

Catalyst



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**WORK-ZONE
MAPPING**

page 2

**WARNING SYSTEM
FOR BICYCLES**

page 3

**FREIGHT &
DISASTER RESPONSE**

page 4

**ELECTRIC VEHICLE
INFRASTRUCTURE**

page 5

TRB AWARDS

page 5

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Ride-hailing services have mixed impact on public transit use

Ride-hailing services such as Uber have changed how people move in urban areas. Several US transit agencies have begun to respond to this disruption by partnering with ride-hailing providers or subsidizing citizens' use of them to cover the "last mile" of trips. It's unclear, however, how access to ride-hailing services affects the demand for specific modes of public transit and what other

Ride hailing continued on page 7

Framework helps small cities, rural areas create automated vehicle demonstration plans

Most testing and demonstrations of automated vehicles (AVs) have taken place in large urban areas, but communities of all kinds need to prepare for eventual AV deployment. Small urban and rural communities, in particular, could see benefits from early adoption, as many of their residents are unable to drive because of age or disability.

A project by U of M researchers provides a framework for small cities and rural areas to create

Framework continued on page 6



Work-zone mapping project aims to reduce crashes through better information



To improve safety in work zones across Minnesota, U of M researchers are working on a tagging and mapping system that can efficiently gather information about the layout of work zones, perform remote inspections, and disseminate warnings to drivers. The goal of this Statewide Work Zone Information System (SWIS) is to serve as a real-time database of active work zones from the moment the first advanced warning sign is placed to the time crews pack up.

“We know that speeding and driver inattention are the two main causes for single-vehicle crashes in Minnesota,” says John Hourdos, director of the U of M’s Minnesota Traffic Observatory and the project’s principal investigator. “Work-zone locations are especially sensitive to these two factors because the vast majority of drivers are required to adjust their speed and their course due to changes in road geometry.”

The development of the SWIS is the third component of an interdisciplinary effort to investigate the effectiveness of using in-vehicle messages to improve drivers’ understanding of work zones

and reduce risky behavior. The first component was a human factors study to identify the most effective way to alert drivers to work zones without disrupting their driving tasks; the second component sought to determine whether Bluetooth tags could be deployed in work zones to provide real-time updates to drivers’ mobile phones through an app.

One key aspect of the new SWIS is that it requires no extra effort from highway road crews. The system uses traffic control devices outfitted with tracking beacons to determine their locations and movement throughout the work zone as they are laid out. Then, the system uses algorithms to determine where a work zone is located and update its information in real time. In addition, the SWIS can determine whether a work zone is fully set up and flag it for inspection when it is ready. The inspection algorithm checks whether the work zone is in compliance with *Manual on Uniform Traffic Control Devices* layout guidelines or planned project layouts—if it is, no manual inspection is needed.

The information collected by the SWIS is designed to be available to both highway crews and the general public through an online interface. The digital map allows users to search for work zones that are currently active and look for past or planned projects. In addition, users with more advanced permissions can create or update projects through the SWIS web interface.

“In addition to improving safety, the SWIS could play a vital role in future connected and automated vehicle applications by providing accurate, up-to-date information on work-zone layouts and conditions to in-vehicle information systems,” Hourdos says.

The research team plans to conduct more field testing with the SWIS to prepare it for use around the state. When active, researchers expect it will be a valuable support technology for drivers that will help reduce incidents in work zones and allow for the monitoring of work-zone activity and compliance while limiting the need for physical site visits.

The project was funded by the Roadway Safety Institute.

Researchers develop alert system to protect cyclists from cars

Self-driving cars, driverless cars, robo-cars—whatever you label them, the popularity of autonomous vehicles is on the rise. But how about taking the sensor technology that allows these machines to detect incoming objects and applying it to bicycles?

That's exactly what U of M mechanical engineering professor Rajesh Rajamani is doing, on a shoestring budget of \$500 per bicycle.

