

# CTS Catalyst

cts.umn.edu

Accelerating the pace of transportation innovation

## FUTURE OF AUTOMATION

page 2

## SAFETY POLICY

page 3

## URBAN WATERSHEDS

page 4

## 'TRANSPORTATION-YOU' CAMPUS VISIT

page 5

## NATIONAL TRANSIT MAP

page 6

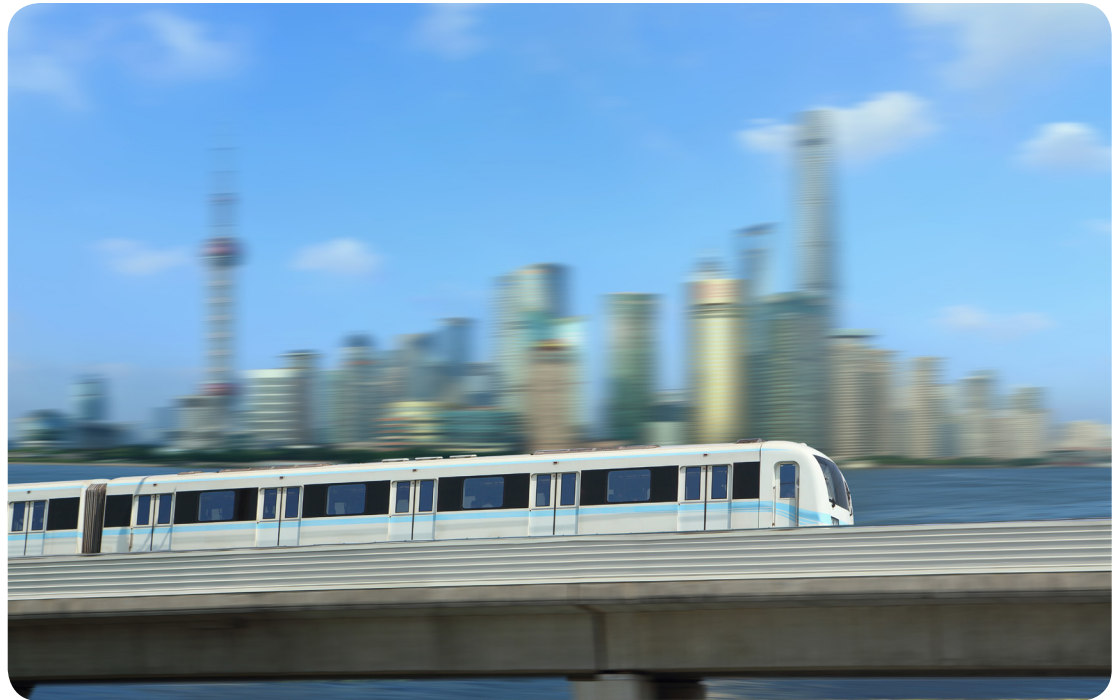


Photo: Shutterstock

## Global Transit Innovations program discovers solutions, inspires change

Providing innovative public transit is crucial for ensuring that people around the world—whether in large or small cities, suburbs, or rural areas—have a high quality of life. But many questions remain about transit and its potential to address societal challenges, and many opportunities exist to improve efficiency and innovation. Skilled experts are also needed to take new knowledge and solutions and put them into practice.

The new Global Transit Innovations (GTI) program aims to find these answers and educate the

*GTI continued on page 7*

## Helping visually impaired pedestrians find their way with new self-aware system

Traveling alone in an unfamiliar environment can be challenging for visually impaired pedestrians, largely because there is not enough information available to them to support decision making. For U of M researchers, helping these pedestrians overcome such challenges is a top priority.

“To improve mobility, access, and confidence in the transportation system, it is important to remove not only the physical barriers but also the information barriers that can impede mobility for people who are visually impaired,” says Chen-Fu Liao, senior systems engineer at the U of M’s Minnesota Traffic Observatory.

*Pedestrians continued on page 5*



Photo: Shutterstock

# How will robots and humans interact in our future transportation system?



Photo: Shutterstock

We have long envisioned a future where cars drive themselves and fly through the air. But what is the reality of automation in our transportation future?

