Work zones are necessary—and often dangerous. Each year more than 100 road construction workers and 500 drivers are killed in highway work zones nationwide. Driver inattention contributes to approximately half of all work-zone crashes and worker strikes.

Though there is consensus about the dangers of highway work zones, the path to reducing injuries and deaths in them is less clear. To help identify solutions to this persistent highway safety problem, U of M researchers investigated the impact of different types of speed enforcement methods on driver attention in work zones.

**Signs help drivers select the best lane during traffic incidents**

Intelligent lane control signs (ILCS) are displays above lanes that warn drivers of incidents ahead. They’re becoming increasingly popular in high-crash areas of busy metropolitan areas as a way to reduce congestion and improve safety. Their effectiveness, however, depends on driver compliance.

In a recent project, U of M researchers set out to determine whether drivers are, in fact, heeding the messages displayed via these high-tech warning systems. To do so, they studied the effectiveness of ILCS messages during incidents in the high-crash area of westbound I-94 along the

**Does automated speed enforcement in work zones reduce distracted driving?**

Speed enforcement continued on page 7
For commercial truck drivers, finding a safe and legal place to rest isn’t as simple as stopping at a roadside motel. Along busy corridors, parked trucks may overflow onto the shoulders of rest area ramps and adjacent roads, creating safety concerns. If they continue driving, truckers may risk becoming dangerously fatigued or violating federal hours-of-service rules.

A project team including the Minnesota Department of Transportation (MnDOT), the University of Minnesota, and the American Transportation Research Institute has developed a system that can identify available truck parking spaces and communicate this information to drivers—helping them determine when and where to park and improving safety for them and other drivers. The team is the recipient of this year’s CTS Research Partnership Award, presented at the annual awards luncheon on April 20.

The Minnesota Truck Parking Availability System uses a network of digital cameras suspended above a parking area to monitor space availability. Image processing software developed by researchers at the Department of Computer Science and Engineering analyzes the video frames and determines the number of occupied spaces in all kinds of weather and lighting conditions. With the system, there’s no need for manual recalibrations or other adjustments to ensure accuracy 24/7. “The system is the only completely nonintrusive monitoring solution in the country providing real-time notifications to drivers,” says Professor Nikos Papanikolopoulos, the principal investigator.

“The benefit of it is that truckers will then be given information to better assess their trip,” says John Tompkins, freight project manager with MnDOT. The project team installed the system at rest areas along Interstate 94 northwest of the Twin Cities as part of a demonstration project funded by MnDOT and the Federal Highway Administration. The first site was activated in January 2013.

Results of usability assessments show a clear impact on driver and carrier attitudes and perceptions. Sixty percent of drivers said the system helped them find parking during their trips; more than 30 percent said it helped them comply with hour-of-service regulations. And more than half of all users (drivers and operators) said the system had either positive or very positive impacts on their productivity.

Without reliable information, truckers often end their shifts early and spend time looking for available parking—costing an estimated $7 billion annually in lost productivity. Less driving also reduces fuel use.

Moving forward, a patent has been filed to commercialize the system. In addition, a joint effort by the Wisconsin and Minnesota DOTs is under way to implement the system between the states along the I-94 corridor for public-sponsored facilities.

“This information will be very helpful if [truckers] get drowsy when driving,” Tompkins says. “It also helps MnDOT be able to spread its truck parking capacity along the I-94 corridor.”

**TRUCKERS LOOKING FOR PARKING**

$7 BILLION ANNUALLY IN LOST PRODUCTIVITY.

**READ CATALYST ONLINE**

for links to research reports and other resources.
Researchers predict a gradual transition to mileage-based pricing for roadway funding

There is agreement in the transportation community that the way we pay for roads needs to change.

“The motor fuel tax has been the primary source of highway revenue since the 1920s and it has served us well over the years,” says Ken Buckeye, program manager with the Minnesota Department of Transportation (MnDOT) Office of Financial Management. “However, with the advent of new sources of energy and the increase in fuel efficiency that is now federally mandated, the motor fuel tax alone is not likely to be adequate in the future. These trends are making it clear that we must begin to chart a path toward a fair and rational mileage-based fee system if we are going to meet our future needs.”

