Study gauges whether in-vehicle signing could improve driver behavior, safety

Researchers at the U of M's HumanFIRST Laboratory recently tested how in-vehicle signing—perhaps presented on a smartphone or vehicle display—could alert drivers and modify their behavior. Led by principal investigator Nichole Morris, the project examined how drivers react to in-vehicle sign (IVS) systems designed to prepare them for transitions to new driving conditions such as speed zone changes, school zones, construction zones, and curves.

The project, sponsored by the Minnesota Local Road Research Board, arose from a previous...  

Students discover transportation topics, careers at summer camp

Twenty-seven students got a hands-on introduction to transportation at the second annual CTS-hosted National Summer Transportation Institute (NSTI) in July. The interactive two-week day camp, open to students entering grades 7–9, featured classroom and lab sessions with transportation experts as well as field trips to facilities across the Twin Cities.

Throughout the program, NSTI campers learned about a wide range of transportation topics and careers, including safety, trucking, aviation, transit, and human factors. Other activities included an extensive tour of the U of M campus and sessions on public speaking and career decision making.
Smartphones have the power to transform transportation with a wealth of new information

These days, it seems everything is monitored. There are sensors to measure, track, and report calories consumed, steps taken, noise levels, traffic speed, travel costs, and much more. As people continue to become more interested in tracking their daily behaviors—through smartphone apps, for example—the resulting data could help transportation agencies gain insight on how people and vehicles move across networks.

“The rise of what we call the Quantified Self Movement will enable advanced traffic, air quality, and security monitoring systems, among other uses,” says Yingling Fan, an associate professor in the Humphrey School of Public Affairs. “We need to develop a better understanding of how agencies could exploit the data and how personal self-monitoring technologies will interact with the technologies that monitor the overall transportation network.”

In a report sponsored by the Minnesota Department of Transportation (MnDOT) and the Minnesota Local Road Research Board, Fan examines the current state of smartphone-based mobility sensing and measuring apps and discusses how these apps can be used to improve our transportation systems and deliver personalized travel behavior interventions in the future.

“Research shows that generic mass media campaigns can raise awareness of the benefits surrounding sustainable transportation, but the ability of generic information to bring about sustained behavioral change is questionable,” Fan says. “Many of these mobility-sensing apps could actually be designed as smartphone-based behavior intervention tools for promoting travel mode shifts. For example, after detecting a driving trip, the app could provide information on how to travel to the destination by alternative transportation modes—describing how to rent a bike, where to board a bus or train, and the best walking, biking, and transit routes to take.”

In addition, the report digs into the current research regarding the benefits of health-oriented smartphone apps; the findings could apply to apps aiming to promote travel sustainability and mode shift. These benefits include bringing behavioral interventions into real-life contexts; delivering cheaper, more convenient, and less stigmatizing interventions; promoting the sharing of data; and enabling the continuous, automated tracking of behaviors needed for timely, tailored interventions.

Finally, Fan discusses how smartphone-based mobility apps could interact with the network of roadway-based vehicle detection and surveillance technologies that are now deployed in most major metro areas.

“To date, most roadway-based sensor technologies have only limited interactions with smartphone-based technologies,” Fan says. “However, the potential for the two to interact is strong. Roadway sensors can provide data that can help improve the accuracy of smartphone sensor data. For instance, it could help determine whether a stopped car had arrived at a destination or was simply stuck in traffic. In addition, smartphone sensors can capture data that roadway sensors have difficulty capturing, such as acceleration patterns.”

Ultimately, Fan concludes that combining smartphone sensor data and roadway sensor data will allow transportation agencies to better understand traffic patterns and generate better data to support traffic management.

“Dr. Fan’s research suggests that we may be able to develop a far more complete understanding of how, where, and when people travel in the future and use it to improve the services we offer,” says Ken Buckeye, program manager with MnDOT’s Office of Financial Management. “Combining smartphone mobility sensing with roadway-based detection technologies opens the door to a wide array of possibilities that could make transportation options more healthy, efficient, safe, and convenient for travelers.”

Fan’s research is part of a multi-pronged study that analyzed the technological shifts altering surface transportation and the implications for Minnesota. Other contributors included Department of Civil, Environmental, and Geo-Engineering (CEGE) professor and principal investigator David Levinson, CEGE assistant professor Adam Boies, and Humphrey School associate professor Jason Cao. Their high-level white papers are compiled in a final report: *The Transportation Futures Project: Planning for Technology Change.*
Professor Greg Lindsey of the Humphrey School of Public Affairs is completing his appointment as Scholar-in-Residence at the Minnesota Department of Transportation (MnDOT) this summer. Lindsey spent part of his sabbatical in the Office of Transit’s Bicycle and Pedestrian Section. The unique appointment built on his work for the Minnesota Bicycle and Pedestrian Counting Initiative, a collaborative effort between MnDOT, the Minnesota Department of Health, local planning agencies and departments of public works, nonprofit organizations, and the University. He shares highlights and advice below.