At the CTS Fall Luncheon on November 9, Duke University associate professor Mary (Missy) Cummings discussed the current state of autonomous transportation and explored how we can balance the interactions between humans and robots in the future.

As one of the first female fighter pilots in the United States, Cummings experienced the role of computers in transportation firsthand. "When I began flying F-18s, I saw that the computer does a much better job landing and taking off from an aircraft carrier than even the best pilots in the nation," Cummings said. "In fact, on takeoff they won't even allow pilots to touch the controls, because humans can easily over-control the plane and cause it to stall—leading to a deadly crash."

The realization that computers can do a better job controlling an aircraft than the most elite pilots led Cummings to return to graduate school

and eventually start the Humans and Autonomy Laboratory, which focuses on the complex interactions of human and computer decision making. As the lab's director, she has worked on many transportation-related projects, including the development of self-driving dump trucks, human-controlled drones to inspect oil pipelines, robotic forklifts, and R2D2-like robots that could someday replace co-pilots in commercial airplanes.

Cummings also offered insight on autonomous cars. In her research, Cummings has found that one of the greatest challenges of self-driving cars is the tendency of the supervising humans to become distracted, especially after long periods of time. In one study, people were asked to operate a simulated self-driving car for a four-hour drive. Three hours into the simulated drive, several moose amble across the road and are not sensed by the car because of lightly misting conditions. Nearly every driver hit the moose as a result of boredom and distraction.

"Urban driving will be easier to automate than cross-country driving because of the boredom that sets in

while traveling long stretches of road," Cummings said. "In order for a driverless car to really work in these conditions, we need a way to know the state of the mind of the human to see if the driver even has a chance of intervening."

Cummings' research has led her to a deep understanding of the jobs robots can do well and the jobs that require human input. "Computers do a great job with skill-based and rule-based reasoning—doing tasks that are automatic and repeatable and [involve] applying a set of procedures that take you through how to deal with an anomaly," Cummings said. "After that comes knowledge-based and then expert-based reasoning, and this is where automation falls apart because computers can't do deductive reasoning or operate under uncertainty."

This need for human knowledge and expertise means that in the future, skill-based jobs may be replaced with new jobs that require higher levels of cognition. "Robotic forklifts, trucks, and trains don't exist by themselves. They have to have human supervision," Cummings said. "Now you have humans in control-room situations, which means our future workforce is going to have a greater need for educated, technology-savvy people who understand how to work under uncertainty."

## AIRBUS PILOTS

use the airplane's

## CONTROL STICK

for only about

# 3.5 MINUTES

in an average flight.



# Understanding policymaker support for traffic safety countermeasures

Mounting evidence shows that certain traffic safety countermeasures consistently save lives on our nation's roadways. Examples include motorcycle helmet laws, primary enforcement of seat belt use, sobriety checkpoints, graduated driver licensing (GDL), mandatory ignition interlock, and automated speed enforcement. But despite the effectiveness of these countermeasures, states that have tried to implement them have had varying levels of success in gaining the support needed from policymakers.

A team of researchers from the U of M's Humphrey School of Public Affairs is working to understand why this support varies so widely in a project funded by the Roadway Safety Institute. The team's work includes assessing the factors that affect the adoption of evidence-based approaches to road safety by state legislators and policy leaders, examining the role of federally required state safety programs, and identifying best practices for states.

"We know that if certain policy countermeasures are adopted more broadly by state legislatures, we would likely see measurable and significant reductions in roadway fatalities and serious injuries," says Lee Munnich, Humphrey School senior fellow and the project's lead investigator. "In this project, we're asking why state legislators and policy leaders support or oppose certain evidence-based countermeasures. For example, are they not convinced of the evidence? Are they concerned about constituent response? And how do things like public opinion surveys, lobbying groups, and law enforcement organizations affect their decisions in support or opposition?"

Earlier this year, Munnich's team completed the first phase of the project, which included reviewing state strategic highway safety plans and Toward Zero Deaths (TZD) programs in Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin.

