Designing in-vehicle systems to improve safety for teens and older drivers

The risk of dying or being seriously injured in a car crash varies with age; teens and older drivers are the two highest-risk populations on the road.

“Distracted driving is what we always hear about, but that is only one of the many risk factors,” says Nichole Morris, director of the HumanFIRST Laboratory at the University of Minnesota. Other factors include seat belt use, alcohol, speeding, and teen passengers. “We also know that many of...”

Getting ready for shared autonomous vehicles

Fleets of shared autonomous vehicles (SAVs) will be on our roads within a decade as part of mobility services offered by both car and technology companies, says Professor Tom Fisher, director of the Minnesota Design Center at the U of M. “This transportation revolution will have a profound effect on our infrastructure and land use as well as on employment, the environment, and the economy,” he says.

Inside, Fisher provides insights for community leaders and planners to prepare for these changes.
University of Minnesota Duluth (UMD) researchers are identifying new ways for transportation agencies to meet regulatory requirements for stormwater runoff. In a recent project, researchers evaluated the use of peat and muck excavated from construction activities, taconite tailings from mining operations, and other stormwater filter media for use in bioswales and bioslopes along northeastern Minnesota highways.

“During rainstorms, water flows across highway pavement until it reaches a stream or patch of soil, but along the way, this runoff often picks up pollutants,” says Kurt Johnson, a research fellow with the UMD Natural Resources Research Institute. “To help highway drainage ditches absorb and filter stormwater before it reaches streams, these ditches are sometimes amended with materials such as a compost and sand mixture to create bioslopes and bioswales. However, hauling these materials to roadway construction sites can be very expensive.”

To contain these costs while continuing to address environmental challenges, the Minnesota Department of Transportation (MnDOT) funded Johnson’s research team to find alternative materials that are just as effective for biofiltration, but can be sourced close to construction sites and recycled from construction or industrial byproducts.

Researchers selected three locally available materials to determine whether they are suitable for use in bioswales and bioslopes. These were two byproducts often generated by excavation during roadway construction—peat (partially decomposed plant matter) and muck (a mixture of organic matter and clay)—as well as taconite tailings, a mining byproduct that could potentially replace sand.

After collecting the products, researchers conducted laboratory experiments to determine how well they absorbed water, retained pollutants, and sustained plant growth. Then, they conducted field tests to determine how well these materials worked in real-world scenarios.

“Ultimately, we found that a combination of peat and taconite tailings compared favorably with current MnDOT specifications for bioslope and bioswale designs,” Johnson says. “While muck showed little potential for this application, the other two materials performed well in terms of infiltration, pollution retention, and plant growth.”

According to Dwayne Stenlund, an erosion control specialist with MnDOT’s Erosion Control and Stormwater Management Unit, these findings will help protect the environment while saving money. “The results of this project will very much facilitate the development of green infrastructure by reducing its cost to MnDOT and Minnesota local agencies, helping them to do more with less.”
In a study with implications for both trucking companies and policymakers, researchers have found that non-adherence with employer-mandated sleep apnea treatment increases the risk of serious truck crashes.

“It’s well established that left untreated, obstructive sleep apnea is associated with higher crash risk in the general driving population, but relevant data about commercial drivers has been scarce,” said Stephen Burks, professor of economics and management at the University of Minnesota Morris, in a recent Roadway Safety Institute (RSI) seminar. “Our study examined the first-ever employer-mandated program for diagnosing and treating this dangerous disease among drivers and found a large and statistically significant association between non-adherence with treatment and preventable tractor-trailer crashes.”

Obstructive sleep apnea (OSA) is a disease in which the patient’s airway closes repeatedly during sleep, causing the brain to partially awaken to resume breathing; this prevents restful sleep, which in turn affects a person’s ability to maintain the type of alert attention required for driving. To help prevent crashes associated with OSA, the major motor carrier Schneider became the first trucking company to institute a mandatory program to screen, diagnose, and treat this disease among its drivers in 2006; drivers diagnosed with sleep apnea are provided with an auto-adjusting positive airway pressure (APAP) treatment, at no out-of-pocket cost for those enrolled in the firm’s employee medical insurance program. Treatment adherence is required for continued employment.

Using the data collected through this employer-mandated program, Burks and his research team set out to identify exactly how risky truckers with untreated OSA are on the road. By comparing the relative crash rates for drivers who followed their OSA treatment plan with drivers who did not, researchers found that the non-adherent drivers had a risk about five times higher than the control group. Even after checking for other factors such as demographic characteristics and job type, they found that the non-adherent group had a significantly higher crash risk than the control group.

“In short, we found that if we followed 1,000 drivers of each type driving for one year, the control and treatment-adherent groups would both have 14 preventable, reportable crashes while the non-adherent group would have 70 such crashes,” Burks said.

An employer-mandated OSA program that includes required treatment adherence could improve safety because it effectively sorts the workforce—it retains those drivers who are adherent and safer while filtering out those who are not adherent and much riskier, thereby improving the preventable crash performance of the entire fleet, Burks said.

