to Pedestrians, Vehicle Speed, and Sign Survival*: The gateway treatment has been designated as a focus treatment by the American Association of State Highway Transportation Officials (AASHTO), which will promote its use among transportation practitioners nationwide. So far, known implementations of the treatment have occurred in both Florida and Minnesota.

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.

Impacts from individual projects:

- *Collaborating with American Indian Communities to Re-Interpret and Strategize About Transportation Safety Risks in Tribal Lands*: Kathy Quick and Guillermo Narváez improved the knowledge and perspectives of Tribal Title IV-E professionals working for tribal governments or for adjoining governments serving American Indian reservation areas. Most professionals who serve reservations, unless they live in the reservations, were not aware of acute concerns about pedestrian safety on reservations, so sharing the findings of these reports has been important to informing their work on reservations and improving safety.

- *Development of an Automated Vehicles Programming Class:* The final workshop developed as part of this project will help improve public knowledge as well as practitioner skills, according to Brian Davis. The workshop will provide transportation professionals with high-quality education about connected and automated vehicles and their enabling technology.
- *Performance Measures for Bicycle and Pedestrian Safety: Methodologies for Monitoring Traffic Volumes and Assessing Exposure to Risk:* The results of this project have the potential to increase public understanding of the relationship between exposure to risk and crash probability.

CHANGES/PROBLEMS

Changes in approach and reasons for change

John Hourdos originally planned to deploy dedicated short-range communication (DSRC) roadside units (RSU) on the testbed. Since another project designed to provide the instrumented vehicles for use in the testbed has not materialized, the DSRC units were purchased and tested for integration but not deployed in the field. (*Implementation of a V2I Highway Safety System and Connected Vehicle Testbed*)

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

Stephen Burks is rewriting the final paper based on the journal editor's request to add sufficient details of the model in the main text so that readers can understand the basis for the research findings. This will delay publication of Burks's final report and necessitate an extension to this project, but he will finish before the end of the Institute's grant. (*Exploring Links Between Medical Conditions and Safety Performance in Tractor Trailer Drivers*)

Stephen Burks had planned to obtain new data on medical insurance claims from a third service vendor of the motor carrier, Hays/PlanIT. The research team obtained a HIPAA-compliant data use agreement (DUA) with Hays/PlanIT, but the vendor cannot provide the data at a cost the motor carrier can afford. As a result, Burks will use the procedure used for the pre-registry medical insurance data by obtaining the data directly from UnitedHealthcare (UHC). This has caused a delay due to the need to negotiate and execute a new DUA with UHC. An attorney with the University of Minnesota Office of the General Counsel will assist in obtaining the necessary agreements. (*The Screening Effectiveness of the Commercial Driver's Medical Examination*)

Rhonda Franklin began high-performance antenna field measurements about one month later than anticipated because of weather issues. Low-performance navigation data collection was also delayed in an effort to get a complete set of the electromagnetic and position data to establish a baseline. These delays should not impact the overall schedule of the project. (*Developing GPS Antenna Error Models for Improved Centimeter Level Positioning*)

John Hourdos encountered considerable delays in acquiring the necessary permissions from MnDOT to deploy two out of five radar stations in a connected vehicle testbed. In addition, given the final unavailability of power at the desired location, Hourdos had to design and assemble a solar powered solution, which was one of the reasons the research team did not proceed on the dedicated short-range communication (DSRC) deployment. (*Implementation of a V2I Highway Safety System and Connected Vehicle Testbed*).

