

CTS Catalyst

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Accelerating the pace of transportation innovation

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Photo: David Gonzalez, MnDOT

'Smart bridge' technology helps monitor I-35W bridge behavior

Since the completion of the I-35W St. Anthony Falls Bridge in September 2008, University of Minnesota researchers have been using "smart bridge" technology to collect and analyze data about the bridge's structural behavior in a project funded by the Minnesota Department of Transportation (MnDOT).

During its construction, the bridge was instrumented with more than 500 sensors that monitor strain, load distribution, vibrations, temperature, potential for corrosion, and the overall movement of the bridge. Other sensors were installed to monitor the bridge's security and control

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Bicycle, pedestrian traffic counts support better decision making

Research on bicycle and pedestrian traffic in the City of Minneapolis is helping policymakers and planners make better decisions about when and where to invest in nonmotorized transportation infrastructure.

Led by Greg Lindsey, a professor at the Humphrey School of Public Affairs, a team of researchers used infrared counters to collect data on the use of Minneapolis trails by cyclists and pedestrians. The team also analyzed field traffic counts taken by the Minneapolis Department of

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'Friend' a package, save the planet?

What if your cell phone and social network could help deliver packages for you? This may be more likely, easier, and more beneficial to the environment than you think, researchers at the University of Minnesota's Institute on the Environment (IonE) and Seoul National University report in *Environmental Science & Technology*.

The study, funded by CTS, used spatial and agent-based models to investigate the potential environmental benefits of enlisting social networks to help deliver packages. While sensitive to how often trusted and willing friends can be found close to both the package and the recipient within a day, results

indicate that very small degrees of network engagement can lead to very large efficiency gains.

Online shopping may be economical and convenient from the shopper's standpoint, but it can carry a hefty environmental price. Particularly, the "last mile" of local delivery is the retail system's largest contributor to fossil fuel consumption, CO₂, and local air emissions. Replacing traditional home truck delivery with pickup locations can help in some instances. But in the suburbs, such systems can actually increase overall travel distances and emissions as personal vehicles detour from their normal daily activity to make



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CTS Scholar gains international insights on sustainability

Sharing knowledge across nations is becoming more and more important for solving today's pressing concerns, such as sustainable mobility and energy. In one such international exchange, CTS Scholar Carissa Schively Slotterback, associate professor and director of the Urban and Regional Planning Program in the Humphrey School of Public Affairs, was invited to Austria in April.

Her trip was part of the George C. Marshall Visit to Austria Program. Established in 1961, the program brings to Austria every year a group of 10 mid-career decision makers from government, academia, and industry associations to learn about Austrian innovations in industry and technology. The program is coordinated and administered by the Austrian Federal Ministry for European and International Affairs. This year's program focused on a broad range of sustainability and "smart cities" topics, including transportation, energy, water, and housing.

In June, Schively Slotterback gave a presentation to the U's Center for Austrian Studies comparing the U.S. and Austrian approaches to sustainability. She shares a few insights below:

A longer view

"Austrians take a long-term approach to decision making, grounded in their much longer history," she says. "For example, Vienna has a long-range plan that calls for 50 percent protected green space to limit sprawl. There is also a public belief in climate change."

Resource constraints

"Austrians acknowledge resource constraints and are taking action to reduce energy consumption through a variety of means," she says. "One example is Kabelwerks, a large-scale redevelopment project on the 20-acre site of a former factory. It has 3,000 residents, a mix of unit sizes and prices, direct transit access, and recreation and bike facilities."

Public utilities and infrastructure

"Government owns key systems, giving them the ability to lead innovation rather than negotiate it, and resources are focused on public priorities," she says. "There is an extensive transit system with intercity rail, subways, streetcars, and buses—and the system is a revenue generator."

Innovation and investments

"There is a focus on innovation at all levels of government—by the European Union, Austria, states, and cities," she says. "Austria's policies are in line with EU policy and incentives, in particular, the EU's Low-Carbon Energy Road Map 2050."

Implications for Minnesota

"I'd say there are two key takeaways: the benefits of long-term thinking, and the benefits of connecting and focusing across urban systems—transportation, land use, housing, and energy."

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How do residents and businesses perceive neighborhood changes caused by transitways?

When a transit investment such as a light-rail transit (LRT) line begins service, surrounding neighborhoods often see significant gains in mobility and accessibility. New lines often lead to a physical upgrade of the neighborhood as well. Other effects, however, may be less desirable, such as neighborhood transformation, demographic changes, housing conversions, and shifts in a neighborhood's social prestige.

Researchers have measured these neighborhood changes using objective data, but few have examined neighborhood residents' self-reported perceptions of this change. To fill this knowledge gap and provide data for policymakers, University of Minnesota researchers surveyed residents and businesses along four Twin Cities transitway corridors.

