University of Minnesota

CENTER FOR TRANSPORTATION STUDIES

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# CTS Catalyst

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Accelerating the pace of transportation innovation



## Unmanned aircraft systems create buzz of activity, but challenges remain

In late 2013, Amazon.com CEO Jeff Bezos reported that his company plans to someday use unmanned aircraft systems to deliver packages. Amazon is not alone in considering these systems as the list of potential uses rapidly expands. Where is this technology headed, and what does it mean for the region, and for transportation? State and national experts discussed these issues at an April 30 forum on the St. Paul campus.

Often referred to as drones, modern UASs can be used for a broad range of activities, from

***Unmanned aircraft*** *continued on page 4*

## Remembering Jim Oberstar

Former U.S. Rep. James L. Oberstar, who represented northeastern Minnesota in Congress for 36 years, died May 3. Oberstar was elected to Congress in 1974 and served until 2011, making him the longest-serving Congressman in Minnesota history. He was a long-time member of the House Transportation Committee and served as its chairman between 2007 and 2011. A strong champion of federal funding for transportation safety and infrastructure, Oberstar was instrumental in establishing several University of Minnesota programs to improve transportation.

Following are comments from University officials on his passing.

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# Primary seat belt law continues to save lives, money


Minnesota's primary seat belt law continues to save lives and reduce serious injuries more than four years after being passed, according to a study by researchers at the U of M's Humphrey School of Public Affairs.

The study examined Minnesota crash data collected from June 2009 (when the law was implemented) through June 2013 and compared it to expected data based on crash trends over time. Findings indicate that there were at least 132 fewer deaths, 434 fewer severe injuries, and 1,270 fewer moderate injuries than expected during this time. Minor injuries did increase by 1,110, suggesting that the seat belt law could be helping to reduce the severity of crash-related injuries.

Prior to 2009, not wearing a seat belt was a secondary offense in Minnesota, which allowed law enforcement officers to ticket for failure to wear seat belts only when there was another moving violation. Under the primary seat belt law, officers can ticket drivers for not wearing a seat belt without any other law being broken.

According to the researchers, the safety benefits of the law translate into a savings of at least $67 million in avoided hospital charges, including nearly $16 million in taxpayer dollars that would have paid for Medicare and Medicaid charges.

The study was sponsored by the Minnesota Department of Public Safety and led by Humphrey School research fellow Frank Douma and Nebiyou Tilahun, a U of M graduate now on the faculty at the University of Illinois-Chicago.

The project built on an initial evaluation completed in 2012. The original study examined the effects of the seat belt law from 2009 to 2011 and found that the law had resulted in 68 fewer deaths, 320 fewer severe injuries, and 432 fewer moderate injuries.

Comparing the results of the two studies reveals that the reduced fatality and severe injury trends have continued. For instance, the 2011–2013 period saw an almost equal reduction in fatalities as the first two years. And although the reduction in severe injuries was smaller in the 2011–2013 period (113 compared to 321 during the first two years), the reduction in moderate injuries was almost twice as high (838 compared to 432).

The researchers also examined seat belt use data and survey results that measured support for the law. Findings show that support increased from 62 percent just before the law was passed to more than 70 percent in 2013, while the percentage of Minnesotans buckling up was at an all-time high of nearly 95 percent in 2013. This shows that some people are wearing their seat belts even though they don't support the law.

**33 STATES** currently have **PRIMARY SEAT BELT LAWS.**

"A number of Minnesotans may now be buckling up only because they have to. They might not choose to wear their seat belt if they weren't required to by law," Douma says. "The benefit of the law becomes most clear in the unfortunate event that these people are involved in a crash."

When this increased seat belt use is combined with the reduction in fatalities and injuries, it further demonstrates that people are surviving—and even walking away from—crashes that may have had different results if the primary seat belt law had not been in effect.

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# Bridge monitoring system can offer advance warning of problems

With the aging of bridge infrastructure in the United States, transportation practitioners and researchers have been increasingly focused on finding a solution to the ongoing challenge of ensuring the safety of our nation's bridges.

Current bridge collapse warning technologies are triggered only by an actual bridge collapse—providing no advance warning of structural distress at early stages that would allow for the inspection and repair of a bridge, or even a closing to prevent collapse in extreme cases.

"We recognized that by developing an advance warning system, we could provide an essential tool for avoiding a potentially dangerous situation, as well as for reducing property loss to both bridge users and bridge owners," says University of Minnesota civil engineering professor Arturo Schultz. "To fill this technology void, we designed an advanced health monitoring system for an in-service bridge that can provide warning of bridge distress."

