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## Research shows pedestrians and bicyclists benefit from 'safety in numbers'

Being able to assess the risk that a person walking or biking will collide with a car could help transportation planners determine the best places to implement safety improvements.

Existing data from crashes, pedestrian and bicyclist counts, and automobile traffic flows can be combined to identify intersections, corridors, or other urban areas with elevated collision risks for bicyclists



or pedestrians. As the availability of count data gradually increases because of automation techniques, it will become easier to identify problem areas. In a recent Roadway Safety Institute (RSI) project, University of Minnesota researchers evaluated whether a phenomenon known as "safety in numbers" was observable in crash data collected for Minneapolis, Minnesota—one of the few cities that currently has a sufficiently rich dataset of pedestrian and bicyclist counts to allow for meaningful safety analysis.

Safety in numbers is the hypothesis that an individual has a better chance of avoiding harm or danger in a group than when alone. In the context of traffic safety, that would mean the safety of bicyclists and pedestrians is positively correlated with more biking and walking activity in a given area, says Andrew Owen, director of the University of Minnesota's Accessibility Observatory. "For example, we would expect to see the per-pedestrian risk of being injured in a crash with a motor vehicle decrease as the number of other pedestrians increases," he says.



For the RSI study, the researchers began by looking at the safety-in-numbers effect for pedestrians in Minneapolis. They analyzed a sample of 488 intersections and determined the relationships between pedestrian traffic flows and the per-pedestrian crash risk. The results indicated that there was, in fact, safety in numbers—pedestrians were at a lower risk of being hit by a car at intersections with more pedestrian traffic, and individual cars were at a lower risk of hitting pedestrians at intersections with more car traffic.

Next, researchers examined how the safety-in-numbers effect applied to bicyclists in the Twin Cities. Using data from 489 intersections, they modeled the number of crashes against the average daily vehicle traffic and the daily bicyclist traffic and measured the accuracy of the model. Again, they found that safety in numbers played a positive role: intersections with more vehicles and cyclists exhibited lower crash rates.

“While the exact cause for the safety-in-numbers effect is not understood, it is still a justification for improving the walkability and bike-ability of urban environments,” Owen says. “By assessing the per-pedestrian and per-bicyclist crash rates at specific locations, as opposed to using crash counts alone, transportation planners and practitioners can more readily identify target areas where improvements to infrastructure may be warranted.”

### **In-vehicle warnings show promise for improving work-zone safety**

Work zones can be dangerous for both drivers and the work crew—but Roadway Safety Institute (RSI) researchers are working on innovative ways to lessen these risks and lower the rate of work-zone crashes. In a new study, an RSI research team investigated the potential advantages and possible disadvantages of vehicle-to-infrastructure (V2I) in-vehicle messages to communicate to drivers.

“When we started this project, we saw a potential for drivers to become more aware and responsive to hazards within the work-zone by presenting the information directly to them through in-vehicle messaging technologies,” says Nichole Morris, director of the University of Minnesota’s HumanFIRST Laboratory, who led the project. “We also wanted to assess the extent to which this type of messaging could lead to driver distraction, as numerous studies have demonstrated the hazards of distracted driving, particularly from interacting with on-board technologies.”



Photo: Shutterstock

One bridging technology to provide V2I in advance of future original equipment manufacturer (OEM) capabilities could be a smartphone. To investigate the possibilities, the researchers began with multiple literature reviews to illustrate the crash risks imposed by work zones and the factors that exacerbate these risks, along with the ideal design guidelines for any in-vehicle messaging system. Next, they conducted a survey to uncover driver attitudes in Minnesota toward work-zone safety, smartphone use, and the

potential for receiving messages through in-vehicle technologies.



“Our survey found that a significant number of drivers use their smartphone while driving—for navigation, talking, and even texting—and that they place them in a variety of locations throughout the vehicle, rarely in a mount,” says Morris. The survey revealed positive attitudes toward the use of a V2I work-zone messaging system but concern over its distraction potential. The researchers also found that many drivers distrust the accuracy of roadside signs for work zones and were receptive to using an electronic messaging system, Morris says.