“Every commercial driver has a screening exam at least every two years to determine their medical fitness to drive, but there is no test given to diagnose sleep apnea—that requires a measurement that takes at least overnight,” Burks said. Currently, medical examiners are not required to ask for the extra information to screen for possible sleep apnea in order to decide who should get such a test, and truck drivers know not to say anything about conditions that might jeopardize their driving careers. “As a result, drivers who have been diagnosed with OSA and who are not adherent with treatment can go to work for another company and be back on the highway with you,” Burks said.

The USDOT began an exploratory rulemaking on OSA screening for truck drivers in 2016, but it was withdrawn by the new administration in 2017, Burks noted. “Our study suggests that mandating screening in the commercial vehicle drivers’ biennial medical exam is worth revisiting.”

“‘Safety First and Always’ is the number one core value at Schneider,” said Tom DiSalvi, Schneider’s vice president of safety and loss prevention. “We understand the significance of OSA. Treating our associates for this disease not only improves vigilance and enhances their safety on the highway, it also dramatically improves our associates’ long-term health and wellness. The findings of Dr. Burks’s research continues to validate Schneider’s efforts and serves as a guidepost for both employers and regulators when considering actions to address OSA.”

Currently, the research team is expanding on this work by analyzing the differences in medical insurance claims costs and preventable crash costs across the same study groups. Initial examination suggests that the OSA program is associated with savings in both dimensions, and that these savings may be significant enough to substantially offset the costs of the program, Burks said.
A parallel transition?
“This transition may seem unprecedented, but we have gone through something like it before. Over a century ago, we switched from horse-drawn vehicles to automobiles because the latter were cheaper, cleaner, and safer. Most people will switch to SAVs for the same reasons.

“The transition from horses to cars in the early 20th century happened within a two-decade period, slowed down because of WWI. The coming transition to SAVs will happen just as fast or faster, given the greater speed of our economy and the greater cost savings at stake. The infrastructure and land-use decisions we’re making right now will be affected by this transition.”

The role of insurance
“Drivers cause most crashes. As people move to shared mobility systems because of lower costs, the number of drivers will shrink, which will increase insurance rates. That will prompt more people to stop driving, which will shrink the base even more, raising rates further to the point at which auto insurance—where it is still available—will become prohibitive to all but a very few. Another economic factor will be reductions in healthcare costs, as driving—the most hazardous daily activity we do—disappears.”

The benefits
“SAVs will mostly be owned by mobility service companies that provide on-demand transportation. This will greatly reduce the cost of transportation, greatly expand mobility to the millions of people who cannot drive, and greatly lower the environmental impacts of moving people and goods. SAVs’ electric operation will decrease air and noise pollution, and their continuous use during the day will largely eliminate the need for on-site parking stalls, lots, ramps, and garages. And SAVs will save thousands of lives and eliminate hundreds of thousands of injuries each year.”

The costs
“As with any major technological shift, SAVs will disrupt some people’s lives. The millions who make their living

Initiative on the Sharing Economy awards discovery grants
The University of Minnesota’s Initiative on the Sharing Economy has awarded its first discovery grants to two new projects.

These grants aim to support transdisciplinary partnerships and collaborative research by U of M faculty and researchers on themes related to the sharing economy, especially shared mobility and shared transportation.

In the first newly funded project, researchers will map sharing economy opportunities in both urban and rural areas. This will include identifying where sharing economy services have the greatest likelihood of success, what conditions are necessary to support them at a local level, and how this economic activity can benefit people who now rarely participate in it. The team will be led by Tom Fisher, director of the Minnesota Design Center, and include Mary Vogel, Minnesota Design Center, and Fernando Burga, Humphrey School of Public Affairs.

The second project aims to quantify and improve market efficiency in app-based ridesharing. After measuring the economic efficiency of the ridesharing market, researchers plan to develop and test an app that aggregates search results from multiple ridesharing platforms in a user’s location. Potential benefits include reducing the time users spend searching for ridesharing options and maximizing their choice.
The project will be led by Ravi Bapna and Gordon Burtch of the Carlson School of Management. The Initiative on the Sharing Economy was established by CTS in partnership with Professor Saif Benjaafar, the Initiative’s director, and other faculty members across the U. It is administered by CTS.

Design Center’s role
“The Minnesota Design Center stands ready to help communities prepare for this change. We have developed suggested language for incorporation into comprehensive plans, with accompanying drawings that show the physical impacts (see sample on page 4). Our researchers welcome the opportunity for conversation.”

Please see the center’s website for details: designcenter.umn.edu.

### Infrastructure and land-use impacts

#### Streets and roads
SAVs may require only one eight-foot-wide travel lane in each direction, with the occasional pullover for dropping off and picking up riders. This leaves a lot of space for other uses. One transition strategy would be to use temporary measures—such as restriped roads and movable planters—to narrow the width and number of travel lanes at low cost.

#### Residential streets and garages
As garages are no longer needed to park vehicles, they might be able to be converted to such uses as accessory dwelling units, working space, and recreational or retail activities. This may require greater flexibility in terms of zoning to allow for mixed uses and more shared open space.

