

CTS Catalyst

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Accelerating the pace of transportation innovation

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Demonstration project helps truck drivers find safe places to park

With increasing amounts of freight traffic on U.S. roadways, commercial truck drivers often struggle to find safe and legal places to park. If parking spaces are not available at a nearby rest area or truck stop, drivers may be forced to pull over in unsafe locations—such as on freeway ramps or shoulders—or become dangerously fatigued if they continue driving. Drivers may also risk violating federal hours-of-service rules, which require them to rest after 11 hours of driving.

In response to this issue, a team from the Minnesota Department of Transportation (MnDOT),

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New U of M program to explore transportation policy and economic competitiveness

There's no dispute that an adequate transportation system is necessary for economic development. What's unclear, however, is how transportation innovations in fields such as technology and finance can drive growth. Gaining a better understanding of such innovations and their impacts is the purpose of the new Transportation Policy and Economic Competitiveness (TPEC) Program at the University of Minnesota.

The five-year program, managed by the State and Local Policy Program (SLPP) at the Humphrey School of Public Affairs, will seek to further define and promote the relationship between

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'Smart window' technology opens new possibilities for transportation noise control

Nearly every time a highway or airport expansion is proposed, transportation planners are faced with opposition from residents who fear the increased noise levels in their homes and businesses. Traffic noise is often mitigated with physical noise barriers, but the large, thick walls often draw opposition as well.

Now, a new technology developed by University of Minnesota mechanical engineering professor Rajesh Rajamani as part of a research project funded by the National Science Foundation could soon provide a nearly invisible solution for transportation noise cancellation—and give transportation planners another tool for overcoming project opposition.

"For homes close to airports and highways, the primary way noise enters the home is through windows. A window can transmit ten times as much sound energy as a wall can," says Rajamani. "We realized that of all the possible ways to reduce transportation noise in the home, the best way to do it is by decreasing the amount of noise that is transmitted through the windows."

To accomplish this goal, researchers set out to create a better method of active noise control for windows. In the most basic sense, active noise control works by using speakers to generate a sound wave that is a mirror image of the undesirable sound wave. While it may seem counterintuitive, superimposing an "anti-noise" wave of the same amplitude as the undesirable noise wave results in a reduced decibel level



of noise in the environment.

In an earlier study, the research team designed extremely thin and nearly transparent speaker panels to fit in the empty space between the two panes of a double-pane window. In a second study, researchers tackled the problem of how to effectively use the new speaker to cancel out undesirable transportation noise from outside the home while preserving the desirable noise—such as music and conversation—from inside the home.

Using two small microphones positioned on either side of the window, researchers found they could identify both the undesirable external sound waves and the desirable internal sound waves. Next, they developed a mathematical algorithm that separates out the desirable from the undesirable sound waves based on the direction of travel. This information is then transmitted to the speaker panel within the window; the speakers use

this information to produce the proper sound wavelengths to cancel out much of the external noise while preserving the desired sound.

"Using this new method of active noise control with wave separation, we found that we can effectively reduce external noise while better preserving internal sound," says Rajamani.

In addition to mitigating traffic noise, this new technology offers other surprising benefits. Researchers have found that the "smart window" speakers can actually be used as home audio speakers without losing any of their noise-control benefits. For example, homeowners can listen to their favorite CD through the smart window speakers while also experiencing reduced highway noise inside their home.

Finally, researchers discovered that the small nanotube films they designed to power the smart windows may also be able to help power hybrid electric vehicles in the future.

How affordable is transportation? U of M research provides framework to find the answer

Transportation affordability varies widely among population groups in the United States. Traditional measurement methods, however, fail to consider the differences in household transportation needs or the impact of specific locations and public policies.

In CTS-funded research, Yingling Fan, an assistant professor in the University's Humphrey School of Public Affairs, and graduate student Arthur Huang developed a more refined framework for measuring transportation affordability. "This new framework provides a foundation for policymaking by asking how affordable transportation options are, for whom, and in what settings," Fan says.