Following the survey, researchers designed the in-vehicle messages and conducted a simulated driving study in the HumanFIRST Lab to test the effectiveness of the messaging system on driving safety. During the driving simulation, participants drove through two different types of work zones three times, each with



different work-zone events and messaging interfaces. These included a portable roadside message sign, a smartphone presenting only audio messages, and a smartphone presenting audio-visual messages; the smartphones were either mounted on the dashboard or placed in the passenger seat to reflect real-world conditions. During the drives, researchers recorded measures of driving performance such as vehicle control, event recall, mental workload, user-friendliness, and eye-tracking metrics.

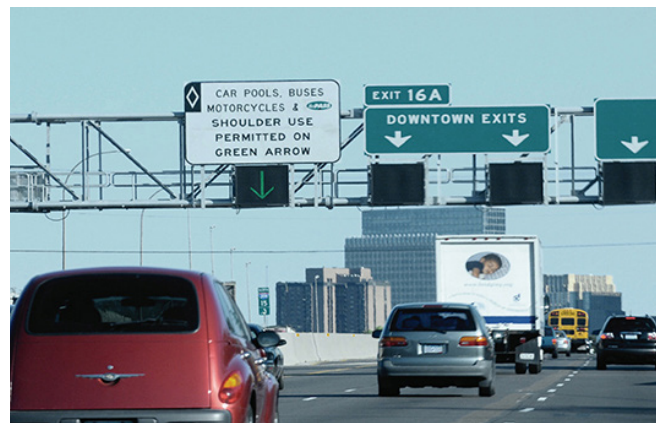
After analyzing the driving simulation data, researchers found that drivers using either type of in-vehicle messaging performed better than they did with the roadside warning signs. Furthermore, drivers had better vehicle control and reported significantly less mental workload, better usability, and greater work-zone-event recall with the in-vehicle warnings than with the roadside signs.

“Using eye-tracking technology, we can see that participants took their gaze off the road less often with the in-vehicle messages, as drivers had to look over to read the roadside signs in order to understand the messages,” says Morris. “In addition, the positive effects of in-vehicle messages appear to be elevated for the more difficult drive, suggesting that in-vehicle messages were helpful for more challenging roadway conditions.”

The study produced two key findings. First, if in-vehicle messages are delivered in a controlled and driving-relevant manner, there appeared to be no effect of distraction, and driving performance improved. Second, placement of the messaging interface did not appear to be a significant factor for driving performance when the messages contained an audio component. Researchers hope to continue this work by field testing in-vehicle message systems and exploring possible avenues for broad implementation.

### Investigating unintended effects of I-35W safety improvements

In 2009, the Minnesota Department of Transportation (MnDOT) began major safety improvements on I-35W as part of the Federal Highway Administration’s Urban Partnership Agreement (UPA). The aim was to reduce congestion on the Twin Cities’ highly traveled I-35W corridor between the Minnesota River and I-94. Among the improvements was the addition of a priced dynamic shoulder lane (PDSL) on parts of the 17-mile stretch of highway. However, following the opening of these improvements, the frequency of rear-end crashes increased in certain sections—especially in the PDSL regions. To determine the underlying causes of this increase, MnDOT enlisted the help of University of Minnesota researchers in the Department of Civil, Environmental, and Geo-Engineering.



“Our primary objective was to determine if these increases were direct effects of the improvements or if they were due to changes in the traffic conditions,” says Professor Gary Davis, the principal investigator of the study and an RSI researcher. “MnDOT was interested in extending some or all of these improvements to other corridors but needed to know what the safety impacts were to aid its decision making.”

Besides Davis, the research team included Jingru Gao, a master’s candidate advised by Davis, and John Hourdos, director of the U of M’s Minnesota Traffic Observatory.

The researchers began with a preliminary analysis to determine the study region and singled out two specific sections that were experiencing more rear-end crashes after the improvements. Next, these two sections were further divided, and data on crashes, traffic flows, weather conditions, and PDSL activation were compiled for each section. Researchers then analyzed the data to estimate the change in rear-end

crash risk following the UPA project while controlling for those other factors.