Rajamani and team are developing a smart bicycle with an attached alert system that sounds a horn when cars get too close to the cyclist. The system comprises three sensors that monitor the trajectories of nearby vehicles, speakers, and a black-box camera that records video when the cyclist is in danger.

The initial prototype was developed with funding from the Roadway Safety Institute. Now, with a nearly \$1 million National Science Foundation grant, Rajamani's team is collaborating with cycling manufacturer Quality Bicycle Products (QBP) to test the technology.

According to the National Highway Traffic Safety Administration, traffic crashes resulted in more than 800 cyclist fatalities in the United States in 2018. Rajamani's goal is to reduce these bicycle-car collisions—but also to minimize cost.

"Because there's so much work on autonomous vehicles and self-driving cars right now, there's always this question of how is your work different?" he explains. "The difference is that for a bicycle, the cost constraints are a lot more."

Similar technology in self-driving cars can cost up to \$80,000. Plus, most cars on the road right now don't have sensing systems, which puts cyclists at risk.

"Bicyclists are the vulnerable users, because obviously the car is not going to get hurt in a bicycle-car collision," Rajamani says. "Bicyclists can choose to have this technology and protect themselves, so they aren't dependent on the cars on the road to have sensors."

Rajamani is working closely with Nichole Morris, director of the U's HumanFIRST Laboratory, to ensure that

the alert system is user-centric—or in this case, cyclist-centric.

Through focus groups, the researchers found that the most pressing concern for frequent bicyclists was being struck by right-turning vehicles at intersections, which led to the incorporation of sensors that would better detect this threat.

"This project presents an important research opportunity to not only help bicyclists communicate what their safety needs are on the road, but also to help improve the design of the collision-warning system based on user feedback," Morris says.

bring a unique skillset to a problem that just couldn't have been accomplished working in isolation," she says.

Both the HumanFIRST Lab and Rajamani's team have been working with local cyclists to test out the alert system since October 2019. After more testing this spring, the researchers hope to have a marketable product for urban commuters.

(By Olivia Hultgren; adapted and reprinted with permission from the College of Science and Engineering, Jan. 2020.)



Rajamani (second from right) and his research team with the smart bicycle

One of her lab's biggest contributions was creating an auditory alarm that would induce a sense of urgency in response from drivers. When drivers hear the typical "beep" of a horn, their reflex is to look behind them for another vehicle. This alert needed to have enough "bikeness" to make drivers look for something other than a car, Morris said.

Morris added that this research is a perfect example of how the work of engineering psychologists can complement that of other engineers, especially when systems hinge on human interaction and safety. "We all

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Public sector looks to freight industry for help with disaster response

Natural disaster response traditionally has been the responsibility of the public sector, but private companies have the potential to make relief efforts faster and more cost-effective. Integrating the two, however, requires balancing efficiency with fairness, and coordinating among so many different organizations requires fluid communication.

The 22nd Annual Freight and Logistics Symposium, held in December in Minneapolis, explored how the public and private sectors can and should work together to respond to natural disasters that cause disruptions in the freight system. Speakers from both sectors discussed the potential for leveraging public-private partnerships and presented details from recent large-scale natural disasters to provide insights on response, recovery, and resiliency.

In the keynote presentation, Jeffrey Dorko, assistant administrator for logistics at the FEMA Office of Response and Recovery, explained that the private-public relationship in disaster response is still being figured out. "America has great, almost limitless capacity to take care of citizens who just had their worst day. But we've got to get what we need from where it is to where it needs to be," he said.

During a disaster, distributing supplies is typically more of an issue than finding them, Dorko noted, and private companies often have this well planned out in advance. Public organizations such as FEMA need to consider these existing supply chains and refrain from getting in their way, he added. "We need to get business back to business," he said.