"Overall, the perception of transitways' impacts on neighborhoods is positive, but there are specific groups that have largely negative perceptions of transit-induced change," says Yingling Fan, an assistant professor in the Humphrey School of Public Affairs and the study's principal investigator. Her co-author was research fellow Andrew Guthrie.

In their work, the researchers randomly surveyed 750 households in 16 neighborhoods along two existing transitways (the Hiawatha LRT line and Northstar commuter rail line) and two planned transitways (Cedar Avenue bus rapid transit and Central Corridor LRT). In addition, researchers surveyed 160 businesses along the same corridors.

Here are highlights of what they found:

- The majority of residents and businesses in transitway corridors have a positive view of transit-induced neighborhood change.
- The *extent* of positive neighborhood change that residents and businesses anticipate in the next five years varies widely from corridor to corridor.



Photo: Metro Transit

- People with any experience using light-rail transit, frequent transit users, and transit-dependent riders all have overwhelmingly positive attitudes regarding transit-induced neighborhood change.
- Racial differences in perceptions of transit-induced neighborhood change do exist, with specific groups on certain corridors having markedly more negative or positive views than others.

The researchers also recommend five key strategies that may help address negative perceptions and possible negative impacts of transit-induced neighborhood change:

- Conduct community-sensitive planning, recognizing that local communities can be defined in multiple ways—such as geography, cultural identity, and time in neighborhood.
- Address misperceptions about crime, automotive access, and pedestrian safety.
- Engage the neutrals (those with neither positive or negative views) to increase buy-in.
- Play to the strengths (those who have positive views) to build grass-roots support.

- Target current transit users for outreach efforts in the planning process for future transitways. The research was funded by the Transitway Impacts Research Program (TIRP), which was launched in 2006 by the Hennepin County-University of Minnesota partnership and has grown to include a mix of funding partners and program supporters.

"Yingling Fan's work is encouraging because it shows us that the public perceives the project positively and looks forward to the benefits of transitway projects," says Robin Cauffman, assistant director for administration, communications and outreach with Metro Transit. "The results also reinforce the lessons we've learned about public engagement."

The full report and a condensed summary of the research are on the TIRP website.

Overall, the perception of transitways' impacts on neighborhoods is positive, but specific groups on certain corridors have more negative or positive views than others.

Benefits of SMART Signal system showcased in new video

A new video from the Intelligent Transportation Systems (ITS) Institute highlights how a system developed at the U of M is reducing congestion on roads controlled by traffic lights.

The SMART Signal (Systematic Monitoring of Arterial Road Traffic Signals) system automatically collects and processes data from traffic signal controllers at multiple intersections. It then creates performance measures, including information on the times and locations congestion occurs on a given roadway.

Traffic engineers can use these measures to determine whether signals are properly timed and to monitor the overall performance of the system.

Civil engineering associate professor Henry Liu led the research team that developed SMART Signal, which has been deployed at more than 30 intersections in Minnesota and six intersections in Pasadena, California.

According to Steven Misgen, metro traffic engineer at the Minnesota Department of Transportation (MnDOT), the system also has benefits for the traveling public. These include reduced congestion and improved

travel time throughout a given corridor.

"As a result, they'll have a better quality of life, [spending] less time sitting in congested intersections," Misgen says.

In 2011, the University of Minnesota's Office of Technology Commercialization signed a licensing agreement with startup company SMART Signal Technologies Inc. to commercialize the system.

Funding and in-kind support for the SMART Signal system have been provided by MnDOT, the ITS Institute, the Minnesota Local Road Research Board, Hennepin County, and the National Cooperative Highway Research Program.

The video is available on the ITS Institute website.



SMART Signal is deployed at

30+

INTERSECTIONS IN MINNESOTA

U of M launches record number of startups

Discoveries by University of Minnesota researchers were used to launch a record 12 startup companies in fiscal 2012. Two of the 12 startups were transportation-related: SMART Signal (see related article above) and Drive Power LLC.

Drive Power makes web- and smartphone-based products that leverage emerging measurement technologies and predictive analytics to help people make more informed driving decisions. For example, a mobile app—DriveScribe—blocks calls, e-mails, and text messages while the vehicle is in operation and provides real-time coaching to novice drivers.

The app was developed by U of M mechanical engineering department researchers led by Alec Gorjestani, who also serves as Drive Power's vice president for technology. The research behind DriveScribe was funded by the Minnesota Department of Transportation and the ITS Institute (a part of CTS).

"The diverse range of disciplines represented in these 12 startup companies demonstrates what a valuable resource the University of Minnesota is to businesses in this state, and beyond," says U of M president Eric Kaler.