The analysis resulted in several significant findings. First, researchers concluded that the operation of the PDSL had no direct effect on the likelihood of rear-end crashes. In addition, they found evidence that crashes were most likely to occur when lane occupancies were around 20 to 30 percent; crash likelihood tended to decrease for lane occupancies below and above this range. Finally, researchers concluded that the PDSL region experienced significantly more congestion following the UPA improvements because of the removal of a bottleneck in the old I-35W/Crosstown Commons, causing the bottleneck to move northward to the I-35W and I-94 junction. This resulted in an increase in higher-risk traffic conditions in the PDSL region. When controlling for this change in traffic conditions, they found no significant increase in rear-end crash risk attributable to the PDSL.

“The PDSL sections showed substantial increases in lane occupancy following the project,” Davis says. “The observed increases in rear-end crash frequency can be explained by increases in higher-risk traffic conditions—and the increase in higher-risk traffic conditions was most likely caused by the removal of the old Crosstown traffic bottleneck.”

Brian Kary, MnDOT freeway operations engineer, concurs. “The research study showed us that the design of the PDSL did not increase crashes on this stretch of 35W,” he says. “Had we not done the PDSL, congestion and ultimately crash rates would have been worse.”

In the future, the methodology demonstrated by this study could be used to evaluate how other freeway-related projects affect safety, Davis says, because the study worked out a way to estimate changes in hourly crash risk while controlling for variations in traffic conditions. In addition, the major finding—that the current implementation of a PDSL did not have an adverse effect on safety—can be used to provide guidance to MnDOT as it considers using PDSLs at other highway locations.

### Summer camps spark students' interest in transportation

Hands-on lessons, field trips, and other activities introduced a diverse group of elementary and middle school students to transportation topics in programs held throughout the summer.



*White Earth Summer Academy students learned how distractions affect safe driving.*

and bicyclists, it was important to discuss with them how to be safe and visible. The students also spent time wearing “concussion goggles,” which helped underscore the need for helmet use. “The students were engaged and seemed to enjoy the lesson,” Nixon said. Another lesson focused on how plants used in roadside vegetation can improve the environment, help pollinators, and control snow.

In July, the Roadway Safety Institute sponsored a safety-themed day as part of the National Summer Transportation Institute (NSTI), during which students took part in a demonstration with the Minnesota State Patrol, toured the Minnesota Department of Transportation (MnDOT) Regional Traffic Management Center, learned about crash analysis, and “drove” a plow in MnDOT’s snowplow simulator.

In June, the Roadway Safety Institute (RSI) participated in the White Earth Indian Reservation Summer Academy of Math and Science for the third consecutive year. The two-week day camp teaches students in grades 4 to 8 about math, science, and engineering using American Indian culture and interactive lessons. It is offered in partnership by the White Earth Nation and the University of Minnesota Extension.

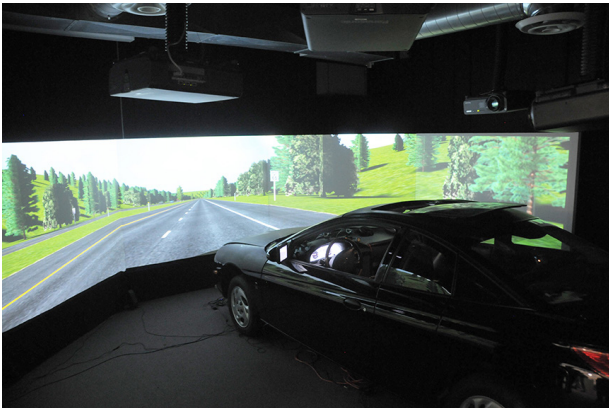
This year’s RSI session included a lesson co-taught by Tom Nixon, Minnesota Toward Zero Deaths East Central and West Central regional coordinator, focused on safety and distraction. Nixon explained that since most of the students are often pedestrians

During its two-week run on the University of Minnesota campus, the NSTI day camp featured classroom activities, lab sessions, and field trips around the Twin Cities for 31 middle-school students. NSTI is part of a national program designed to attract a diverse range of students to education and career opportunities in transportation. The camp was sponsored by the Center for Transportation Studies with funding from the Federal Highway Administration administered by MnDOT.

### Infrastructure award to improve University's driving simulators

The University of Minnesota's HumanFIRST Laboratory has received a 2017 Research Infrastructure Investment Program award of just over \$186,000 from the University's Office of the Vice President for Research (OVPR). One-to-one match funding will be provided by the laboratory's own accumulated funds gathered through usage fees.