In the new study sponsored by the Minnesota Department of Transportation (MnDOT), researchers developed a detailed framework for selecting, configuring, testing, and monitoring an in-service bridge using commercially available monitoring equipment. The system uses acoustic emission sensors to listen to the sound of stress waves in bridges—cracking of steel plates and bolts, for example. By comparing the results to data from lab testing, the researchers can detect potential problems.

"This research will guide future decisions by MnDOT about how to best manage our bridges, establishing another tool to accurately assess bridge condition and ensure public safety," says Moises Dimaculangan, MnDOT bridge rating engineer.

For this study, researchers selected a steel bridge categorized as fracture critical—meaning that due to the design of the bridge, a serious crack could undermine its stability. "Because the bridge we selected has had no history of problems since it was built in 1979, it was an ideal platform to develop, implement, and test a global health monitoring system for fracture-critical steel bridges," Schultz says. "We had the freedom to work on the bridge without having to be concerned with bridge distress."

After monitoring the selected bridge with the new bridge monitoring system for 22 months, researchers found that no signs of cracking were evident in the bridge—as expected. They also learned that powering the bridge-monitoring system with solar panels is problematic due to the large power demands of the system and the lower reliability of solar power compared to AC power, and recommend that future monitoring systems for fracture-critical bridges rely exclusively on AC power. Most importantly, researchers created a monitoring framework that can help ensure the safety of our nation's fracture-critical bridges.

"Unlike in previous applications, in which only localized areas where fracture is expected are monitored, the system we developed uses sensors distributed at a large spacing to provide global monitoring for the entire bridge," Schultz explains. "This new model allows for a comprehensive view of the overall health of a bridge, which is the best way to ensure the bridge is safe and problem-free."

In next steps, the researchers are honing the fracture alarm criteria and developing an automated alarm system; plans are to implement the system on other fracture-critical steel bridges. "This work will give bridge users reassurance that if something is wrong, agencies will be notified and be able to take action," says graduate student Anton Tillman.

*Acoustic sensors listen for potential problems—such as a bolt cracking—to monitor the health of a bridge.*

***Unmanned aircraft** from page 1*

aerial photography, surveying, and communications to disaster response, wildlife research, and infrastructure protection.

One of the industries that is expected to quickly adopt UAS use is precision agriculture, said Professor David Mulla of the University's Department of Soil, Water and Climate and director of the Precision Agriculture Center. Precision agriculture, Mulla explained, means applying the right management practice at the right rate, the right time, and the right place. Doing this requires information about different field and crop properties. "We need to collect data, and this is where remote sensing comes into play—whether it's from satellites, airplanes, ground vehicles, or unmanned aerial systems," he said, adding that UASs provide very high-resolution imagery at relatively low cost.

A hurdle to broader use is the lack of rules and regulations. Last November the Federal Aviation Administration (FAA) released its first annual roadmap outlining policies, regulations, technologies, and procedures needed to safely integrate UAS into the nation's airspace; it plans to issue regulations by 2015. "The greatest challenge is integrating UAS into the National Airspace System," said Brigadier General Alan Palmer, director of the Center for UAS Research, Education, and Training at the University of North Dakota. "We want to do this safely, we want to do no harm, and we want to be sure not to violate somebody's personal space. We do not have any regulations for standards, training, certification, or anything like them. But we will get there."

Privacy is a much-cited concern. "We need to be transparent," said Charles Samuelson of the American Civil Liberties Union (Minnesota). "We need to say not only why we are collecting the data, but what we think we will get out of it and what we will use it for."

Another major issue is the existing aviation/navigation infrastructure. When it was built 50 years ago, it didn't account for a future that would include UAS. "There is a lot of work going on to identify the infrastructure changes that would [possibly] take place in order to support the services for UAS," said Randy Willis, manager of air traffic strategic operations at the FAA UAS Integration Office.

Other speakers discussed topics such as economic impacts and workforce development. Mos Kaveh, associate dean of the U's College of Science and Engineering, noted that the college is studying robotics, sensors, and advanced manufacturing as part of the MnDRIVE initiative. (MnDRIVE is a partnership between the University and the state of Minnesota to advance Minnesota's economy and enhance the University's ability to produce breakthrough research.) "The broad area of robotics and sensors is very relevant to UAS," he said.

The forum was sponsored by the Airport Technical Assistance Program (AirTAP), a part of CTS. Cosponsors were the Minnesota Department of Transportation, the Minnesota Department of Employment and Economic Development, and MnDRIVE.

