

ROADWAY SAFETY INSTITUTE

Human-centered solutions to advance roadway safety

Program Progress Performance Report for University Transportation Centers

Recipient Organization

Regents of the University
of Minnesota
200 Oak Street SE; Suite 450
Minneapolis, MN 55455-2070

Recipient Identifying Number

CON# 042705

DUNS and EIN Numbers

DUNS: 55-591-7996
EIN: 41-6007513

Federal Grant Number

DTRT13-G-UTC35

Submitted to:

Amy Stearns, Grant Manager
Office of the Assistant Secretary for
Research and Technology
US Department of Transportation

Submitted by:

Max Donath, Director
Roadway Safety Institute
University of Minnesota
donath@umn.edu, 612-625-2304

Grant Period: 9/30/13 – 9/30/18

Reporting Period: 10/1/2015 – 3/31/2016

Report term: Semiannual

Submission Date: 4/29/2016

Signature of Submitting Official:



Max Donath, Director, Roadway Safety Institute

CONTENTS

Accomplishments	1
Major goals and objectives of the program	1
Accomplishments	2
Opportunities for training and professional development	8
Dissemination	8
Plans for next reporting period	8
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	14
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 them.....	16
Changes that have a significant impact on expenditures.....	17
Significant changes in use or 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 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.

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 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 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 partnering with WTS's Transportation YOU program to encourage young female students 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 a STEM-related museum.

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 seminars and webinars; developing an online repository of safety tools for local engineers in our region; 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 will develop versions of research hardware and software that can be deployed through collaboration with public safety agencies, foundations,



and the private sector. We are also communicating research findings to the transportation community for their successful implementation. We have created a consortium website, an electronic newsletter, topical briefs, research videos, and an Institute biennial report.

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 developing and delivering a day of 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 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:

- The Institute has used this grant to fund 18 research projects. 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.
- We have secured \$5,583,334 in match funding, which includes 33 MnDOT-funded projects related to roadway safety as well as match contributions from our consortium partners.
- All RSI researchers with federally funded projects have submitted peer-reviewed Nine-Month Progress Reports and subsequently received a second year of project funding. We are also in the process of allocating a third year of funding to the researchers. To date, 16 researchers have decided to use the money to continue their current projects, while one researcher has proposed a new project. Work plans are currently in development.

Highlights from active research projects:

- *Exploring Links Between Medical Conditions and Safety Performance in Tractor Trailer Drivers:* Stephen Burks published a paper on obstructive sleep apnea (OSA) in a major refereed journal (*Sleep*) and completed an analysis of cost differences of medical insurance claims between tractor trailer drivers with OSA and those without. Burks also developed the legal conditions for acquiring new data and signed data use agreements (DUA) with all relevant parties to make it legally and technically possible to acquire new operational and medical data under HIPAA. This work received national attention and will likely be considered during rulemaking by the FMCSA.
- *Estimation of Traffic Conflicts at Signalized Intersections Using High-Resolution Traffic Signal Data:* Gary Davis has developed and tested an algorithm for identifying red-light-running events.