#### Parking ramps
SAVs will make parking ramps as currently used largely unnecessary. Within the life of most of these structures, they will no longer be needed to store large numbers of vehicles, and they may become places for SAVs to park in the middle of the night. To minimize the demolition of parking ramps, from now on, all should be designed to have flat floors, with inclines or spirals that can be taken out in the future as ramps get converted to other uses. These structures should also have a large enough floor-to-floor height (12 feet or more) that they can transform into housing, office, or production space. Finally, parking ramps need to be designed with sufficient loading capacity to accommodate future uses.

#### Parking lots
A majority of surface parking lots can be converted to other uses. This will require a re-examination of parking requirements and an incentive system to encourage or allow property owners to transition their surface parking lots into other, more beneficial uses.

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One of the new projects will develop an app that aggregates search results from multiple ridesharing platforms.
The project will be conducted using a cooperative fuel research engine in the Department of Mechanical Engineering.

The University of Minnesota has received $1.1 million from the Department of Energy (DOE) for a project that will advance low-temperature combustion technologies to improve efficiency in natural gas engines.

The project, led by Professor Will Northrop, director of the U’s Thomas E. Murphy Engine Research Laboratory, will include co-investigators at Carnegie Mellon University and Johnson Matthey. It is one of three projects recently funded by the DOE as part of a $4 million effort to support research focused on medium-and heavy-duty on-road natural gas engines.

A DOE press release about the funding awards explains that, because of abundant domestic supplies, the United States could increase energy security by using low-cost natural gas as an alternative to other energy sources—such as diesel engines—for transporting goods.

Research such as Northrop’s could help cost-effectively achieve diesel-like efficiency in natural gas engines while still meeting emissions standards, which will ultimately improve the affordability of natural-gas fueled vehicles, according to the DOE.

Kids learn about bridges, traffic control at Tech Fest

In February, CTS partnered with the Minnesota Department of Transportation (MnDOT) to bring transportation-related activities to Tech Fest, an annual event held at The Works Museum in Bloomington, Minnesota.

The event, geared toward kids ages four and up, is designed to inspire interest in engineering and technology. It features hands-on activities and demos from the museum and its partners.

Around 250 kids visited the CTS booth, where they played Gridlock Buster, our online traffic control game. CTS staff were also joined by MnDOT engineers, who helped attendees learn about and build their own bridges using MnDOT’s bridge-in-a-bag activity.
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these feed into one another, so there is no silver-bullet solution," she says.

To help address teen driving dangers, HumanFIRST researchers developed a smartphone technology that improves safety by monitoring risky behaviors such as speeding, stop sign violations, aggressive driving maneuvers, and seat belt use and notifying a parent about them. The technology was evaluated in a study with 300 newly licensed drivers and found to be highly successful in improving teens' driving.

Older drivers—those ages 65 and older—represent the second-highest injury and fatality rate, after younger drivers, and are first in fatalities per 100 million miles driven.

"With the success of [teen driver] technology, we wanted to see how we could capitalize on it with other groups, and older drivers were the natural next fit," Morris says. "We have a lot of older drivers on the roadway and the number will continue to grow as the Baby Boomer generation ages. So we wanted to know how we can adapt this system to meet the needs and limitations of an aging driver."

In a project funded by the Roadway Safety Institute, the team began by conducting focus groups. The first group included technology-savvy older drivers who seemed resistant to the idea of an "older driver support system." Instead, they advocated for a system that would be useful to all drivers. On the other hand, a group of non-technology-savvy older drivers was far more accepting of such a system. "I believe that this group's participants were more open to the use of an older driver support system because they were starting to see the limit of their independence and were eager for a tool that could help them retain it," Morris says.

Next, researchers spoke in-depth with older drivers and experts in gerontology and occupational therapy to determine what types of modifications to the teen driver support system would be needed for older drivers; these changes included more contextual information, current and upcoming speed information, and under-speed feedback. Once these changes were made, researchers conducted a driving simulation study and recorded user feedback—with surprising results.

"Older drivers really liked the system, but felt most of the additions we made to support older drivers were overkill," Morris says. "At the end of the day, there was very little that needed to change between the teen and older driver versions, and we found that older drivers can best be supported with a universally designed system that addresses the needs and risks of all drivers, not a version specifically targeted for older drivers."

Morris cites this study as a perfect example of the scientific process at work. "If you follow the science correctly, it doesn't always give you what you start out looking for. Our result was not the tailored product I thought we were going to end up with, but rather a universally applied design."

Researchers tested this universally designed driving application, called RoadCoach, in a controlled field test and found it had a high rate of acceptance among older drivers. Up next: A field operational test this spring of 30 older drivers to determine if risky behaviors can be reduced over a longer time period and if acceptance of the system remains high after prolonged use.

In 2015, there were more than 40 MILLION licensed drivers ages 65 and older, WHICH IS A 50% INCREASE from 1999.

—Source: FHWA

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