In a report sponsored by MnDOT and the Minnesota Local Road Research Board, U of M experts examined the options for implementing user-based road fees and explore the future of road pricing in the United States. Options include mileage-based user fees, toll roads and bridges, truck-only toll lanes, high-occupancy vehicle lanes, and cordon-based toll areas.

Today, user fees are not the primary source of roadway funds nationally. This is especially true for local roads, which rely primarily on property taxes. Using general-revenue sources spreads costs across non-users as well as users and sends no signal about the appropriate amount of roadway that should be built or how scarce road space should be allocated.

“While the gas tax is better than the alternative of general revenue, or not paying for roads at all, it has several problems,” says David Levinson, a professor in the Department of Civil, Environmental, and Geo-Engineering (CEGE) and the principal investigator of the study. “It does not account for inflation and rising fuel efficiency and does not apply to vehicles that do not use gasoline. It doesn’t pay for the full cost of building and maintaining local roads, recover the full costs of pavement damage from heavy vehicles, or address roadway congestion. Nor does it account for the full social costs of air pollution and crashes.”

Among all the available options analyzed, mileage-based user fees are what Levinson believes to be “the seemingly inevitable end-state for pricing and funding of roads.” Eventually, mileage charges could be used instead of a gas tax to establish a much stronger user-fee principle by charging each vehicle by miles traveled, time of day, and the type and weight of a vehicle. This is especially relevant with widespread adoption of electric vehicles and alternative fuels, he says.

Using user fees rather than general tax revenue to support roads would roughly double the out-of-pocket cost of travel by car, Levinson says. However, other costs such as property taxes, health expenses, insurance, and congestion-related time loss would decline.

“Depending on its implementation, pricing presents the opportunity to fully move roads off of general revenue and internalize congestion and possibly air pollution externalities,” he says.

The price increase for users would have a number of implications, such as reducing per-capita demand for travel (by about 25 percent), reducing peak demand for roads, spurring denser land-use development, increasing demand for non-auto modes and carpooling, substituting delivery for shopping, and increasing telecommuting.

“Unless there’s a sudden collapse of the feasibility of the gas tax for revenue,” Levinson notes, “this will be a slow transition. We anticipate years of pricing trials and policy discussions before pricing becomes mainstream.”

Levinson’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 CEGE assistant professor Adam Boies and Humphrey School of Public Affairs associate professors Jason Cao and Yingling Fan. Their high-level white papers are compiled in a final report: The Transportation Futures Project: Planning for Technology Change.
Road construction in northeast Minnesota often affects wetlands, and thus requires compensatory mitigation. Northeast Minnesota still retains more than 80 percent of its pre-European-settlement wetland acreage, so very few opportunities are available for traditional mitigation such as wetland restoration.

To determine whether abandoned “borrow pits”—areas that have been excavated for road construction materials—can be effectively converted to wetland for mitigation, researchers with the University of Minnesota Duluth Natural Resources Research Institute (NRRI) studied 14 wetland mitigation sites north of Virginia, Minnesota, along the U.S. Trunk Highway 53 reconstruction project corridor. The study was sponsored by the Minnesota Department of Transportation (MnDOT).

“Wetland creation—constructing wetlands in locations where they have not historically existed—generally gets a bad rap,” says Sarma Straumanis, MnDOT wetland program coordinator. “This poor reputation is driven by the failure of many wetland creations nationwide to live up to their performance standards.”

Abandoned “borrow” areas are one of the few remaining areas that can serve as wetland mitigation sites within the affected watersheds. “What we’ve seen is that the lack of long-term monitoring of mitigation sites is the primary reason for failure and non-compliance,” says Kurt Johnson, NRRI research fellow and principal investigator. “This project allowed us to continue the monitoring of two existing wetland demonstration sites that were created in 2007 for an additional four years and to monitor 12 new sites for four years.”