- from detailed loop-detector data archived by the SMART Signal system. Davis has now started to compile crash data to test whether frequency of red-light running is a reliable predictor of crash risk.
- *Evaluation of the Effectiveness of ATM Messages Used During Incidents:* John Hourdos completed this project, which confirms the utility of intelligent lane control signs (ILCS) for incident management and contains an in-depth analysis of the effects of different types of messages and message combinations on driver behavior—specifically, on lane choice upstream of an incident. Hourdos also compared synergy between signs and the presence of first responders.
 - *Performance Measures for Bicycle and Pedestrian Safety: Methodologies for Monitoring Traffic Volumes and Assessing Exposure to Risk:* Greg Lindsey is nearing completion of methodologies and models that transportation engineers can use when estimating bicycle traffic volumes. Tasks included modeling bicycle traffic in Duluth and Bemidji, mapping crashes in Duluth and Bemidji, describing bicycle traffic in Grand Marais, and developing direct demand models of bicycle traffic in Minneapolis. Lindsey has further illustrated through case studies how these models can be used to assess exposure to risk on street networks and on different types of transportation infrastructure.
 - *Directional Rumble Strips for Reducing Wrong-Way-Driving Freeway Entries:* Albert Luo conducted initial field tests of transverse rumble strips in Illinois and Alabama, conducted a national survey to collect input on the feasibility and concept design for directional rumble strips (DRS) from transportation professionals, and developed a total of five patterns and eight configurations of DRS to evaluate. Luo then conducted a statistical analysis to evaluate each of the tested configurations in terms of sound and vibration.
 - *In-vehicle Work-Zone Messages:* Nichole Morris completed a work zone safety culture survey with approximately 100 Minnesota drivers that found most drivers were open to using in-vehicle technology to access better and more up-to-date information about work zones—with the caveat that any such technology be designed and tested for its potential to cause distraction.
 - *Older Driver Support System (ODSS) Usability and Design Investigation:* Nichole Morris conducted interviews and three focus groups of older drivers—two made up of older drivers with technology experience, and one of older drivers without. Morris also completed an interface display survey, then selected icons based on the findings, paired those icons with auditory messages chosen by survey participants, and implemented them into the design of the demonstration interface of an ODSS.
 - *Improving Railroad Grade Crossing Safety: Positioning, Planning, and Operation of Emergency Response Resources and Coordination Between Jurisdictions:* Yanfeng Ouyang developed new mathematical models to study how deployment and utilization of emergency response resources should be coordinated across various jurisdictions if these resources would need to be used collectively to cover incidents at railroad crossings. Ouyang has published a corresponding paper on decomposition of emergency disruption correlation and a second paper, on optimal emergency response resource location planning against correlated disruptions, is currently under revision.
 - *Safety in Numbers? Accessibility, Traffic, and Safety of Nonmotorized Travelers:* Andrew Owen collected pedestrian network data and block-level job count data for 50 US metro areas, calculated block-level pedestrian accessibility to jobs in all metro areas, collected crash and fatality datasets from individual metropolitan areas, and estimated pedestrian traffic levels at intersections based on accessibility and network centrality. Owen has completed phase one of the study, which found a statistically significant relationship between accessibility and pedestrian traffic levels.
 - *Collaborating with American Indian Communities to Re-Interpret and Strategize About Transportation Safety Risks in Tribal Lands:* Kathy Quick and Guillermo Narváez, in an effort to provide a ground-level picture of safety risks on tribal lands and identify corresponding policies and investments to address those concerns, have secured case-study sites with four tribal governments,

started to collect data, and visited seven tribal governments to discuss transportation concerns. Most significantly, the researchers have successfully built relationships that will allow them to continue their work for the duration of this project and thereafter.

- *Novel Collision-Avoidance System for Bicycles*: Rajesh Rajamani developed and verified algorithms that use sonar, magnetic, and laser sensors to estimate position and orientation of potential collisions involving vehicles and bicycles; analyzed the performance of various bicycle sensors and instrumentation to enable experimental evaluation of a collision warning system; evaluated the system for two key collision scenarios; and developed a real-time rear-vehicle tracking system. The collision warning system he developed is able to estimate vehicle position and orientation for side-swipe collisions and collisions from a right-turning vehicle at an intersection.
- *Alcohol-Related Hot-Spot Analysis and Prediction for Improving DWI/OVI Law Enforcement*: William Schneider used hot-spot maps to guide patrol officers to areas with large numbers of intoxicated drivers and has begun to validate the efficiency of the individual patrol to help determine the ideal shift times and number of cars to use for each patrol in an effort to reduce alcohol-related crashes. Using sensitivity analyses, Schneider found that a 95 percent statistical significance in hot spots best locates the significant areas with more intoxicated drivers.

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 safety-themed exhibit at The Works Museum in Bloomington, MN, slated to open in June 2016. During this reporting period, the decision was made to focus on pedestrian visibility and reflectivity and staff worked with museum representatives and an exhibit fabricator on design options. We also piloted our exhibit concepts on February 27 at Tech Fest, a daylong event for young children and families hosted by The Works. We offered activities related to pedestrian safety and visibility that included a video showing the importance of wearing reflective clothing at night; a diorama demonstrating the principle of retroreflectivity; and a photo booth where kids could try on reflective dress-up clothes. Approximately 1,000 people attended the event.
- We delivered the remainder of our for-credit seminar series, which featured both RSI researchers and transportation experts from around the nation discussing their safety-related work. Between October 1 and December 10, nine events were held that attracted 376 people; this is a 59 percent increase over the same period in 2014. The seminars were open to the public and also streamed on the web. Nine University of Minnesota students received course credit for attending the seminars, and RSI researchers Albert Luo (Southern Illinois University Edwardsville) and Hugo Zhou (Auburn University) offered the seminars as extra credit. The seminars also provided an opportunity to connect researchers with local practitioners; we set up a number of meetings and tours for our six out-of-town speakers while they were in Minneapolis.
- The Institute awarded 15 travel scholarships to master's and doctorate students to attend the TRB Annual Meeting in January 2016. The scholarships, which awarded up to \$1,000 toward travel and conference expenses, exposed students to current transportation research and provided important networking opportunities. During the TRB conference, we also presented our Student of the Year Award to Brendan Murphy, a 2015 graduate of the University of Minnesota's civil engineering master's program.
- In November and December 2015, Institute staff organized and delivered three pedestrian safety workshops—in Waukesha, WI; Columbus, OH; and Indianapolis, IN. At the workshops, which