Dorko and other symposium speakers also covered the following major topics:

- **The role of the private sector during a disaster.** The private-sector freight industry could increase the speed and efficiency of disaster relief, in terms of shipping capacity as well as planning and logistics. But efficiency needs to be balanced with fairness to avoid disasters being used as a means for profit. Speakers from the public and private sectors discussed both sides of the issue.
- **Communication and planning during a disaster.** When disaster strikes, effective communication and planning systems are as essential as speedy response. Presenters used Hurricane Katrina in 2005 as an example of what happens when these systems break down. They also discussed what problems still exist in the freight industry and how to fix

them.

- **Climate change and resiliency.** Alterations in extreme weather patterns as a result of climate change are a major concern for transportation agencies, and infrastructure changes are needed to ensure the system can handle increased stress. Presenters examined some of the setbacks currently facing infrastructure resiliency in the United States as well as some promising initiatives led by the Minnesota Department of Transportation and the federal government.
- **The importance of data and issues with sharing.** In our digital world, GPS, traffic cameras, and other technology are making it increasingly easy to track and model traffic flow. Sharing this data has become key to effective disaster relief. Presenters discussed potential sources and applications of data and how issues with privacy and proprietary information might be addressed.

For more detailed coverage of the symposium, visit cts.umn.edu/events/freight/2019.



Student project helps city plan for electric vehicle infrastructure

Statewide trends indicate enormous growth potential in the market share for electric vehicles (EVs) in the next decade. The city of St. Anthony, which straddles Hennepin and Ramsey counties in the Twin Cities metro, worked with the U of M last semester to gain guidance for mapping its own electric future. The city is one of the 2019–2020 community partners in the U's Resilient Communities Project (RCP).

"This is a timely topic that larger communities around St. Anthony, including St. Paul, Golden Valley, and St. Louis Park, have started exploring in recent years, but our small-city size poses challenges when trying to find resources and staff time to explore this topic on our own," says Jay Hartman, public works director with the City of St. Anthony Village. (St. Anthony is also known as St. Anthony Village.)

The number of St. Anthony residents who have purchased EVs continues to rise, Hartman says, and city hall staff receive more frequent inquiries and requests to make EV infrastructure available. The goal of the project was to explore the feasibility of an EV-charging infrastructure network in St. Anthony using case-study research and community feedback.

Kimberly Napoline, a Master of Public Policy candidate in the Humphrey School of Public Affairs, conducted the project in an independent study course. Her advisor was Frank Douma, director of the State and Local Policy Program at the Humphrey School.

To guide her research, Napoline conducted a stakeholder analysis that included meetings with St. Anthony's city council, its Parks and Environment Commission, the Citizens for Sustainability Group, and the Minnesota EV Owners group. She then studied EV charging policies and programs of other Minnesota cities and compiled issues for St. Anthony to consider.

One key issue is the different types of charging stations. "The three main types come with their own cost and electrical capacity limitations," she says.

Standards are also needed to ensure



that EV infrastructure is developed in a consistent way; these include policies such as zoning, subdivision ordinances, and parking regulations. "Also, if a firm or individual wants to install a charging station, it's important for the permitting process to be transparent, consistent, and relatively simple to navigate," Napoline says.

Based on her initial research and conversations, Napoline recommends several locations for EV charging stations in St. Anthony, including city hall, Silver Lake Village Shopping Center, and Silverwood Park. "These sites come with particular advantages that make them perfect for an electric vehicle charging station," she says.

"Kimberly has done an outstanding job getting this project off the ground," Hartman says. "We now have a starting point. In her final report, Kim has provided our staff direction as to the next steps we will be working on in summer of 2020 and beyond."

Napoline's report is available at rcp.umn.edu. RCP, housed within the Center for Urban and Regional Affairs, connects local government agencies with U of M students and faculty to advance community resilience and student learning. Other RCP community partners this year are Scott County, the City of Ramsey, the Minneapolis Public Housing Authority, and the League of Minnesota Cities.

Research papers honored at national TRB meeting

Two papers by U of M researchers received awards at the annual meeting of the Transportation Research Board, held in Washington, DC, in January.