What were some benefits of the residency?
Our principal project was to help MnDOT institutionalize bike and pedestrian monitoring in the state. “Institutionalizing” means we want to make the practice a cultural norm and routine in both MnDOT and the organizations MnDOT works with throughout Minnesota. I could have worked on the project from the U, but cultural norms aren’t changed by an outsider. That’s why my residency was important for this particular project.

My residency also allowed me to establish relationships. For example, Commissioner [Charles] Zelle asked that I serve on MnDOT’s Bicycle Law Advisory Task Force. He asked that we review the existing state statutes, administrative rules, and design manual and make recommendations to streamline and integrate those three documents. Our recommendation is to make bike planning and design comparable to highway planning by eliminating the administrative rules. We also recommend strengthening the statutes and design manual. The proposal was introduced to the legislature but wasn’t passed this year.

Overall, I was able to engage with the agency in multiple ways that would not have been possible if not for the residency, developing relationships with professionals in Traffic Data Analysis, Safety, and other units in addition to the Office of Transit.

What’s next for your research and outreach efforts?
I’m continuing work on other MnDOT-funded research and plan to participate in activities to pass the Task Force legislation during the next session.

My residency also strengthened my ability to link students with public agencies, especially on projects related to our institutionalization efforts. For example, Department of Natural Resources (DNR) officials became interested in monitoring traffic on state trails and contacted us. Humphrey students prepared a plan for them, and we held a capstone course focused on trail monitoring. This work led to a connection with the Greater Minnesota Regional Parks and Trail Commission, which is also interested in measuring use. I’ll be meeting with commission members later this summer.

What cultural differences did you observe between academia and an agency?
Researchers have the luxury of posing interesting questions and working to resolve them—finding the best possible methods to complex questions. But public agencies are under deadlines and face resource, legal, and political constraints. Through collaboration, researchers can better appreciate the challenges agencies face and the way they define problems, and then move...
New calculator makes it easier to reduce stormwater runoff from road construction

Road projects increasingly include techniques that reduce stormwater runoff volumes, improve runoff water quality, and reduce peak flow rate. Typical practices to reduce stormwater runoff volume include design and construction of infiltration basins. An alternative “green infrastructure” method is the use of vegetated roadside swales (drainage ditches), which receive road runoff from the entire roadway. Water is infiltrated over the side of the slope, and any water that runs off the side slopes has a further opportunity to infiltrate as it flows down the center of the swale.

Understanding the effectiveness of these side-slope solutions is essential, particularly in the project design phase. To address this need, U of M researchers developed a new, simplified tool that enables users to calculate the annual infiltration performance and generate a good estimation of the water captured by the channel and side slope of a roadside swale.

Data for the project were generated with 32 tests performed during three seasons along four different highways maintained by the Minnesota Department of Transportation in the Twin Cities metro area. “The tests showed that water flows down the slope in concentrated regions resembling fingers,” says John Gulliver, professor in the Department of Civil, Environmental and Geo-Engineering.

The research team (Gulliver, Professor John Nieber, and Ph.D. candidate Maria Garcia-Serrana) also collected data on the amount of water that infiltrates during storm events of different intensities and confirmed that infiltration was greater for longer side slopes and certain soil types. “Ultimately, we found that the vegetation, type of soil, and length of side slope are important to consider when constructing roadside swales that will be efficient in stormwater treatment,” he says.

After gathering data, researchers developed a runoff-infiltration model that calculates the amount of water infiltrated along the side slope of a roadside swale and couples that with a model of infiltration in the swale channel. The result is a combined model for both the side slope and channel of a roadside swale that can be used to estimate the infiltration performance of this green infrastructure for given rainfall intensities.

“After creating this model, we then transformed it into a simplified calculator that requires just four readily available inputs,” Gulliver says. “The result is a tool transportation practitioners can use to easily estimate the amount of water that will be captured by the channel and side slope of a roadside swale or drainage ditch.”

“We are very excited about this new research,” says Beth D. Neuendorf, district water resources engineer with MnDOT. “Previous calculators focused solely on the ditch bottoms. We are impressed with the University’s ability to take a complex process and create a simplified calculator to predict the infiltration capacity of swale side slopes. We are hoping this is another [best management practice] that we can use throughout Minnesota.”

Researchers measure water infiltration.
The Minnesota Local Road Research Board (LRRB) has produced a new video to guide practitioners through the use of a spreadsheet tool that can help determine when it’s safe to use flashing yellow arrows.

Traffic engineers can use the spreadsheet tool to determine at which times of day crash risk is sufficiently low for flashing yellow arrows to be implemented safely for permitted left turns at a specific intersection. The tool was developed as part of a project sponsored by the LRRB and led by Gary Davis, a professor in the Department of Civil, Environmental, and Geo-Engineering at the U of M.