Fan was invited to share her expertise at the National Conference of State Legislatures in Washington, D.C., on December 3. She shares some highlights below.

How does your framework differ from traditional measurements?

Our framework adds three categories to reflect specific locations and population groups:

- *Household socio-demographics* considers the differences in households' transportation needs, time availabilities, and resources. For example, a single mother has very different needs in terms of travel time, destination, and mode than an unmarried man who lives alone.
- The *policy environment* considers variations such as transit fare policy, the availability of publicly funded subsidy programs, and land-use and housing policies.
- The *built environment* measures accessibility to desired services by different modes of transportation. This determines how far people travel to carry out activities; more compact areas mean shorter trips.

How does your framework account for time?

Time is an especially important consideration. Disadvantaged households may be forced to choose slower, lower-quality transportation services—and thus appear to need less even though they want more. Walking, for example, costs almost nothing in monetary terms yet has a high price in time. The framework defines transportation affordability as a household's capacity to pay transportation costs—including both monetary and time-based costs—without incurring financial difficulties and time pressures.

Why is transportation affordability an important issue?

About 17 percent of low-income households have no private vehicles. In our auto-dominated society, this means that these households have a limited capability to reach destinations and opportunities. As a result, their incomes and quality of life suffer. For example, owning an automobile is associated with a higher probability of employment, longer working hours per week, and stronger social ties.

What do you see as implications of the research?

Interestingly, we found a sort of Catch-22. Low-income households have the fewest resources, yet in the existing urban landscape, their transportation needs are better served by the automobile—the most expensive mode. At the same time, our research shows that excessive automobile use could lead to a built environment requiring more travel to reach destinations—which means higher transportation costs.

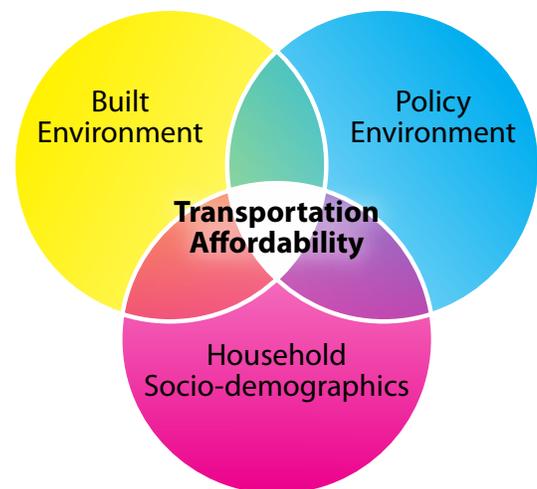
What are your recommendations for policymakers?

In the long term, transportation policies need to promote changes in the built environment to reduce auto dominance. Moving to a more compact, mixed-use urban form can reduce reliance on automobiles and the amount of travel required for daily activities.

In the short term, policies for promoting auto access among the socioeconomically disadvantaged should be considered. Even occasional access could make a big difference in meeting their travel demands. Examples include financial subsidies for car ownership and cooperative car-sharing programs.

What caught the attention of the legislators in D.C.?

Legislators wanted to learn more about what they can do. Ideas discussed included interagency partnerships at the state level and public-private partnerships. Scott Dibble from our state senate also noted that transportation affordability isn't just a metro or urban issue—diverse population groups are choosing to live in outstate and rural places, too.



About
17 PERCENT
of low-income households
HAVE NO PRIVATE VEHICLES.

Capacity issues among challenges facing the freight industry

Capacity—too much of it, or too little—is a top concern in the freight industry, according to speakers at the 17th Annual Freight and Logistics Symposium in December.

In the keynote presentation, Rosalyn Wilson, senior business analyst with Delcan Corporation, said both ocean and air cargo have too much capacity. Throughout the recent recession, ocean carriers continued to order and float new megaships, creating problems with overcapacity and low pricing, thus raising solvency concerns and uncertainty for shippers.