drew a combined total 88 attendees, Western Michigan University's Ron Van Houten presented research findings and recommendations from several pedestrian safety treatment studies. RSI staff then led a facilitated discussion to help attendees explore safety needs in their own communities. These safety challenges will be shared with RSI staff and researchers for potential research or outreach projects.

- On October 27, seven female students from Blaine High School visited the University of Minnesota campus. This visit was organized by WTS Minnesota's TransportationYOU program. Students spent the day with transportation faculty, researchers, and practicing professionals and explored campus through the lens of safety and other transportation disciplines. One highlight was a tour of the HumanFIRST Laboratory, where students tested the lab's driving simulator. Volunteer mentors from WTS also participated in the entire day and shared their own experiences of college and work.
- On March 8, Institute staff taught sessions on pedestrian safety and basic traffic principles to 60 eighth-grade students from Minneapolis. The students visited the University of Minnesota as part of the AVID (Advancement Via Individual Determination) program, which promotes college and STEM careers for first-generation college students. The pedestrian safety curriculum covered retroreflectivity, which is the focus of our museum exhibit at The Works.
- During the fall of 2015, Daniel Work helped organize and deliver a series of workshops and tutorials at the National Science Foundation's Institute for Pure and Applied Mathematics at UCLA. The events aimed to bring engineers and mathematicians together to improve transportation modeling. Work discussed his current RSI research with the 135 attendees.
- We moved closer toward our goal of providing roadway safety training materials for local engineers to share with their maintenance staff. After discussing curricular needs with Region 5 LTAP/TTAP directors, we decided to focus our efforts on creating modular resources that could be combined with existing curricula and trainings. These free online resources will promote roadway safety awareness while creating synergy between the UTC and LTAP/TTAP programs.

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 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:

- Institute staff developed two new topical briefs. The first, "Bicycle and Pedestrian Safety Research," was distributed at Ron Van Houten's pedestrian safety workshops in the fall. The second focuses on LiDAR scanning research. All five of our briefs are available on our website.
- Two issues of our e-newsletter were distributed, one in November 2015 and one in February 2016. Since the last reporting period, we have grown our subscriber base by nearly 200, and the average open rate has increased from 23.5 percent to 24.6 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 maintain our RSI Facebook, Twitter, and LinkedIn accounts. Our Twitter account has shown notable growth; during the last reporting period, we more than doubled our number of followers and received between 3,000 and 5,000 Twitter impressions each month. Last fall we also launched an RSI YouTube Channel that has received more than 1,400 views.