As part of that work, the researchers prepared a draft case study for each

state. The case study on Minnesota, for example, found that the state has demonstrated mixed results in implementing policy countermeasures. Minnesota has been successful in legislating primary enforcement of seat belt use, GDL program upgrades, and mandated ignition interlock implementation in certain cases, but it

improvements in roadway safety," he says. "We hope that the assessment tool will help policymakers to reevaluate their positions to push for evidence-based road safety policy countermeasures."

This research, he adds, will contribute to further developing and successfully implementing roadway safety policy strategies at the state and local level—in



Photo: Shutterstock

*Minnesota is one of 34 states with a primary seat belt law.*

does not require universal motorcycle helmet use or authorize automated speed enforcement or the use of sobriety checkpoints. This means the state legislature could do considerably more to make advances in those areas, the researchers say.

The team also developed methodology for a TZD program assessment tool and conducted policy interviews with state legislators and safety policy leaders. During the next year, continued work will include developing and testing the new TZD assessment tool, conducting roadway safety policy roundtables, and completing a policy brief.

Ultimately, Munnich hopes this work will help shape the future of roadway safety policy. "Safety strategies require policy leadership as well as institutional collaboration for continued

addition to providing best practices and strategies for legislators, state DOTs, public safety offices, and elected officials.

Currently,  
**19 STATES**  
have laws requiring all  
**MOTORCYCLISTS TO WEAR HELMETS.**

There are  
**23 STATES**  
with mandatory  
**IGNITION INTERLOCK**  
provisions for all offenses.

# Improving rainfall-runoff model creates a more sustainable stormwater system

In urban and suburban areas, much of the land surface is covered by “impervious surface”—buildings and pavement that prevent rain from soaking into the ground. Large amounts of this runoff are directed into storm drains that carry it into nearby waterways. Unfortunately, runoff can also carry pollutants such as oil, dirt, chemicals, and lawn fertilizers directly into streams and rivers.

To better estimate the impervious area in urban watersheds, a U of M research team developed a new method that could eventually lead to the design of a more sustainable urban stormwater infrastructure.

Typically, the total impervious area (TIA) in a watershed has been used to determine the impacts of urbanization on water resources. Not all impervious surfaces, however, are created equal.

“While some impervious surfaces, such as streets, often channel rainfall directly into storm drains, other surfaces, such as the roofs of single-family homes, are typically not directly connected to the storm sewer system,” says John Gulliver, professor in the Department of Civil, Environmental, and Geo-Engineering (CEGE) and the principal investigator. For this reason, recent studies suggest that a better indicator of urban runoff is effective impervious area (EIA)—the portion of the total impervious area that is hydraulically connected to the storm sewer system. “It is often considerably less than the TIA,” he says.

Calculating EIA can be a challenge, Gulliver explains. Not only does it require separating out the directly connected impervious surfaces from those that are not, it must also reflect that not all directly connected impervious surfaces are hydraulically connected to the stormwater system. For example, water might be prevented from entering the stormwater system because of surface depressions, cracks in the pavement, vegetation, or clogged storm drains.

To help solve this challenge, the



Photo: Shutterstock

research team developed a new method to estimate the EIA in urban watersheds with data that are readily available. First, the team improved the existing rainfall-runoff calculation method by reducing the uncertainty associated with EIA estimates and applying it to 40 gauged urban watersheds with different sizes and hydrologic conditions, mostly in the Twin Cities metro area and in Austin, Texas. They then used these results to develop a new model that can estimate EIA for ungauged watersheds based on the TIA and the hydrologic soil group.

“Overestimating impervious area results in costly overdesign of hydraulic structures,” Gulliver says. “Accurately determining the EIA will result in more effective planning, location, and design of stormwater control measures, better identification of stormwater runoff pollution sources, cost savings, and, perhaps, more public consent for projects due to decreasing project size.”

“This research provides regulated entities another tool that can more accurately estimate runoff and pollutant loading from urban watersheds in the absence of monitoring data,” says Scott Anderson, senior civil engineer of water resources with the City of Bloomington. “Ultimately, it offers the ability to more easily plan stormwater management best management practices in an efficient

and cost-effective way.”