Since 2006, 38 startup companies have been launched by the University.

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the pickup—unless recipients can find a few good friends to help.

Compared to a typical home delivery route, greenhouse gas emissions reductions from a socially networked pickup system were projected to range from 45 percent to 98 percent, depending on the social connectedness of the recipients and the willingness of individuals in their social networks to participate. Systemwide benefits could be significantly lower under assumptions of less than 100 percent market adoption, however. In fact, the study points out that many of the gains might be nullified in the short term as fewer home truck deliveries make existing delivery systems less efficient.

"What is important is that sharing be allowed in the system, not how many ultimately chose to share time or resources," says study co-author Timothy Smith, director of IonE's NorthStar Initiative for Sustainable Enterprise. "We find that providing the relatively few really inefficient actors in the network the opportunity to seek the help of many better-positioned actors can radically improve performance." This is particularly relevant today, Smith says, as online retailers such as Amazon begin introducing delivery pickup lockers in grocery, convenience, and drug stores.

"The ability of information technologies to find and put to work disparate and once unconnected resources holds huge promise for the next generation of productivity improvement," Smith adds.

To obtain a copy of the *ES&T* article, contact Smith at timsmith@umn.edu.



Each day more than

5 MILLION
PACKAGES ARE DELIVERED

to U.S. locations by FedEx, UPS, and the Postal Service.

Innovations in road safety are focus of forum with national leaders

Technology and policy innovations have helped to reduce traffic fatalities in recent years, but even more can be done. On August 23, national and state leaders gathered at a forum in Minneapolis to discuss innovations in road safety, including research at the University of Minnesota.

"Safety is the number one priority of the USDOT," said Victor Mendez, administrator of the Federal Highway Administration. Mendez praised Minnesota's "outstanding" safety record, noting that the state's fatalities have fallen at a rate twice of the national average. He attributed this in part to the collaborative efforts of Minnesota's Toward Zero Deaths (TZD) program as well as work by the University of Minnesota "to bring new thinking to old problems." Despite these trends, Mendez warned against complacency. "America is safer today," he said. "Research in Minnesota will make us safer."

U.S. Senator Amy Klobuchar echoed Mendez. "Too many people are dying on our roadways," she said. "We need to do everything we can to improve safety."

Tom Sorel, commissioner of the Minnesota Department of Transportation (MnDOT), reported that momentum is

Almost
33,000
PEOPLE
perished on the nation's roadways in 2010.

building around the country and the world to reduce serious injuries and fatalities. The national TZD program is modeled after Minnesota's, and about 30 states have similar programs, he added.

The forum also included presentations of U of M research. Max Donath, director of the Intelligent Transportation Systems Institute, focused his remarks on technologies to improve the performance of teen drivers, who are overrepresented in fatal crashes. Tom Horan, research director with the Center for Excellence in Rural Safety (CERS), gave an overview of CrashHelp, a smartphone-based system that allows emergency responders to collect multimedia data about crash victims on-scene and send it directly into emergency rooms.

The forum was hosted by former Congressman James L. Oberstar and sponsored by CERS, CTS, and MnDOT.



FHWA administrator Victor Mendez (left) learned about research at the U's HumanFIRST lab from lab director Mike Manser during Mendez's visit to Minnesota.

DON'T FORGET TO REGISTER:

CTS FALL LUNCHEON

November 28 | Minneapolis

"Impact 2020: Predictions for the Transportation Industry"
Futurist Frank A. Stasiowski, president and founder of PSMJ Resources, will describe trends that could define the next decade and have a direct impact on transportation. He will also address what research and actions are needed now to prepare for this future. The luncheon will culminate the celebration of CTS's 25th anniversary. Details and registration are on the CTS website.



Freight and Logistics Symposium: The New American Energy Revolution

December 7 | Minneapolis
Energy sources and needs are changing our world at breakneck speed. In the Upper Midwest, for example, fracking, ethanol, and wind turbines have moved in practically overnight, bringing with them big money, heavy equipment, and seismic shifts to the social and economic landscape—as well as big impacts to our roads. Ready or not, the new American energy revolution has begun.

At this year's Freight and Logistics Symposium, representatives from the business community, academia, and the public sector will look at major trends and the effects of our changing energy supply on freight and logistics providers. More information and registration are on the CTS website.

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automatic anti-icing and lighting systems.

A research team led by civil engineering professors Cathy French and Carol Shield and graduate student Brock Hedegaard has been interpreting data gathered by these sensors during the bridge's first four years of operation.

The team has used the data to investigate changes in behavior caused by vehicle and environmental loading, evaluate load-rating assumptions, and determine the effectiveness of the "smart bridge" monitoring technology. The information could potentially impact future bridge designs and long-term monitoring plans.