- A biennial report that highlighted the Institute’s work to date was developed and distributed. The publication, which was shared at the TRB Annual Meeting in January and UTC Safety Summit in March, demonstrates the depth and breadth of the Institute’s research portfolio and initiatives.
- Institute staff started work on a video that provides a programmatic overview of the Roadway Safety Institute, highlights the positive future impacts of the research, and communicates the value of the UTC program to a broad audience. The video should be finished in the late spring.
- We partnered with Iowa State University (ISU), the lead institution for the Region 7 UTC, on a Transportation Research Webinar series designed to highlight innovative transportation research. Two webinars occurred during this reporting period, attracting nearly 150 attendees between them.
- Andrew Morrow from the University of Minnesota’s Office for Technology Commercialization participated in a Commercial Remote Sensing & Spatial Information Technologies Workshop in Oklahoma City on October 2, 2015. Morrow used the Teen Driver Support System project as a case study to demonstrate the process of commercializing a university’s intellectual property. This project, initiated during the University of Minnesota’s last UTC grant, is led by RSI director Max Donath and has served as a platform for Nichole Morris’s RSI project Older Driver Support System (ODSS) Usability and Design Investigation.
- RSI director Max Donath and RSI researcher Chen-Fu Liao participated in Congressional Staff Day at the University of Minnesota on October 8, 2015. The event informed national and Minnesota congressional staff of the broad range of transportation research, education, and outreach initiatives important to Minnesota. Donath provided an overview of the Roadway Safety Institute to attendees, while Liao gave a tour of the Minnesota Traffic Observatory and a brief presentation on his RSI research project.
- RSI research fellow Brian Davis demonstrated his innovative LiDAR technology at the 2015 Dr. J. Don Brock TransOvation™ Workshop on November 16, 2015. The workshop was sponsored by the American Road and Transportation Builders Association and took place at the 3M Innovation Center in St. Paul, MN. Davis demonstrated how LiDAR can enhance driver-assist systems to roughly 50 attendees, including consultants, construction firms, and other industry professionals. Davis also demonstrated his LiDAR technology at two Innovative Technology Workshops sponsored by the Minnesota Local Road Research Board in February.
- RSI staff member Jim Grothaus gave an overview of the Roadway Safety Institute at the Minnesota County Engineers Meeting in Brainerd, MN on January 21, 2016.
- Max Donath participated in the Center for Transportation Studies’ Transportation Tour and Seminar for Minnesota Legislators on February 23, 2016, during which he gave a presentation highlighting the Institute’s work on railroad grade crossing safety and commercial vehicle driver safety to approximately 15 Minnesota legislators and legislative staff.
- Max Donath traveled to Washington, DC, to participate in the UTC Safety Summit hosted by Carnegie Mellon University on March 30–31, 2015. Donath gave a brief presentation on the Institute’s research and educational initiatives; highlighted notable projects during the Technology and Research Showcase; and distributed copies of our biennial report to attendees.
- In fall 2015, Lee Munnich, as part of his RSI research project, conducted Roadway Safety Policy and Leadership Roundtables in the state capitals of Illinois, Indiana, Michigan, and Wisconsin. Each roundtable had 8–10 participants, including the state safety engineer. During the event, Munnich led a discussion about the challenges and opportunities for adopting evidence-based policy countermeasures for roadway safety. He also distributed a one-page overview of the Institute.
- The Winter 2016 issue of *Inventing Tomorrow*, the alumni magazine of the University of Minnesota’s College of Science & Engineering, included an article titled “Ruling the Road” that



highlighted the safety-related work of Institute researchers John Hourdos and Chen-Fu Liao. The magazine was distributed to more than 62,000 alumni and friends of the college.

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 October 15 for its biannual meeting. The meeting's focus was on bicycle and pedestrian safety, and members engaged in a rich discussion. RSI researchers Chen-Fu Liao and Raj Rajamani gave presentations about their innovative research projects developing new safety technologies for pedestrians and bicyclists. The Board also welcomed two new members: King W. Gee from AASHTO and Jim Barna from the Ohio Department of Transportation.
- The RSI University Partners Committee, made up of researchers from all five partner universities, met via conference call on November 2, 2015. During the call, the group strategized about how to increase the Institute's reach in Region 5, including the possibility of sponsoring sessions at several relevant conferences.
- The Institute convened a group of Region 5 state safety engineers via conference call to move forward with our safety-related pooled-fund project. On March 7, RSI researcher Greg Lindsey presented to the group on bicycle and pedestrian volume measurement and their relationship to risk exposure metrics. On March 14, RSI researcher Nichole Morris shared information about dynamic curve speed warning. During each call, the group discussed potential next steps with these important research topics.
- Laurie McGinnis, chair of the RSI Advisory Board and director of the Center for Transportation Studies, was recently elected to the CUTC Board of Directors and attended its November 2015 meeting.

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.