A proceedings will be available on the AirTAP website: **airtap.umn.edu.**

**THE UAS GLOBAL MARKET IS APPROXIMATELY**

**$11.3 BILLION**

and will grow to

**$140 BILLION**

in the next 10 years.

*Source: Association of Unmanned Vehicle Systems International's 2013 Economic Report*

*Unmanned aerial systems collect data about fields, crops, and insect populations at very high resolution and relatively low cost.*

# Sidewalk replacement contributes to Minneapolis tree loss

Last June a windstorm toppled about 1,800 trees in Minneapolis. Many of the fallen trees were in boulevards (the area between sidewalks and streets) rather than in yards. This raised concerns that recent sidewalk replacement—and resulting severed tree roots—had been a factor.

To better understand the higher-than-normal losses, the Minneapolis Park and Recreation Board (MPRB) turned to the U's Urban Forestry Outreach, Research and Extension lab. "The MPRB Forestry Department has partnered with the University of Minnesota for years," says Ralph Sievert, MPRB forestry director. "When this study presented itself, we did not hesitate to ask the lab to participate."

Led by forestry department professor Gary Johnson, the lab studied damaged and undamaged trees along the storm's path. The data set included 3,076 trees, of which 367 were total failures (tipped or partially tipped) due to the storm.

"The major finding is that replacing the sidewalk increased the odds of root failure by 2.24 times," Johnson says. For example, when no replacement work was done, the average linden had a 10.6 percent chance of root failure; with sidewalk replacement, this increased to 21.0 percent.

When combined with replacement work, tree species was also a significant factor. Linden trees were most likely to fail, followed by ash, maple, and elm. "Essentially, when replacement work was done near any one of these trees, the rate of failures more than doubled," Johnson says.

Boulevard width was a factor, but *only* if there was sidewalk replacement. For example, a linden in a four-foot-wide boulevard with damage to its root system from sidewalk replacement had a failure rate of 29.4 percent. The same tree in an eight-foot-wide boulevard had a failure rate of 14.6 percent. Likewise, increases in soil compaction were significantly related to tree failures *only* when sidewalk replacement work was involved.

Trees with larger diameters were more likely to fail regardless of whether sidewalk replacement work had been done, Johnson adds.

"Now we have a great opportunity to make improvements," Sievert says. "I'm anticipating this leading to safer, healthier trees with fewer instances of infrastructure damage."

Johnson is the author of *The Road to a Thoughtful Street Tree Master Plan* (2008-32), published by the Minnesota Local Road Research Board (**lrrb.org**).

# Workshop shares strategies for reducing aircraft-wildlife collisions

Birds and aircraft should not flock together. There's no better example of this, perhaps, than U.S. Airways Flight 1549: Canada geese were ingested into both engines of an Airbus 320, forcing its captain to land in the Hudson River.

Controlling wildlife near airports is one way to minimize the potential for these dangerous collisions. The Airport Technical Assistance Program (**AirTAP.umn.edu**), a part of CTS, offers an annual training workshop on wildlife control strategies. This year's was held May 14 and was led by the Metropolitan Airports Commission (MAC) in its Driver Training Center at the Minneapolis–St. Paul International Airport.

The workshop is open to all airport staff interested in hearing best practices and sharing ideas. Led by the MAC's Jon Ostrom, the workshop included a classroom session on current regulations and hands-on demonstrations for controlling birds, deer, and other unwanted visitors. Bill Towle, director of the St. Cloud Regional Airport, says one of the most valuable parts of the day is the discussion of common problems that all airports, regardless of size, face daily.

"We believe this is the only workshop for airport wildlife control in the country," says AirTAP director Jim Grothaus.


About

**10,900**

**BIRD AND OTHER WILDLIFE STRIKES**

were reported for U.S. civil aircraft in 2012.

*Source: Bird Strike Committee USA*

# Identifying new solutions for road subgrade compaction challenges

The foundation of any road is its subgrade—the compacted native soil the road is built on. While many people think of pavement performance primarily in terms of the pavement design and structure, the subgrade is actually one of the biggest factors in pavement performance.

"Getting the best possible compaction of the subgrade is required during construction to maximize the longevity of the road and minimize the required pavement thickness," says University of Minnesota bioproducts and biosystems engineering professor John Nieber. "Unfortunately, due to the variation in soils used for subgrade and the challenges involved in measuring the characteristics of these soils, the quality of subgrade compaction is sometimes less than optimal."