The research team included Ali Ebrahimian of CEGE and Professor Bruce N. Wilson of the Department of Bioproducts and Biosystems Engineering. The project was funded by the Minnesota Local Road Research Board.

## Exhibitors sought for career expo

The 2016 Transportation Career Expo will be held February 16 from 4:30 to 7:15 p.m. in Coffman Memorial Union’s Great Hall on the Minneapolis campus.

The expo allows companies and agencies to network with students and recent graduates and tell them about their organizations and job opportunities. It also offers an opportunity for professional organizations to reach out to students as potential members.

If your organization would like to exhibit at the expo, please register by January 15 at [cts.umn.edu/events/careerexpo](https://cts.umn.edu/events/careerexpo). For more information, contact Kylie Bivins at [bivins@umn.edu](mailto:bivins@umn.edu) or 612-625-5608.



# High school girls explore transportation at the U of M

In October, CTS hosted seven girls from Blaine High School on a University of Minnesota campus visit designed to spark their interest in transportation. The visit was organized by TransportationYOU, a mentoring program of the Women's Transportation Seminar (WTS) that encourages girls ages 13–18 to pursue transportation careers.

During their half-day visit, the students explored campus through a scavenger hunt, rode the Green Line, got behind the wheel of the HumanFIRST Laboratory's driving simulator, saw a demonstration of the Nice Ride bike-sharing system, and toured the Civil Engineering Building. All activities were led by transportation faculty, researchers, and practicing professionals.

At the end of their visit, students shared lunch with a current undergraduate engineering student who



talked with them about her experiences at the U of M. Volunteer mentors from WTS also participated in the day's activities and shared their own college and work experiences.

The students agreed that they enjoyed seeing a college campus firsthand and that the information they gained will be valuable as they prepare for college and their future careers.

## *Pedestrians from page 1*

In previous work, Liao developed the Mobile Accessible Pedestrian System (MAPS), which uses smartphone technology to provide location and signal timing information to visually impaired pedestrians. In a subsequent project, Liao expanded the system to provide alerts and routing instructions for navigating work zones.

Liao collaborated with Vision Loss Resources (VLR) throughout the development of his system. Kate Grathwol, VLR president and CEO, explains that the agency teaches blind and visually impaired Minnesotans how to cross streets, where to catch light rail, and how to use the bus—skills that give them independence—“but then the world changes, and there's road construction, or a sidewalk closed,” she says. Since visually impaired pedestrians are unable to read signs, they may need to ask for help.

“That's not a bad thing, but nobody else has to—they can see. The real impact of this app is that it allows the same access for the blind and visually

impaired that sighted people have,” Grathwol says.

Although MAPS received positive feedback from testers, Liao discovered the GPS technology underlying the system was not reliable enough.

“Because we provide information to the visually impaired, we cannot afford to provide wrong information [even] one time,” Liao says.

Liao's latest project, sponsored by the Roadway Safety Institute, aims to improve the app's accuracy and reliability by developing a “self-aware” infrastructure system—one that can monitor itself and ensure the information it's providing is up to date, even in a GPS-unfriendly environment.

Researchers began with commercial Bluetooth low-energy (BLE) beacons, such as the kind that can be used to locate a misplaced purse or keychain. Since these BLE beacons are primarily designed to be detected and not communicate with each other, the researchers are integrating them with the necessary interface elements to

sense other BLE devices within their range, Liao says.

The BLE beacons can be placed on traffic barrels, barricades, signs in work zones, or at decision locations—such as store entrances—in indoor environments. Then, using a positioning and mapping algorithm, the system can estimate a user's location based on nearby Bluetooth signals, share information among nearby devices, and inform the system administrator if any information has changed. The system can also detect when any of its beacons are not functioning—due to a loss of power or vandalism, for example.

Work on this project is currently under way. In the project's final phase, researchers will integrate the Bluetooth system with the smartphone app and then conduct real-world tests of the new technology.



# National Transit Map helps users examine geographic patterns and disparities

A new data system is available from the Global Transit Innovations (GTI) program.