"*Implementing Low-Stress Bicycle Routing in National Accessibility Evaluation*" received the 2019 Best Paper Award from TRB's Bicycle Transportation Committee. Authors were Brendan Murphy, lead researcher for the Accessibility Observatory (AO), and AO director Andrew Owen. The paper, one of approximately 150 submitted to the committee, stems from AO research that created a new metric to incorporate traffic stress and cycling comfort in the evaluation of access to destinations by bicycle. The research was sponsored by the National Accessibility Evaluation Pooled-Fund Study.

"*New Procedure to Evaluate the Post-Crack Behavior of Fiber-Reinforced Concrete*" was honored as the 2019 Best Paper by TRB's Concrete Material Section. (The section consists of four committees and a task force.) Authors were graduate student Bryce Hansen (now a structural engineer at Barr Engineering) and Manik Barman, an assistant professor in the Department of Civil Engineering at the University of Minnesota Duluth. In their MnDOT-funded work, the team developed guidelines for using the material (structural fibers), which offers promise as a cost-effective repair option for concrete pavement.

plans to test and demonstrate AVs. “Our goal is that by the time readers finish the report, they know what steps to take, what stakeholders to include, and what questions to ask to create a complete AV demonstration proposal,” says Frank Douma, director of the State and Local Policy Program at the Humphrey School of Public Affairs.

Rural areas have disproportionate numbers of fatalities and serious injuries, and many rural cities struggle to provide convenient and affordable transit services. “Introducing AV technology into these communities could provide a more efficient and lower-cost alternative to traditional public transit and greatly improve the lives of many people,” says Douma, the project’s principal investigator.

In the project, Douma and Erin Petersen of the U’s Law School reviewed the current legal and policy context for AVs at the federal, state, and local levels. “The overall consensus is that AVs are already legal, but certain restrictions may limit testing and operation depending on the state,” Douma says. “In Minnesota, it’s likely that cities have the authority to grant permission for testing AVs on their roads.”

The researchers also reviewed best practices from past and current

AV demonstrations in the US and Europe. They then created an outline of the major components of an AV demonstration plan, including route, schedule, costs, and weather hazards. To better understand some of these potential details, the team worked with two communities in Minnesota—Fergus Falls and White Bear Lake—to gather information about community needs, desires, and limitations.

The researchers created AV route maps as starting points for discussion and met with stakeholders—city council members, chambers of commerce, and others—to help them understand what a potential route might look like. The community engagement led to modified routes in both cities; the city manager’s team in White Bear Lake approved the new route, while approval of the Fergus Falls route is pending.

MnDOT selected White Bear Lake’s demonstration proposal for its Connected and Automated Vehicles (CAV) Challenge program. The program allows industry and transportation partners to propose innovative projects to advance CAV technologies in Minnesota.