On the air cargo side, overcapacity is due in part from airline passengers choosing to carry on their luggage rather than pay to have it checked. As a result, the cargo holds of passenger planes have extra space for premium air cargo—which is estimated to have about a 65 percent profit margin for passenger airlines, she noted.

On the flip side, trucking, which is the largest component of the supply chain industry, has operated at 95 to 97 percent capacity for the past three years. Wilson believes this capacity crunch will create major problems for the industry by 2016 and 2017.

If and when this lack of truck capacity reaches crisis levels, intermodal rail likely stands to benefit most, Wilson predicted. Throughout the recession, railroads continued to invest in their infrastructure and equipment and are now perfectly positioned to fill any gaps in trucking capacity, she said.

Other speakers also noted capacity issues—whether a shortage of drivers or an abundance of data. Chip Smith, CEO of Bay and Bay Transportation, said a major issue is the ability to find and keep enough qualified drivers. Some of the shortage stems from changes in federal hours-of-service rules, which limit the average work week for truck drivers to 70 hours.

Jason Craig, government affairs manager with C.H. Robinson, said a particular challenge his firm faces is what to do with the massive amount of data available in the supply chain—and how to get more out of it. Cargill's Randy Brown, vice president of transportation and logistics, said Cargill is rolling out an improved global analytics capability to make use of its data. "We've ... woken up to the fact that data drives our decision making, and that the ability to analyze all of the available information to make decisions requires a deeper level of analytics."



Trucking has operated at
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PERCENT CAPACITY
for the past three years.

Other symposium topics included a U of M study of manufacturers' perceptions of the transportation system (see article in the December 2013 *Catalyst*), the growth of third-party logistics providers, and the need for public awareness and support of freight's role in economic growth.

Summaries of the presentations are in the symposium proceedings, online at cts.umn.edu/Events/Freight.

The symposium is sponsored by CTS in cooperation with the Minnesota Department of Transportation, Minnesota Freight Advisory Committee, Council of Supply Chain Management Professionals Twin Cities Roundtable, Metropolitan Council, and the Transportation Club.

CTS seeks research director

CTS has an opening for a director of coordinated research. This position will direct the Center's coordinated research program, lead the design and delivery of sponsored programs and projects, and build partnerships between sponsors and University faculty and staff. Details and application information are at cts.umn.edu/About/Jobs.

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transportation and economic development in Minnesota and the region. The program was established in response to a directive from the Minnesota Legislature in its 2013 session; the Minnesota Department of Transportation (MnDOT) is providing funding.

“Minnesota needs this research to better understand how transportation contributes to economic competitiveness,” says Rep. Frank Hornstein, chair of the Minnesota House Transportation Finance Committee. “We look forward to this research helping us make the best transportation decisions for the state.”

Rigorous academic research will form the backbone of the program, says Lee Munnich, director of SLPP and TPEC. Research will address three main areas:

- **Innovative transportation finance options.** Various initiatives, including the Itasca Project’s Transportation Return on Investment Study and Governor Dayton’s recent Transportation Finance Advisory Committee, have noted that current revenues will not be adequate to maximize transportation’s benefits to Minnesota’s economy. Research in this area will focus on identifying and developing sustainable revenue streams to meet capital and maintenance costs. Topics will include mileage-based user fees, public-private partnerships, MnPASS corridors, and value capture.
- **Industry clusters.** Industry clusters are geographically concentrated groups of interconnected companies, universities, and related institutions. Dynamic and innovative industry clusters are critical for the success of a regional economy, but exactly how freight transportation ensures the success of these clusters and enhances the competitiveness of the region is

not well understood. This research will aim to improve knowledge of those industries.

- **Transportation technologies.** Information technology is dramatically changing the management and operation of transportation systems. Research will investigate the impacts of and opportunities from intelligent transportation systems, robotics, self-driving cars, energy technologies, safety technologies, congestion management systems, and intermodal applications.