The National Transit Map – United States describes the availability and performance of transit services in each of the 497 U.S. Census-defined urbanized areas (UZAs) using 2013 data from the U.S. National Transit Database (NTD). Three types of transit availability and performance indicators are included:

- Presence of various transit modes in each UZA
- Level of transit facilities in each UZA (both in total and by mode), including number of transit vehicles operated at maximum service, number of transit stations, and transitway mileage
- Annual performance of transit services in each UZA (both in total and by mode), including annual fare revenue earned, annual vehicle revenue miles, and annual unlinked passenger trips

The map makes NTD data more accessible to researcher communities and the public. People interested in knowing mode-specific transit service availability and performance can explore the map in various ways to examine geographic patterns.

“Spatial visualization of transit service measures helps people understand geographic disparities in transit services across the country,” says Yingling Fan, GTI director and the developer of the map.

For example, users can see the positive relationship between UZA population size and the presence of rail transit services—and the cities that are exceptions to this general rule. Tampa and Salt Lake City are two extreme

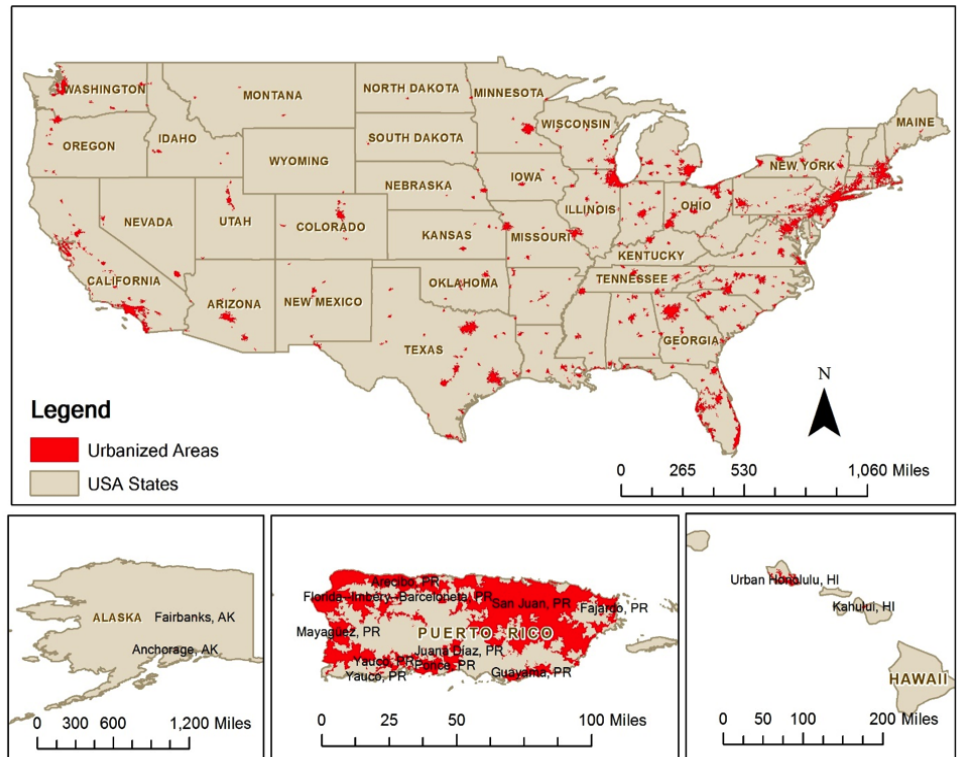
cases: Tampa has a large population size yet relatively small percentage of rail services; Salt Lake City has a moderate population size yet relatively large percentage of rail services. “This type of data and visualization may stimulate interest in identifying underlying factors at the UZA level that influence transit service availability and performance,” Fan says.

To create the map, Fan developed a methodology to aggregate agency-level service data to the UZA level. “This project developed procedures to avoid double counting and deliver information at the UZA level, which is more useful for

many urban-planning-related analyses,” Fan says. The compiled data were further visualized by a team of GIS professionals from U-Spatial, a collaborative consortium at the U of M.

In the next phase of her work, Fan is applying the methodology to develop a national transit map for China.