The new wetland sites were formed through the removal of borrow material for road construction. Next, salvaged peat and muck from several locations within the project corridor were applied. Finally, wetland seed mixes approved by Minnesota state agencies were applied to each site.

Researchers used several techniques to monitor progress. Water level wells were created at each site and monitored biweekly during the growing season. Two types of plant surveys were used to determine which types of vegetation were growing. During the first two years of the study, plant surveys were conducted at sample plots and the percentage of cover by each plant species was estimated based on the sample surveys. During the study’s final two years, researchers developed a new monitoring methodology to better quantify the quantity and quality of each wetland’s plant community using GPS mapping.

Monitoring results show that all but one of the sites consistently met wetland hydrology criteria, and that the 14 mitigation sites range in their potential to receive wetland mitigation credit. Researchers also outlined recommended steps for further improving the wetland sites.

“This research demonstrates that wetland creation can be successful given an appropriate landscape setting, an insightful design, an extended monitoring period—and favorable circumstances courtesy of Mother Nature,” Straumanis says.

Former CTS director rejoins U, shares thoughts on research

Robert Johns, director of CTS from 2001 to 2009, has returned to the University as a senior fellow at the Humphrey School of Public Affairs. He will conduct and support transportation-related research in Humphrey’s urban and regional planning area and teach in its leadership and management area. He has also been appointed a CTS Scholar.

From 2009 to 2016, Johns served as director of the U.S. Department of Transportation’s John A. Volpe National Transportation Systems Center, a fee-for-service organization of 570 federal employees that conducts approximately $300 million in annual research for its clients, including DOT modal administrations and other federal agencies.

He shares his thoughts about transportation research on page 6.

Johns continued on page 6
Leaders honored at CTS Awards Luncheon

CTS presented the following awards at its Annual Meeting and Awards Ceremony on April 20 in Minneapolis.

**Richard P. Braun Distinguished Service Award**
(outstanding leadership in research and innovation)
*John Gulliver*, professor and former head, Department of Civil, Environmental, and Geo-Engineering

**Ray L. Lappegaard Distinguished Service Award**
(outstanding leadership, mentorship, and support for the profession)
*Don Theisen*, public works director, Washington County

**William K. Smith Distinguished Service Award**
(leadership, mentorship, and education of future leaders in private-sector freight transportation)
*Brad Emch*, vice president of sales and marketing, SAV Transportation Group

**Distinguished Public Leadership Award**
(public leaders who have influenced innovative transportation policy directions)
*Judge James E. Dehn*

**Education Awards**

**Matthew J. Huber Award** (students in engineering, science, and technology fields)
*Maria Garcia-Serrana*, doctoral candidate, civil engineering; *John Gulliver*, advisor
*Vahid Moshtagh*, master’s degree, transportation engineering; *Gary Davis*, advisor

**John S. Adams Award** (students in policy and planning fields)
*Kirti Das*: Doctoral candidate, public affairs; *Yingling Fan*, advisor
*Alireza Ermagun*: master’s candidate, urban and regional planning; *Greg Lindsey*, advisor

**Roadway Safety Institute Outstanding Student of the Year**
*Brendan Murphy*, master’s degree, civil engineering; *David Levinson*, advisor

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Video shares highlights of past year

CTS aired a new video at the awards luncheon that takes a look back at the past year. It includes highlights of several research projects and last summer’s camp for K-12 students. The video is available for viewing on the CTS website.
south edge of downtown Minneapolis.

“This two-mile stretch of road experiences more crashes than any other freeway location in Minnesota, with crash events observed almost every other day on average,” says Hourdos, director of the Minnesota Traffic Observatory and the study’s principal investigator. “This section of highway is also the site of our unique field laboratory that allows us to gain a detailed picture of the area through seamless surveillance coverage and precise traffic measurements.”

For the MnDOT-funded project, researchers selected 28 incidents from among the 481 that occurred between 2012 and 2013. They thoroughly analyzed each of these 28 events using loop detector and lane-change data and also performed statistical analyses to test several hypotheses.