The HumanFIRST Laboratory is a facility of the U of M's Department of Mechanical Engineering and is affiliated with the Roadway Safety Institute. It conducts research to collect, analyze, and understand driver behavior generated during driving simulation studies and field tests of enhanced human-machine interfaces designed to reduce risky driving behaviors.



*The HumanFIRST immersive driving simulator, currently undergoing a significant upgrade*

The HumanFIRST Lab houses two advanced driving simulators, which together host most of its research experiments. Funds from the award will be used to overhaul components of both simulators. The laboratory's immersive simulator will see a replacement of its 2002 Saturn full-vehicle cab with a modern sedan and an upgraded three-axis motion system. The existing discrete, five-panel projector system will be replaced with five high-resolution projectors onto a smooth, cylindrical display and will include LCD-embedded side mirrors. The new vehicle cab will facilitate research into driver human-computer interaction with its glass dash and large touchscreen display. Finally, the computer systems operating the immersive simulator and its companion portable simulator used for off-site and interdepartmental collaborations will be replaced with the latest-generation computing hardware and graphical software for creating the simulated driving worlds.

"When it was originally installed, the immersive simulator was state-of-the-art and among the best in the country," says mechanical engineering professor and RSI director Max Donath, who, with HumanFIRST Lab director Nichole Morris, submitted the funding request. "However, competing institutions have now surpassed our capabilities and many primary components of both simulators were nearing the end of their life."

This upgrade is expected to re-engage Minnesota as a national leader in driving behavior research. "As automated vehicle technology continues to advance, it will be critical to test machine-driver handoff between automated and manual driving modes in simulated settings," Donath says. Demand for research in automated vehicles is only expected to grow, he adds.

Morris says the lab's simulators will also allow her research team to safely test impaired driving performance to better understand and deal with drivers who may be fatigued, under the influence of drugs or alcohol, or have mild cognitive impairment. "Impaired driving continues to account for at least one third of fatal crashes on our roadways and little progress in this area has been made in recent years," she says.

The Research Infrastructure Investment Program awards totaled over \$2.5 million from OVPR and matching funds from the supporting colleges or centers. The 13 projects that received funding this year will impact researchers from 2 campuses, 7 colleges, and 21 departments, units, and centers.



*NSTI campers look inside a State Patrol cruiser.*



### Morris named HumanFIRST Lab director



Nichole Morris has been named director of the HumanFIRST Laboratory. Since joining the lab in 2011 as a research associate, Morris has participated in several key research efforts, including connected vehicles technologies, lane-departure warning systems, teen driver support systems, traveler information smartphone applications, usability, and automated speed enforcement. Her work on the design of a crash report form for law enforcement received a Best Practice Award from the International Forum of Traffic Record and Highway Information Systems in September 2014.

Morris's research focuses on human-computer interactions with technology related to various aspects of transportation, and her research interests include multi-sensory perception, aging, judgment and decision making, usability, and human factors. She received a Ph.D. in psychology (human factors) from Wichita State University in 2011. She also holds an M.A. and B.A. in psychology from Wichita State University.

### Seminar series moving to spring semester

This Roadway Safety Institute (RSI) seminar series provides updates on research related to the Institute's focus areas of high-risk road users and traffic safety systems. Seminar topics cover a wide range of disciplines, including mechanical engineering, civil engineering, electrical engineering, human factors, statistics, policy and risk analysis, and computer science. Planning, social, and behavioral issues related to roadway safety are also discussed.

The series, previously held during fall semester, is moving to the spring semester of 2018. Seminars will be held on Thursday afternoons. Specific dates and topics will be posted on the RSI website as soon as they're available.

Seminars are free and open to anyone interested in learning more about research related to the Roadway Safety Institute. Each seminar qualifies for one Professional Development Hour. Students can take the seminar series for credit at the University of Minnesota, but they must register for either CEGE 8213, ME 8772, or PA 8290. Participants may attend the seminars in person or watch the live webcasts. Seminar recordings will also be available for later viewing. Webcast links and access instructions will be available on the individual seminar web pages prior to each event.



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