The U.S. map, compiled dataset, and methodology report are posted on the GTI website: [gti.umn.edu](http://gti.umn.edu).



Urbanized areas included in the National Transit Map – United States



## University of Minnesota reception at TRB

The University of Minnesota is hosting a reception for friends and alumni during the Transportation Research Board 95th Annual Meeting in Washington, DC. The reception will be held at the Anthem Restaurant in the Marriott Marquis on Sunday, January 10, 2016, from 5:30 to 7:00 p.m.

Details are available at [cts.umn.edu/Events/TRBReception](http://cts.umn.edu/Events/TRBReception).



**GTI from page 1**

next generation of transit leaders and practitioners. GTI was established by CTS in partnership with Yingling Fan, a McKnight Land-Grant Professor at the Humphrey School of Public Affairs, who will serve as GTI director.

“GTI is dedicated to meeting society’s persistent and complex challenges, including auto dependence, energy shortages, the environment, income inequality, and growing disparities in health and well-being,” Fan says.

GTI builds on the Transitway Impacts Research Program (TIRP), which includes a mix of state, regional, and local jurisdictional partners. Since 2006, studies funded under TIRP have explored the complex impacts of transit on land use, property values, job accessibility, public health, and social equity. “The goal of GTI is to expand this research capacity and expertise and take it to a global level,” says Laurie McGinnis, CTS director.

The educational component of GTI aims to attract bright minds to the transit-planning field. The program will foster a global student experience through an international exchange, initially with university students in the U.S. and China. The program will also offer training to educate practitioners and agency staff to implement research findings and recommendations.

“GTI is built on the collective strength of individual relationships and the groundwork laid by prior research collaboration,” Fan says. The first international collaboration among GTI researchers was in 2009, enabled by support from the Peking University-Lincoln Institute Center in Peking, China, and CTS. Currently, GTI has faculty contributors from five different countries: Canada, New Zealand, the United Kingdom, China, and the United States.



Photo: Metro Transit

*GTI’s mission is to inspire change in transit planning through research and education.*

Fan notes that GTI defines public transit broadly as any shared passenger transport services that are available for use by the general public. By this definition, transit modes include not only the traditional ones such as buses (city buses, bus rapid transit, commuter buses, etc.), trains (light rail, commuter rail, heavy rail, monorail, streetcar, high-speed rail, etc.), and ferries, but also contemporary Dial-a-Ride, car sharing, and bicycle sharing services.

The GTI website includes ongoing and completed research, publications (working papers, journal articles, research reports, summaries, and briefs), and profiles of current GTI researchers. A new product from Fan is an interactive National Transit Map (see article on page 6).

To learn more about GTI and its activities or to become a partner and participate, please see [gti.umn.edu](http://gti.umn.edu).

You may also sign up to receive periodic updates from GTI.



## READ CATALYST ONLINE

for links to research reports and other resources.

## EVENTS CALENDAR

[cts.umn.edu/Events](http://cts.umn.edu/Events)

## SUBSCRIBE

to e-mail announcements of upcoming events:  
[cts.umn.edu/Publications/Subscribe](http://cts.umn.edu/Publications/Subscribe)



♻️ Recycled paper with 30% postconsumer waste • The University of Minnesota is an equal opportunity educator and employer. This publication is available in alternative formats upon request.



# Catalyst

Center for Transportation Studies  
University of Minnesota  
200 Transportation & Safety Building  
511 Washington Ave S.E.  
Minneapolis, MN 55455

First Class Mail  
U.S. Postage  
PAID  
Twin Cities, MN  
Permit No. 90155



# Catalyst

A publication of the Center for Transportation Studies  
University of Minnesota

**DECEMBER 2015**

A new self-aware system helps  
**VISUALLY IMPAIRED  
PEDESTRIANS**  
find their way.  
page 1

How will  
**ROBOTS AND HUMANS  
INTERACT**  
in our future transportation system?  
page 2

**A NEW MODEL**  
could help design more  
**SUSTAINABLE URBAN  
STORMWATER**  
infrastructure.  
page 4



**Global Transit Innovations** program  
discovers solutions, inspires change.

page 1