- The Institute awarded travel scholarships for two female students to attend the WTS Regional Conference in Indianapolis on February 19–20, 2016. The students each received \$1500 toward their travel expenses.
- Kathy Quick traveled to Washington, DC, on November 2, 2015 to share her tribal safety research with Region 5 congressional delegates as well as tribal safety experts from the FHWA and the Bureau of Indian Affairs. RSI director Max Donath, also in attendance, provided an overview of Roadway Safety Institute research initiatives.
- Kathy Quick and Guillermo Narváz presented at a TRB webinar titled "Understanding Transportation Safety Risks on Tribal Lands: Learning from a Collaborative Research Project with American Indian Communities in Minnesota" on February 4, 2016. During their presentation, the pair discussed ways to interpret and respond to the high rates of crash-related fatalities and severe injuries among American Indians and shared results from a study conducted as part of their RSI research project. The webinar, organized by the TRB Standing Committee on Native American Transportation Issues, attracted 253 attendees from around the country.
- The Institute participated in the Minnesota Tribes and Transportation Conference on October 13, 2015. Among the 150 attendees, 9 of the 11 federally recognized tribes were represented. RSI program director Stephanie Malinoff provided an overview of the Institute's education and workforce development initiatives intended to engage the next generation of the transportation



workforce. RSI researchers Kathy Quick, Guillermo Narváez, and Tom Horan presented on their research aimed at better understanding transportation safety risks on tribal lands through collaboration with American Indian communities in Minnesota. The Institute was also a sponsor of this year's event.

- Because of her experience with tribal safety research, Kathy Quick has been selected for the research subcommittee of TRB's Native American Transportation Issues committee (ABE80).
- The RSI Seminar Series featured Linda Ng Boyle, professor and chair of the Department of Industrial and Systems Engineering at the University of Washington, on October 8, 2015. Her visit help to meet our goal of supporting female faculty in STEM disciplines as well as sparking interest among female students to pursue transportation safety careers.

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 4,763 visits and 11,732 unique page views. The most popular pages were the home, research, and seminar pages.
- RSI researchers were featured in nearly 80 media stories this period. Two researchers received extensive national media coverage in March:
 - Nichole Morris of the HumanFIRST Lab was interviewed for the *New York Times* and the *NBC Today Show* on the topic of teen driving safety and the need for parental involvement.
 - Stephen Burks published an article in the journal *Sleep* that found that truck drivers with untreated sleep apnea have a 5X greater crash risk than those who treat their apnea or who don't have sleep apnea. The article received national media attention, including coverage by CBS News, ABC News, Reuters, *US News & World Report*, and industry publications.
- For a full list of media stories, please visit 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 (April 1, 2016 – September 30, 2016).

Research

- We will develop a process to bring 3 to 6 new researchers into the Institute. We have earmarked \$600,000 of our Year 3 funding for this purpose. We will also begin to distribute Year 3 funding to our current researchers.
- We will secure additional match funding by continuing to work with MnDOT to identify safety-related projects for our researchers.
- Ray Benekohal will complete an updated macro accident-prediction model after adding information discovered in the micro analysis and integrate macro and micro models for improved prediction and analysis of accidents at railroad crossings. Benekohal will also complete a tool that can be used to

conduct a micro-level analysis at individual railroad crossings along railroad corridors for regional studies (*Improving Railroad Grade Crossing Safety: Accident Prediction Models Using Macro- and Micro-Scale Analysis*).