John Hourdos encountered delays in registering the Smart Work Zone Beacons with Verizon. Despite repeated attempts and petitions, Verizon was unable to activate for almost a year several original equipment manufacturer (OEM) components originally procured for the prototype. Hourdos was finally able to activate a lesser functionality beacon component, which allowed development of the current prototypes. Although not an elegant solution, it is functional and it advanced the work to the testing and integration stage. (*Work Zone Mapping and Tag Deployment System*)

Albert Luo and Hugo Zhou might need a five-month extension to complete their project because Auburn University received its subcontract five months after the project start date. Since directional rumble strips (DRS) cannot be installed under snow conditions, implementation of the DRS in Illinois will likely be postponed because of the approaching winter. (*Field Implementation of Direction Rumble Strips for Deterring Wrong-Way Entries*)

Nichole Morris had to ask the vendor to rebuild the motion base of the driving simulator, which had a major design flaw. This created a delay in the simulation lab, which has in turn delayed some of the work on this project. However, completion of the project will still occur before June 2019. (*HumanFIRST Driving Simulation Educational Development*)

Kathy Quick completed a lengthy process with the University of Minnesota to contract the co-PI as a vendor. This took approximately three months longer than the PI and co-PI had been led to believe it would take from University of Minnesota financial services staff. At this point, the research team is fully staffed, the project is fully underway, and the team is working to complete the project as originally scheduled. (*Improving Emergency Medical Service Response to Motor Vehicle Crashes in American Indian Reservations*)

Changes that have a significant impact on expenditures

Nothing to report.

Significant changes in use or 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
Advocacy Council for Tribal Transportation	Greater Minnesota				X	
American Association of State Highway and Transportation Officials	Washington, DC		X			
American Transportation Research Institute	St. Paul, MN		X			
Ann Arbor, City of	Ann Arbor, MI		X			X
Arrowhead Regional Development Commission	Duluth, MN		X		X	
Civil Engineering Department, Auburn University	Auburn, AL			X	X	
College of Science and Engineering, UMN	Minneapolis, MN	X				
CSX Corporation	Jacksonville, FL		X	X	X	X
Esri Corporation	Redlands, CA		X			
Federal Highway Administration	Washington, DC		X		X	
Federal Highway Administration, Minnesota Division	St. Paul, MN		X			
Fond du Lac Band of Lake Superior Chippewa	Cloquet, MN				X	
Grand Rapids, City of	Grand Rapids, MI		X			X
Harvard Medical School	Cambridge, MA				X	
Headwaters Regional Development Commission	Bemidji, MN		X		X	
Hennepin County	Minneapolis, MN		X		X	
Humphrey School of Public Affairs, UMN	Minneapolis, MN	X	X			
Leech Lake Band of Ojibwe	Cass Lake, MN				X	
Mayo Clinic	Rochester, MN				X	X
Mechanical Engineering Department, SIUE	Edwardsville, IL			X		
Metro Transit	St. Paul, MN		X			
Michigan Department of Transportation	Lansing, MI	X	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	
Minnesota Department of Public Safety	St. Paul, MN		X			
Minnesota Department of Transportation	St. Paul, MN	X	X	X	X	X
Minnesota Senate	St. Paul, MN		X			
Ohio Department of Transportation	Columbus, OH					
Otter Tail County	Fergus Falls, MN		X			

Quality Bicycle Products	Bloomington, MN				X	
Red Lake Nation	Red Lake, MN				X	
Region 9 Development Commission	Mankato, MN		X		X	
St. Paul, City of	St. Paul, MN		X			
Sawtooth Mountain Clinic	Grand Marais, MN		X		X	
Schneider Enterprise Resources, LLC	Green Bay, WI		X			
School of Nursing, UMN	Minneapolis, MN				X	X
Southern Illinois University Edwardsville (SIUE)	Edwardsville, IL	X		X		
The Works Museum	Bloomington, MN	X		X		
University of Akron	Akron, OH	X	X	X		X
University of Illinois at Urbana-Champaign	Urbana, IL	X				
University of Minnesota Duluth	Duluth, MN	X				
University of Minnesota Extension					X	
University of Minnesota, Morris	Morris, MN	X	X	X	X	
Vice President for Research, UMN	Minneapolis, MN	X				
Virginia Tech Transportation Institute	Blacksburg, VA				X	
Western Michigan University	Kalamazoo, MI	X				
White Earth Nation	White Earth, MN			X		
Wichita State University	Wichita, KS		X	X	X	X
WTS Minnesota/Transportation YOU	Minneapolis, MN				X	