Research results are intended to help MnDOT and its partners engage stakeholders, analyze investments, and approach programming. “Ultimately, everyone in Minnesota should benefit from an efficient and productive transportation system that builds rather than constrains the economic vitality of the state and the Upper Midwest,” says Sen. Scott Dibble, chair of the Minnesota Senate Transportation Committee.

In addition to research, the program will undertake other activities producing more rapid results. One task will be compiling data for a Minnesota Transportation Finance Database and updating it each year. Another product will be a white paper about the potential impacts of self-driving vehicle technologies on Minnesota’s economy. “These technologies will likely be available in the marketplace within the next 10 years, if not sooner,” Munnich says. “The implications will reach far and wide.”

The program will also provide opportunities for students to learn and gain experience. In addition, it will disseminate research results and engage practitioners, other researchers, and the public.

Read more about the Transportation Policy and Economic Competitiveness program at tpec.umn.edu.



Video answers common questions about Minnesota's gravel roads

Gravel roads are a critical part of our transportation infrastructure—there are 66,000 miles of them in Minnesota alone. Businesses and industries depend on them, as do the people who travel and live along them. Sometimes, these users have questions: Why is a road gravel instead of paved? Why do conditions vary from one gravel road to another?

To address such common questions and concerns about gravel roads, CTS has produced a five-minute informational video for the Minnesota Local Road Research Board (LRRB). The video is intended to provide a useful tool for county engineers and township supervisors to educate the public about gravel road maintenance.

“The idea for this video came from the county engineers in the western side of the state at an LRRB focus group,” says Julie Skallman, State Aid engineer with the Minnesota Department of Transportation (MnDOT). “They were frequently asked to explain why some of their gravel roads were rough and how they maintain them. The thought was [that] a short video posted on their websites might answer some of the questions from the public or serve as a good reminder later on.”

The video describes the basic materials and construction of a gravel road, common problems with gravel roads, and what's involved in keeping a gravel road in the best condition. In addition, the video provides tips for gravel road users to prevent damage to the road.

A panel of technical advisors provided guidance about the content of the video during its production. The panel included representatives from three Minnesota counties, MnDOT, and the Minnesota Local Technical Assistance Program (LTAP).

The video, on YouTube and lrrb.org, is one in a series the LRRB has developed for social media distribution as a venue to educate Minnesota residents and practitioners about various topics. According to Farideh Amiri, research program engineer with MnDOT Research Services, the objective for creating the brief videos is to provide a compelling communication and educational tool that can reach many people quickly and easily. In addition, the videos help local agency staff address requests they receive from the public. “It will address the LRRB’s goal of equipping local agencies with efficient and clear educational tools in order to decrease the time demands on local engineering and administrative staff and costs,” she says. “It’s another tool in the toolbox.”



Tips to prevent damage to a gravel road

- Double road life: Stay in your lane.
- Prevent loose gravel and dust: Travel at appropriate speed.
- Prevent washboarding: Avoid abrupt starting and stopping.
- Prevent potholes and ruts: Observe vehicle size and weight limits.

MINNESOTANS LEAVE THEIR MARK AT NATIONAL CONFERENCE

At the Transportation Research Board annual conference in Washington, D.C., on January 12–15,

U OF M RESEARCHERS PRESENTED 45 PAPERS AND POSTERS

on topics ranging from congestion pricing to concrete pavement, and

12 STUDENTS ATTENDED

through funding from CTS.

Truck Parking from page 1

University of Minnesota, and American Transportation Research Institute (ATRI) is developing a system that can identify available truck parking spaces and communicate the information to drivers—helping them determine when and where to stop.

“The potential to improve safety by reducing driver fatigue and improving a driver’s ability to park safely is one of the system’s greatest benefits,” says John Tompkins, MnDOT’s freight project manager and one of the project’s leaders. In addition, the system could lead to better trip and operations management by drivers and carriers and help MnDOT and truck stop owners manage their facilities more effectively.