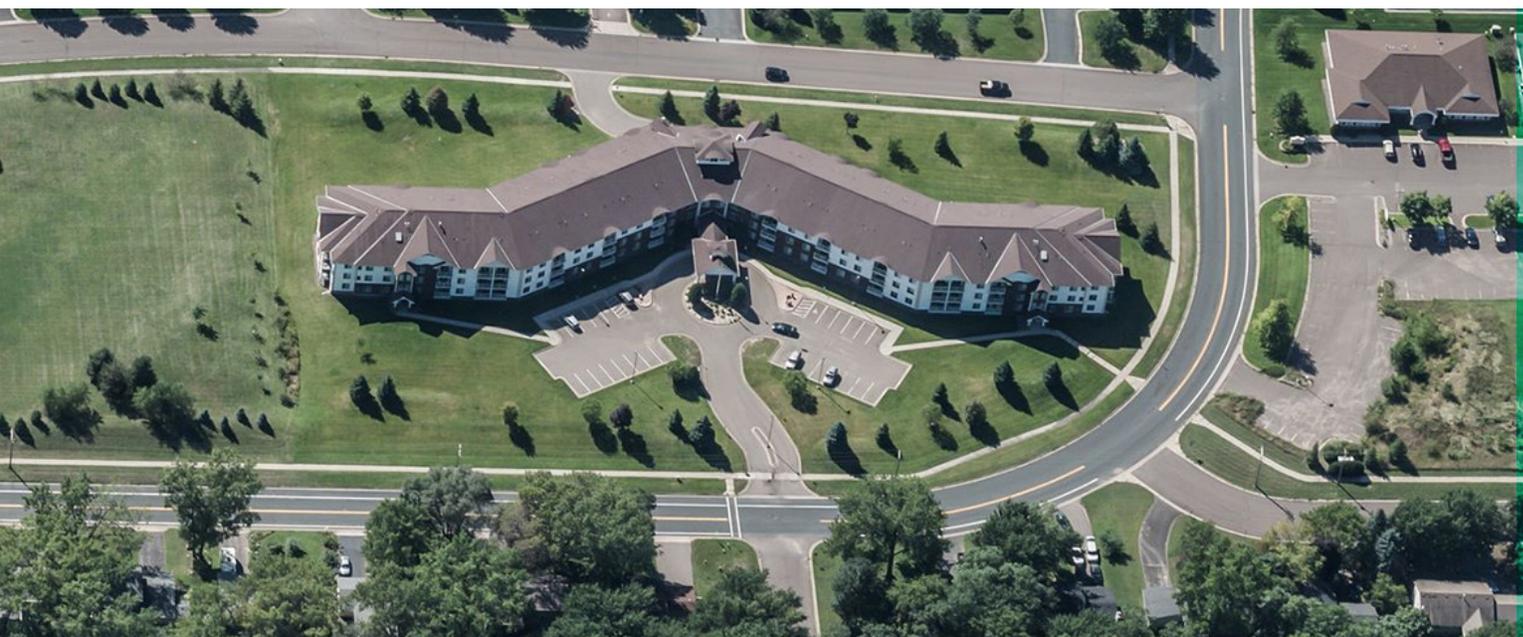
“The University of Minnesota has been instrumental in developing strong public engagement and

outreach programs to understand how we can advance equitable transportation outcomes,” says Kristin R. White, executive director of MnDOT’s Connected & Automated Vehicles Office. “Minnesota’s CAV leaders have been able to leverage the University’s expertise to inform local and state CAV policy.”

Douma says two significant initial conclusions became apparent by working with the two cities. “First, when creating an AV demonstration plan, it’s important to engage with a wide range of local representatives who have differing roles and experiences. Their perspectives help create a comprehensive plan that addresses the needs of the entire community, and it makes the process smooth and quick. Second, focusing on community outreach leads to an enthusiastic community and group of stakeholders.”

AVs have the potential to significantly benefit rural and small urban communities, Douma concludes. “The opportunity to bring the technology to these communities exists—now.”

The project was sponsored by the Roadway Safety Institute.



The AV demonstration route in White Bear Lake includes apartment complexes.