“Instead of taking the more traditional approach of testing and measuring the effect an ILCS system has on overall congestion, we aimed to evaluate and quantify the effect the system has on drivers—specifically, on inducing desirable lane selection behavior,” says Hourdos. “Comparing and modeling the lane-change rates was the centerpiece of this research.”

Based on the project results, researchers concluded that the use of ILCS for incident management has a significant effect on driver behavior, specifically in prompting proper lane selection during capacity-reducing incidents. Other project findings include:

- Using more than two sets of signs upstream of an incident produces no additional benefit.
- Strong messages such as “Lane Closed Ahead” and “Merge” do the best job of inducing lane change.
- The presence of first responders has an observable positive effect on lane change but is not as effective as instructions on an ILCS.
- ILCS can become ineffective under stop-and-go conditions.

“We saw that the ILCS were capable of emptying the incident lane well upstream of the obstruction caused by the incident, even when the next lane was considerably congested,” says Hourdos. “After a certain point, the preferred operational strategy may be to display an innocuous message such as ‘Use Caution’ rather than instructing drivers to change lanes in order to preserve the storage capacity of all lanes upstream of an incident.”

“The study showed that the ILCS are effective in changing driver behavior, but it did not compare how much additional benefit they provide compared to standard variable message signs,” says Brian Kary, MnDOT freeway operations engineer. “Although we saw measurable benefits from the deployment through this study, more research is needed to see if the ILCS are a cost-effective approach to managing traffic during incidents.”
“Work zones are dangerous for many reasons,” says Nichole Morris, a research associate with the HumanFIRST Laboratory. “There are numerous factors drivers may not expect, such as lane closures and high traffic volumes. In addition, high-risk driving behaviors such as distraction, speeding, and aggressive driving make the problem worse.”

The investigation examined enforcement methods currently used in Minnesota as well as the potential influence of automated speed enforcement (ASE). “Up to this point, little has been known about how ASE compares with other speed limit enhancements in terms of its impact on driver attention and distraction,” Morris explains.

The project, sponsored by the Minnesota Department of Transportation (MnDOT), used a high-tech driving simulator with eye-tracking technology to examine how drivers responded to four types of work-zone enforcement: control (no enforcement), police car present, dynamic “your speed” signs, and automated speed enforcement.

The test-subject drivers were asked to drive through a realistic simulated work zone on a divided Minnesota rural roadway while engaging in a secondary “distraction” task. The researchers then analyzed the results to determine whether drivers responded to the four types of speed limit enhancements differently with regard to speed limit compliance, safe following distances, crash rates, lane control, visual attention, and distraction seeking.

“Overall, our results did not find that automated speed enforcement in itself strongly improves driver attention in work zones,” Morris says. “However, we did find some evidence that drivers heighten their visual attention with a combination of automated speed enforcement and dynamic speed display signs.”

In addition, researchers found the largest effects were among younger and older drivers, who tended to exceed the speed limit most often and varied their speed slightly based on the type of enforcement present. Middle-aged drivers exhibited the greatest speed control and tended to abide by the speed limit to the same extent regardless of the type of enforcement present.

“Because younger and older drivers are the most at-risk groups for work-zone crashes, it is promising that they appear to be the most positively influenced by the combination of automated speed enforcement and dynamic speed display signs,” says Morris.

Ken Johnson, MnDOT’s state work-zone engineer, was the project manager. “While automated speed enforcement is currently not being considered legislatively, we needed to determine if this method would be distracting to motorists as they navigate the work zone,” he says. “The results indicate that automated speed enforcement neither improved driver attention nor distracted the driver. This is important to know as we don’t want to add to driver distraction in an area where they need to pay attention.”
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System helps
TRUCK DRIVERS PLAN PARKING
and improve safety.
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Researchers predict 
GRADUAL TRANSITION TO 
MILEAGE-BASED ROAD PRICING.
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Signs help drivers select the best lane during traffic incidents.
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