The instructional video helps users understand the methodology behind the spreadsheet tool as well as how to use it. An instructor walks users through an example intersection, describes the inputs needed, and explains how to interpret the results.

The video, developed for the LRRB by SRF Consulting Group, is available at [lrrb.org](http://lrrb.org).
MnDOT study that looked at the feasibility of using smartphones for implementing connected vehicle programs. One of the questions that came out of that study was whether road signage could be eliminated from the roadside and displayed in the vehicle instead. Doing so could save tax dollars related to sign installation and maintenance, improve landscapes, and make it easier to keep signage up-to-date.

Researchers began by developing a simulated route for the HumanFIRST driving simulator using a real roadway network from southern Minnesota. Forty participants were asked to drive the 24-mile simulated route (which included freeways, two-lane rural roads, and towns) with and without the IVS system activated. As they drove, performance measures were collected.

The researchers found that an IVS system would affect driving performance in several ways. When it was used without external signs, speeding and speed variability increased. “Safety across all crash types was significantly reduced when in-vehicle warnings were used without external signs,” Morris says.

Speeds did not increase, however, when both IVS systems and external signs were used, and variability in speed declined slightly. “This suggests that as a supplement to external signs, the IVS system might reduce traffic speed variability and improve safety,” she says.

Victor Lund, a traffic engineer with St. Louis County and the technical liaison for the study, says traffic engineers are very concerned about the safety impacts of people driving at different speeds. “An IVS system might help reduce speed differentials, and we get really excited when we see something constructive toward that end.”

Another key finding from the study: IVS systems did not appear to cause driver distraction. “Sometimes smartphones are the cause of driver distraction,” Morris says. “An IVS system might be a tool to break that distraction by showing the driver there’s something important ahead and to change speed.”

The researchers also evaluated the usability of the technology. Test participants reported that the mental workload required to drive when an IVS was used instead of external signs was greater than under baseline conditions. Driver satisfaction with the IVS was also lower when it was used alone.

Based on the results, the researchers offer several recommendations. “Although using IVS systems instead of external signs would presumably save money on infrastructure costs, we do not recommend this,” Morris says. “However, we do believe that using these systems in conjunction with external signs has the potential to reduce speeding and crashes, and needs to be explored further.”

In the future, researchers hope to see this work expanded to examine the role of emerging IVS systems that could deliver important safety information between connected vehicles, such as speeds at intersections and work zones. In addition, understanding how drivers respond to IVS systems could assist emergency vehicles in creating a cleared path and encourage drivers to comply with “move over” laws, Morris says.

from the theoretical “best way” toward real-world solutions. Unless researchers understand the agency perspective, the likelihood of our work being used is minimized.

Are there any broad lessons to share?
The public sector often seems to be maligned, but one thing that stands out for me is the dedication of the professionals at MnDOT to meeting the state’s needs. State policy has historically focused on major transportation modes, but now we need new data and new ways of doing business. Officials are committed to doing the highest quality job possible to address evolving policies and issues.

What would you recommend for future residencies?
I’d recommend scholars talk at length with the collaborating agency, identify project priorities, and work jointly to address them in a way that produces new knowledge and meets the organization’s needs. I encourage agencies to reach out to faculty and explore deeper ways to work together and build enduring relationships.
Some of the students’ favorite activities were:

- Seeing how road signs are made at the Anoka County Highway Department
- Getting to see bridge construction up close during a boat tour of the St. Croix Crossing bridge site
- Riding through the light-rail train wash at Metro Transit
- Exploring a police car during a presentation on safety by the U of M Police Department
- Watching planes and a helicopter take off while touring St. Paul’s Holman field—and getting a glimpse inside the air traffic control tower
- Investigating equipment at Minnesota Department of Transportation (MnDOT) Maintenance and Truck Fabrication facilities
- Using driving simulators to learn about the risks of distracted driving in a program by UPS Road Code

Another highlight for campers was participating in a bridge-building project over the course of the program. With guidance from MnDOT engineers, campers worked in small groups to construct popsicle-stick bridges. The bridges were tested at the camp’s closing ceremony to see which group built the strongest structure.

Overall, camper evaluations indicate that the program helped students become more aware of the wide range of possible careers in transportation. Parents reported that students not only enjoyed the camp but also took the lessons they learned to heart.

“[My daughter] became more aware of the importance of road safety,” one parent said. “She’s constantly making sure we are not touching our phones while we’re driving.”

NSTI is part of a national program designed to attract a diverse range of students to education and career opportunities in transportation. It was sponsored by CTS with funding from the Federal Highway Administration administered by MnDOT.

Tentative dates for next year’s camp are July 17–28, 2017. Application materials will be available in early 2017 on the CTS website.

To learn more about the camp and to see more photos of this year’s activities, visit cts.umn.edu/summercamp.
SUMMER CAMP offers students a HANDS-ON INTRODUCTION to transportation.

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