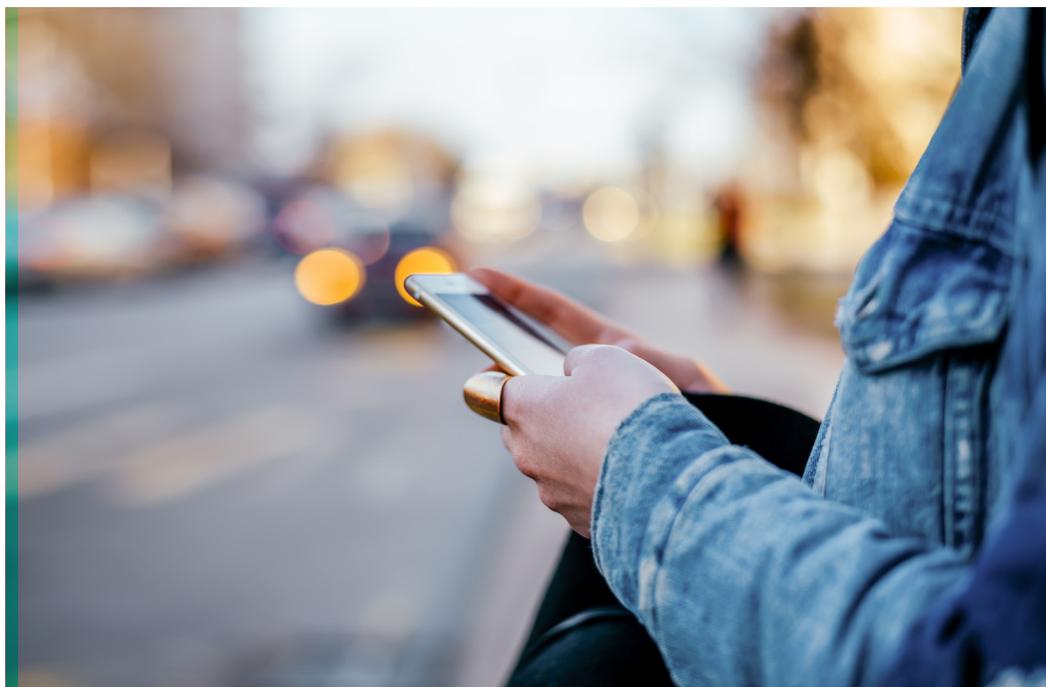
factors—such as inclement weather—are involved.

Researchers in the U's Information & Decision Sciences department explore these issues in a paper published in the journal *Information Systems Research*. "Our estimates indicate that after a ride-hailing service enters an urban area, usage of road-based, short-haul public transit services—namely, city buses—declines," says doctoral candidate Yash Babar. "Specifically, Uber's entry is associated with a 1.29 percent decline in city bus service utilization, in an average city."

At the same time, these services increase the use of rail-based and long-haul transit services such as commuter rail. "Uber's entry is associated with a 2.96 percent increase in commuter rail use," he says. "These estimated effects may seem relatively small, but they translate to substantial annual losses or gains for transit agencies."

For their analysis, Babar and Associate Professor Gordon Burtch used public transit utilization data maintained by the Federal Transit Administration for more than 2,200 transportation agencies. They gathered information about Uber's arrival into different locations based on public press releases and newspaper reports. They then compared agencies that had similar trends in transit use over the 24 months prior to the arrival of Uber and estimated how use changed 12 months after arrival.

In line with other studies, their findings indicate that ride-hailing services compete with public transit modes that share roads with private vehicles. However, the services can complement modes that have a separate right-of-way and operate on individual



tracks or rails.

The researchers also found that a variety of factors soften—or amplify—the impacts of ride-hailing. For example, the drop in city bus use is bigger in areas with inclement weather, particularly hot or snowy days. Bus use also falls more in areas with more violent crime. "One additional violent crime per thousand people is associated with a 1 to 3 percent larger drop in city bus utilization upon Uber's arrival," Babar says. But for commuter rail, that same rise in violent crime increases usage by 2.5 percent, he adds, perhaps because of the perceived added safety of the last-mile option.

The researchers found an array of effects on transit use from the other factors they analyzed: the size of the local population, riders' average trip distances, gas prices, and perceived transit service quality.

For light-rail transit (LRT), they didn't

find a statistically significant average effect of ride-hailing entry. However, all the moderating factors have a significant effect on LRT use—poorer weather, for example, leads to less LRT use.

Based on their findings, the researchers advise transit agencies contemplating partnerships with ride-hailing services to consider the losses or gains they may have experienced, or may experience, from the arrival of these services. They also stress the importance of local context. "The potential impacts on usage vary to some degree even within a transit mode," Burtch says.

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Framework helps
SMALL CITIES, RURAL AREAS CREATE
AUTOMATED VEHICLE
demonstration plans.

page 1

New statewide
INFORMATION SYSTEM
aims to improve
WORK-ZONE SAFETY.

page 2

RESEARCHERS DEVELOP
alert system to
PROTECT CYCLISTS
from cars.

page 3



Ride-hailing services have mixed impact
on public transit use.

page 1