The system uses a network of digital cameras suspended above a parking area to monitor space availability. Image processing software developed by researchers at the U of M’s computer science and engineering (CS&E) department analyzes the video frames and determines the number of occupied spaces. This information can then be used to let drivers know how many parking spots are still available.

As part of a demonstration project

funded by MnDOT and the Federal Highway Administration, the project team is installing the system at three MnDOT rest areas and one private truck stop on Interstate 94 (I-94) west and northwest of the Twin Cities. The I-94 corridor—critical to the movement of goods in Minnesota and an important connection between trade centers on the West Coast and in the Midwest—experiences a large volume of truck traffic.

The Elm Creek Rest Area, two miles north of Interstate 494 on I-94, was the first implementation site for the system. The U of M research team, led by CS&E professor Nikolaos Papanikolopoulos, installed the system at the rest area in late 2012. The team then used this installation to calibrate, test, and refine the system—with positive results. According to CS&E information technology manager Ted Morris, counts have been consistently accurate to within plus or minus one parking space.

Since the initial installation, the system has also been deployed at the Big Spunk Lake Rest Area between Albany and Avon, Minnesota. An installation at the Enfield Rest Area near St. Cloud is currently in progress, and

planning is under way for the final site, a private truck stop.

Next steps for the project include implementing several mechanisms that will communicate parking information to truck drivers. First, the team plans to install variable message signs along I-94 this spring. When making placement decisions, the team plans to consider the results of a truck driver survey completed by ATRI, which showed that drivers would find the signs most helpful when located either a few miles or about 20 miles before a given rest area. Also in the works are an in-cab messaging system and a website.

Overall results of the demonstration project will help the team determine whether this technology holds promise for use in other corridors throughout the nation.

DRIVER FATIGUE
causes an estimated
40
PERCENT
of all truck crashes.



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U OF M PROGRAM

to explore transportation policy and

ECONOMIC COMPETITIVENESS.

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'SMART WINDOWS'

are a nearly invisible solution for transportation

NOISE CANCELLATION.

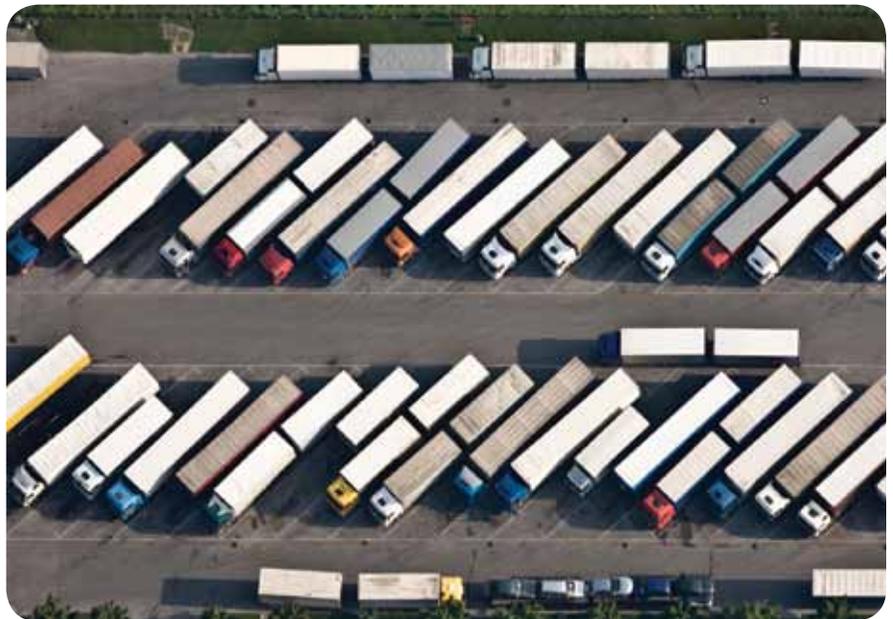
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CAPACITY ISSUES

are among the challenges facing the

FREIGHT INDUSTRY.

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Demonstration project is helping
truck drivers find safe places to park.

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