- Stephen Burks will continue to move the initial draft of the paper on OSA status and medical cost differences toward journal submission to a relevant medical journal; his previous paper focused on crash risk differences. Burks will also work to complete the legal and contractual conditions for new data to flow from the participating motor carrier and its medical service providers (*Exploring Links Between Medical Conditions and Safety Performance in Tractor Trailer Drivers*).
- Imran Hayee will mathematically characterize relative accuracy of GPS receivers and conduct field tests to measure the average or standard deviation of that relative accuracy (*Development and Demonstration of Merge-Assist System Using Connected Vehicle Technology*).
- Tom Horan will obtain more user feedback through interviews and webinars, further refine applications based on user feedback, expand his study to greater Region 5, and refine analysis comparing fatal crashes on tribal lands and adjacent lands. Horan will also use comparison analysis to identify tribes and adjacent areas with high rates of fatal crashes for analysis within that area to identify key factors leading to fatal crashes. He'll then correlate data and results with actual information from specific tribal transportation plans to create a set of recommendations for improvements (*Using GIS to Improve Tribal Traffic Safety*).
- Nichole Morris will complete a driving video test to be given to older individuals. Morris will also begin working with ClowdLab LLC to alter the teen driver commercial app in an effort to create a test version of the ODSS that will function on a smartphone for the controlled field test (*Older Driver Support System (ODSS) Usability and Design Investigation*).
- Yanfeng Ouyang will develop an approach based on a set of non-cooperative game theoretical methods to study how various stakeholders in the railroad hazmat transportation industry and in public agencies collectively determine their relevant management decisions. Ouyang will deliver model formulation, algorithm and solution methods, and real-world case study results (*Improving Railroad Grade Crossing Safety: Positioning, Planning, and Operation of Emergency Response Resources and Coordination Between Jurisdictions*).
- Kathy Quick will conduct a detailed data analysis and follow-up data collection. Quick will work with the tribal safety management committee of Lifesavers and the TTAP program to design a national survey on tribal transportation safety priorities. TTAP will administer the survey, and Quick will analyze the results (*Collaborating with American Indian Communities to Re-Interpret and Strategize about Transportation Safety Risks in Tribal Lands*).
- Raj Rajamani will address challenges due to unreliable side reflections from rear vehicles, experimentally evaluate and refine the model predictive controller on the bicycle, and enhance bicycle instrumentation to include multiple laser sensors and a video camera system to record potential collisions (*Novel Collision-Avoidance System for Bicycles*).
- William Schneider hopes to complete his project through creating failure probability distributions as well as final maps for patrols (*Alcohol-Related Hot-Spot Analysis and Prediction for Improving DWI/OVI Law Enforcement*).

Education and workforce development

- Our exhibit at The Works Museum will open at the end of June 2016.
- In August, Ron Van Houten will give a workshop called “Innovations in Pedestrian Safety” at the American Public Works Association’s annual conference in Minneapolis. The workshop, sponsored by the Institute, will include a classroom presentation and a walking tour of various crosswalk treatments around the venue.

- In July, Institute staff will coordinate safety curriculum for the National Summer Transportation Institute at the University of Minnesota, a day camp for middle school students in the Twin Cities. We will also participate in summer camps hosted by the College of Science & Engineering.
- We will plan and deliver the first of several events in our Fall 2016 RSI Seminar Series.
- We will secure a paid summer internship for an undergraduate student in MnDOT's Office of Traffic Safety and Technology. The intern will receive hands-on experience working on transportation-related projects and learning from professionals in the field.
- We will support LTAP/TTAP efforts to provide roadway safety training to maintenance workers by developing content and videos for our online resources and selecting a platform to host the finished products.

Technology transfer

- We will distribute two issues of our e-newsletter, one in May and one in August. 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 finish work on a video that provides a programmatic overview of the Roadway Safety Institute and communicates the value of the UTC program to a broad audience
- We will work with Iowa State University (ISU) to deliver two additional events in our Transportation Research Webinars series designed to highlight innovative research.
- We will explore the possibility of participating in safety-related sessions at transportation conferences around the region, including MAASTO and the Illinois Traffic Engineering and Safety Conference.

Collaboration

- The RSI Advisory Board will meet on April 12, 2016, in Minneapolis to provide input on the Institute's submission for the UTC competition. The group will also hear a presentation by RSI researcher Stephen Burks of the University of Minnesota Morris.
- The RSI University Partners Committee will convene via conference call on May 11, 2016.
- The Region 5 state safety engineers will work with their respective departments to review the two proposed pooled-fund projects and secure funding.

Diversity

- On June 13, 2016, the Institute will provide a 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. Curriculum development is currently under way.
- We will start developing a "curriculum toolbox" to be shared with Region 5 WTS chapters. Over the past two years, 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, 16 RSI researchers and staff gave 45 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 roadwaysafety.umn.edu/publications/ostr/documents/pppr5_presentations_list.pdf.

RSI researchers published the following papers during this reporting period:

- Bennett, M., and R. Van Houten. 2016. “An Examination of Some Variables Influencing the Efficacy of the Gateway In-Street Sign Configuration on Motorist Yielding Right-of-Way to Pedestrians.” *TRB 95th Annual Meeting Compendium of Papers*, paper number 16-1920.
- Burks, S., J. Anderson, M. Bombyk, R. Haider, D. Ganzhorn, X. Jiao, C. Lewis, A. Lexvold, H. Liu, J. Ning, A. Toll, J. Hickman, E. Mabry, M. Berger, A. Malhotra, C. Czeisler, and S. Kales. 2016. “Non-Adherence with Employer-Mandated Sleep Apnea Treatment and Increased Risk of Serious Truck Crashes.” *Sleep*. Available online March 21.
- Delaere, G., R. Van Houten, and J. Shurbutt. 2015. “Countdown Pedestrian Signals and Low-Vision Pedestrians.” *Transportation Research Record* 2492: 57–60.
- Fees, C., D. Torbic, K. Bauer, R. Van Houten, N. Roseberry, and J. LaPlante. 2015. “Design Guidance for Bicycle Lane Widths.” *Transportation Research Record* 2520: 78–89.
- Hankey, S., and G. Lindsey. 2016. “Facility-Demand Models of Peak-Period Pedestrian and Bicycle Traffic: A Comparison of Fully-Specified and Reduced-Form Models.” *TRB 95th Annual Meeting Compendium of Papers*, paper number 16-5371.
- Narváez, G., and K. Quick. 2016. “New Methods for Identifying Roadway Safety Priorities in American Indian Reservations.” *TRB 95th Annual Meeting Compendium of Papers*, paper number 16-5737.
- Schneider, W. 2016. “A Comparison of Overtime Stops Made Inside and Out of Cluster Identified Hot Spots.” *TRB 95th Annual Meeting Compendium of Papers*, paper number 16-5209.
- Van Houten, R., G. Delaere, and J. Shurbutt. 2016. “Countdown Pedestrian Signals With and Without the Flashing Hand: A Field Study.” *TRB 95th Annual Meeting Compendium of Papers*, paper number 16-2135.
- Wang, J., S. Hankey, X. Wu, and G. Lindsey. 2016. “Monitoring and Modeling of Urban Trail Traffic Validation of Direct Demand Models in Minneapolis, Minnesota, and Columbus, Ohio.” *Transportation Research Record* 2593: 47–59.
- Wang, R., and D. Work. 2015. “Data Driven Approaches for Passenger Train Delay Estimation.” *2015 IEEE 18th International Conference on Intelligent Transportation Systems (ITSC)*: 535–540.

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 (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

Tom Horan has developed a workflow that correlates NHTSA’s Fatality Analysis Reporting System data with tribal transportation crash reports. The new workflow outlines the best way to aggregate, analyze, and visually display traffic safety data.

Greg Lindsey has created a facility demand model that estimates bicycle peak-hour flows on Minneapolis streets and helps to estimate exposure to air pollution. Lindsey has shared the model with a researcher in Indiana, who will use it to link bicycle traffic volumes to bicycle crash rates.

Inventions, patent applications, and/or licenses

Nothing to report.

Other products

Andrew Owen has uploaded accessibility datasets and methodology descriptions to the Data Repository for the University of Minnesota (DRUM).

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.

- On February 11, 2016, NHTSA administrator Mark Rosekind and regional administrator Darin Jones, along with Kathleen Haney, traffic records coordinator with the Minnesota Department of Public Safety, visited the HumanFIRST Lab on the University of Minnesota campus and discussed results of a project led by Nichole Morris. Morris and her team redesigned the electronic crash report interface used by Minnesota law enforcement officers to improve the accuracy, speed, reliability, and meaningfulness of data collected from the scene of a crash. Since Rosekind’s visit, Morris has been invited to Washington, DC, to give a presentation and propose her system as a national model.
- On March 10, 2016, FHWA Deputy Administrator Greg Nadeau visited the University of Minnesota campus, toured the Minnesota Traffic Observatory, and met with Institute staff. RSI

- director Max Donath gave Nadeau an overview of the Institute, while John Hourdos shared highlights from his current RSI project, which aims to create a connected vehicle testbed.
- In March 2016, RSI program director Stephanie Malinoff was selected to join TRB's Standing Committee on Transportation Safety Management (ANB10). Her participation provides the opportunity to share Institute activities and research on a national level.
 - In January 2016, Rajesh Rajamani collaborated with Quality Bicycle Products (QBP) on an NSF proposal that leverages the bicycle collision technology developed during his RSI project. QBP, headquartered in Bloomington, MN, is a global industry leader that distributes bicycles, bicycle parts, and accessories to more than 5,000 retailers around the country and 650 companies in Europe and Asia.
 - Kathy Quick and Guillermo Narváez are finalizing arrangements to work with the national Tribal Transportation Assistance Program (TTAP) to assist with designing a survey of tribal governments around the country that will assess key safety concerns and help them with preliminary data analysis.
 - On October 14, 2015, Yanfeng Ouyang and his research team met with representatives from the Illinois Fire Service Institute and toured its facility, watched daily drills, and learned about the emergency response resource deployment policy in Urbana-Champaign. The group also discussed a potential collaboration.
 - On December 1, 2015, Daniel Work met with representatives from CSX Operations Research to discuss the ongoing collaboration between CSX and the University of Illinois at Urbana-Champaign.