According to Nieber, part of the challenge in subgrade compaction is making lab findings more relevant during construction. For each project, soil samples are taken to the lab to determine the proper moisture content and density for the subgrade. However, determining whether these values are achieved in the field is often difficult because of the limitations of the technologies available for measuring bulk density and water content *in situ* (in its original place).

"The key to ensuring the field compaction values come as close as possible to the lab values is having an accurate way to measure density and moisture content in the field," Nieber explains. Traditionally, one of the instruments used to conduct these measurements has been a radioactive nuclear density gauge. However, transportation agencies are currently trying to find alternatives to this instrument because of safety, regulation, and financial concerns, he says.

To help address these challenges, a study conducted by University of Minnesota researchers and sponsored by the Minnesota Department of Transportation (MnDOT) evaluated four potential instruments—alternatives to the nuclear density gauge—that might be used to measure the *in situ* moisture status of subgrade soils. The study identified the soil types and situations in which each of these four instruments is most useful, and alerts transportation practitioners to possible sources of data error for each of the instruments.

"Our goal is to deploy a field device for measuring moisture content that enhances the ability of our inspectors to be effective with reduced resources and greater responsibilities," says John Siekmeier, research engineer with MnDOT and the technical liaison for the project.

"We know that even small differences in moisture content can lead the strength of some soils to drop very quickly, resulting in under-performance of the pavement foundation," Nieber says. "With this research, transportation practitioners are one step closer to identifying better ways to get accurate, real-time *in situ* measurements of moisture content in the field and allow them to make the proper adjustments during construction in order to improve the pavement's long-term performance.

## NEW RESEARCH REPORTS

Recently published reports on transportation-related research at the University of Minnesota:

**PUBLIC ENGAGEMENT IN LOCAL ROAD SYSTEMS**
(MnDOT 2014-17)

**FREIGHT PERFORMANCE ANALYSIS IN THE TWIN CITIES**
(MnDOT 2014-14)

**INNOVATIVE PARKING PRICING DEMONSTRATION**
(CTS 14-02)

Research reports are available at **cts.umn.edu/Publications/ResearchReports**.

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### *Laurie McGinnis, CTS Director*

"Jim Oberstar was a true friend to transportation research and innovation at the University of Minnesota. At heart, he was an educator and storyteller who loved talking to students about their studies and their research. Over ten years ago, CTS and the University founded the James L. Oberstar Forum on Transportation Policy and Technology to provide a venue for national, state, and academic leaders to gather and generate a 'cornucopia of ideas' for the latest transportation issues of the day. Jim was always in the middle of those debates and discussions, sharing his passion and knowledge with everyone in attendance, then taking what he learned back to Washington to share with his colleagues in Congress."

### *Max Donath, Director, Roadway Safety Institute*

"He was a giant among legislators, fearless to fight for what he believed in and at the same time willing to work with anyone to get important bills passed. He was always interested in new ideas that could solve our pressing transportation problems. He was passionate about improving our transportation infrastructure and finding new ways to finance its operations. His knowledge of all matters related to transportation was awesome. His departure from the scene is a loss to all of us."

### *Eric Kaler, University President*

"Rep. Jim Oberstar was a truly great American. In his more than three decades of service to our state and country, Congressman Oberstar championed many University of Minnesota efforts—including transportation and public policy research—and for that we will always be most grateful. Congressman Oberstar's contributions to the U are visible and lasting, with a legacy that lives on through a fellowship at the Humphrey School of Public Affairs."

### *Eric Schwartz, Dean, Humphrey School of Public Affairs*

"James Oberstar was not only a major force on transportation and so many other policy issues, but also a great friend and supporter of the Humphrey School. With Jim's cooperation and support, we established the James L. Oberstar Endowed Scholarship Fund in January to support students at the Humphrey School with commitments to public service, and to pay tribute to the public contributions of Rep. Oberstar. The Oberstar Fund will now serve to honor the memory of this distinguished Minnesotan."

### *Lee Munnich, Director, State and Local Policy Program, Humphrey School*

"After leaving Congress, Jim Oberstar joined the Humphrey School as chair of the Center for Excellence in Rural Safety. He led several transportation policy forums at the Humphrey School on topics such as innovations in road safety, the St. Croix Bridge, transportation finance, transit, and the freight economy. I know that Jim would hope his long career and passion for transportation will inspire bipartisan support for funding transportation infrastructure."

*Oberstar tours the Minnesota Traffic Observatory with Max Donath.*

*Oberstar takes the wheel in the HumanFIRST Lab driving simulator.*

## EVENTS CALENDAR

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