To help them interpret the sensor data, the researchers developed a series of two- and three-dimensional finite element models. To validate the models, team used data collected from static and dynamic truck tests—involving eight loaded sand trucks in various configurations—that were conducted after the construction of the bridge and repeated two years later. These truck tests also provided data that can be used as a benchmark over the bridge's lifetime to detect changes in behavior.

Overall results of the project indicate that the bridge is performing well and is meeting its design expectations. Other significant findings indicate that environmental factors—such as seasonal and even daily temperature variations—have a more substantial effect on bridge behavior than previously thought.

"The data that's been collected since the bridge was built is important because it's helping us understand how this type of structure behaves in this environment and under traffic loads," says Nancy Daubenberger, state bridge engineer at MnDOT.

In addition, project results have helped MnDOT obtain a more complete, correct, and informative manual for rating the new bridge.



The study also examined the strengths and weaknesses of the instrumentation systems used to monitor the bridge, including various strain gauges, thermistors, accelerometers, linear potentiometers, and sensors monitoring electrochemical activity.

The team found that most of the instrumentation has performed well and would be valuable in future "smart bridge" installations. Recommendations include adding more thermistors in future monitoring efforts to collect more information about temperature variations in the cross section of the bridge.

Currently, the research team is using the initial data to estimate the time-dependent deformations of the structure expected over its design life.

"We look forward to continuing our work with the U of M research team over the next few years on various methods of structural health monitoring," Daubenberger says.

The I-35W St. Anthony Falls Bridge has
10 LANES,
COST \$234 MILLION TO BUILD, AND
HAS A
100-YEAR
LIFE SPAN.

NEW RESEARCH REPORTS

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

**ESTIMATION OF ARTERIAL
TRAVEL TIME AND DELAY**
(CTS 12-20)

**POTENTIAL FREIGHT
INDUSTRY BENEFITS OF
MILEAGE-BASED USER
FEES**
(MnDOT 2012-19)

**INTELLIGENT PAVEMENT
FOR TRAFFIC FLOW
DETECTION**
(CTS 12-29)

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

Counts from page 1

Public Works and Bike Walk Twin Cities and used the counts to develop models for estimating nonmotorized traffic on Minneapolis streets, sidewalks, and trails. The project was funded by the Intelligent Transportation Systems Institute.

Results indicate that bicycle and pedestrian traffic volumes follow distinct patterns that vary by location, infrastructure type, time of day, day of the week, and season. The team also found that bicycle traffic is significantly affected by land-use mix, the presence of bicycle facilities, and socio-demographic factors like education level. Factors affecting pedestrian traffic include road classification and proximity to retail centers and bodies of water.

Using this information, the researchers developed models for estimating bicycle, pedestrian, and mixed-mode traffic. These models were then used to estimate and map nonmotorized traffic for all street segments in Minneapolis. The maps show higher levels of traffic on arterial and collector streets, in the downtown area, and near neighborhood shopping areas.

Ultimately, Lindsey says, these models will provide transportation planners with the tools to make more informed investment choices. The study's findings have already been used by the Volpe National Transportation Systems Center and Bike Walk Twin Cities in a report to Congress on the Nonmotorized Pilot Project Program.

The data and models are also being used in collaboration with the Minneapolis Parks and Recreation Board (MPRB). Initial data collected by the infrared counters found that three locations on MPRB trails around Lake Calhoun, Lake Nokomis, and Wirth Park have about two million users annually.

In an effort to expand this information into an estimate of total miles traveled by trail users, the researchers now plan to systematically sample each segment of paved trail maintained by the MPRB. The team will use these counts to update the estimation model and calculate total annual traffic for each segment as well as total trail user-miles traveled on all MPRB trails. The estimates—similar to calculations of vehicle-miles traveled on roadways—could be used to support planning, engineering, maintenance, and funding decisions.

"This could provide decision makers with a better understanding of the use of the entire system," Lindsey says. "It would be helpful for both management decisions and applications for financial support for trail development."



**BICYCLE TRAFFIC IS
INCREASING
4.6 PERCENT**
per year in Minneapolis, according
to the study's model.



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Research on
**BICYCLE AND PEDESTRIAN
TRAFFIC**
in Minneapolis is improving planning and
investment decisions.
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A study investigated the potential
**ENVIRONMENTAL
BENEFITS**
of enlisting
**SOCIAL NETWORKS TO HELP
DELIVER PACKAGES.**
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Researchers examined what neighborhood
RESIDENTS AND BUSINESSES
think of the changes caused by
TRANSITWAYS.
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helps monitor I-35W bridge behavior

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