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 risks, 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.

Impacts from individual projects:

- *Computerized Crash Reports Usability and Design Investigation*: Nichole Morris reports an impact on public safety. In January 2016, Minnesota law enforcement agencies began using an improved crash reporting interface that's a direct result of Morris's research. Since January, over 40,000 crashes have been logged using the new system.
- *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.

- *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 Nonmotorized 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 nonmotorized travel safety.
- *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.

Impacts from individual projects:

- *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 of locating first responders. 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 Narváez 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.

Impact on physical, institutional, and information resources

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

Impacts from individual projects:

- *Safety in Numbers? Accessibility, Traffic, and Safety of Nonmotorized 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 are 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, 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.

Seventeen out of eighteen RSI-funded projects have enlisted undergraduate or graduate student assistants. During this reporting period, these jobs provided 70 students with research and practical work experience related to roadway safety. PIs supervising students include Ray Benekohal, 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.

Impacts from individual projects:

- During his pedestrian safety training workshops in Fall 2015, Ron Van Houten introduced new technologies and practices to safety professionals throughout Region 5.
- *Performance Measures for Bicycle and Pedestrian Safety: Methodologies for Monitoring Traffic Volumes and Assessing Exposure to Risk*: MnDOT traffic safety engineers have indicated an interest in using the results from Greg Lindsey's case studies for training materials.
- *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 he 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.

Impacts from individual projects:

- *Improving Railroad Grade Crossing Safety: Accident Prediction Models Using Macro- and Micro-Scale Analysis*: Ray Benekohal's work will bring the public's attention to safety issues at rail-highway crossings.
- *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.

- *Older Driver Support System (ODSS) Usability and Design Investigation*: Nichole Morris' work will improve public knowledge regarding older drivers' driving habits and abilities.
- *Factors Affecting the Adoption of Evidence-Based Approaches to Road Safety by State Policymakers*: Lee Munnich's roundtable discussions produced a greater understanding of the factors contributing to the adoption of certain highway safety policy countermeasures in the six study states. This could potentially impact future discussions among stakeholders, including policymakers and state highway safety officials.
- *Improving Railroad Grade Crossing Safety: Positioning, Planning, and Operation of Emergency Response Resources and Coordination Between Jurisdictions*: The policy and engineering guidelines developed during Ouyang's project have the potential to improve public knowledge, change regulatory policies, and increase social welfare via enhanced safety and environmental conditions.
- Ron Van Houten's pedestrian safety workshops, conducted for safety professionals throughout Region 5, have the potential to change decision making at the state or local level.

CHANGES/PROBLEMS

Changes in approach and reasons for change

Exploring Links Between Medical Conditions and Safety Performance in Tractor Trailer Drivers: Stephen Burks has added a few tasks to his project, including the study of differences in crash costs across obstructive sleep apnea subgroups.

Using GIS to Improve Tribal Traffic Safety: After having difficulty obtaining state-level data, Tom Horan has developed a new workflow to streamline the process.

Performance Measures for Bicycle and Pedestrian Safety: Methodologies for Monitoring Traffic Volumes and Assessing Exposure to Risk: Greg Lindsey is considering gathering additional counting data in Bemidji and Duluth, as the current number of counts limits the effectiveness of his demand models.

Collaborating with American Indian Communities to Re-Interpret and Strategize About Transportation Safety Risks in Tribal Lands: Kathy Quick and Guillermo Narváez have decided to limit their case study work to Minnesota, as they are working with more tribal communities in the state than anticipated.

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

Older Driver Support System (ODSS) Usability and Design Investigation: Nichole Morris's research team experienced a delay due to a failure in their driving simulator. The failure has since been addressed, and Morris is working to get the project back on schedule.

Safety in Numbers? Accessibility, Traffic, and Safety of Nonmotorized Travelers: To date, Andrew Owen has had to limit his work to Minnesota because of delays in acquiring data from other cities. He's currently working to resolve the issue.



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
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