University of Minnesota
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CTS Research E-News brings you the latest research project milestones, published reports, and seminar coverage.

In this issue:

Policy & Planning

I-35W bridge collapse had complex effect on metropolitan traffic flows, researchers find

New I-35W bridge, September 2008

The collapse of the Interstate 35W bridge over the Mississippi River in Minneapolis on August 1, 2007, instantly transformed the Twin Cities' transportation network. Thousands of commuters were forced to revise their daily travel routes literally overnight, resulting in dramatic changes in traffic patterns around the busy downtown area. Recognizing that the tragedy afforded researchers a unique opportunity to study real-world responses to sudden network disruption, University of Minnesota researchers including associate professor and Richard P. Braun/CTS Chair in Transportation Engineering **David Levinson** and civil engineering assistant professor **Henry Liu** initiated a suite of research projects designed to capture and analyze data on travel behavior in the immediate aftermath of an unexpected large-scale disruption. Findings from these studies may help the Minnesota Department of Transportation (which sponsored the research) and other transportation agencies prepare for and respond to catastrophic network disruptions. Levinson and graduate student **Shanjiang Zhu** used a variety of data sources to understand the changes in traffic flows resulting from the collapse, including traveler surveys, GPS tracking of study participants' travel, and aggregate data on traffic volumes, traffic controls, and transit ridership. Data collection incorporated both the post-collapse period and, insofar as possible, the pre-collapse period.

The researchers found that an unexpected disruption produces an avoidance response among travelers whose routes are affected. Drivers initially avoid the area around the disruption site until the perceived risk of traveling through it is reduced with time. This response produces an oscillation in travel patterns, as traffic levels on links near the disruption drop precipitously and then rebound as travelers adjust to the altered topology of the travel network.

Comparing this phenomenon to the effects of preplanned disruptions such as the closure of bridges or highway segments for reconstruction, the researchers found that the impacts of such expected closures were much smaller. The researchers speculate that the psychological shock of a sudden collapse or other catastrophic event is much more powerful than that produced by a "normal" network disruption, and suggest that rapid implementation of an effective system of detours may be key to minimizing this effect.

Network redundancy—the availability of alternate routes, including other bridges across the Mississippi—was a critical factor in accommodating the excess traffic produced by the bridge collapse. Mn/DOT was able to detour traffic along alternate freeway routes including I-94/Minnesota Highway 280 soon after the collapse, mitigating some of the negative effects of the event. However, Levinson and Zhu note in their research report, if the I-94 bridge had collapsed instead, the asymmetrical nature of the road network in the area would have made the I-35W bridge route much less able to absorb excess traffic. This finding appears to have important implications for analyses of network robustness. The addition of a temporary fourth lane on the I-94 bridge also proved to be very important to maintaining effective traffic flow in the area.

Based on their analysis of travel demand data, Levinson and Zhu conclude that the new I-35W bridge (which opened one year after the collapse with greater capacity and faster average travel speeds than its predecessor) helped reduce travel costs most of the time, but that this benefit was fairly small—on the order of 0.2 to 0.3%. This finding is consistent with a preliminary study by Levinson and graduate student **Feng Xie** using planning models developed at the University of Minnesota. This agreement between the models and observed travel demand data, the researchers say, suggests that forecasting models incorporating elastic demand (varying in response to travel cost) can provide good first-order

estimates of the impacts caused by network disruptions. "Quick-response" travel demand models could also be useful in developing mitigation plans for planned network disruptions.

Traffic Flow and Road User Impacts of the Collapse of the I-35W Bridge over the Mississippi River (Mn/DOT 2010-21) is available from the CTS Web site. More information on University of Minnesota research on the bridge collapse is also available online.

Focus groups assess public sentiment toward FEE lanes

In May 2009, the Minnesota Department of Transportation sponsored an initiative to study user reactions to several lane options currently being considered to better manage capacity and congestion on area highways. Researchers **Adeel Lari** and **Sara Aultman** conducted six focus group sessions of transportation users and stakeholders in the Minneapolis-St. Paul area.

Many cities around the United States have successfully managed congestion by converting high-occupancy vehicle (HOV) lanes to high-occupancy toll (HOT) lanes. HOT lanes are created by applying a pricing system to an already-established HOV lane and require single occupancy vehicles to pay a fee to access the lane (transit, motorcyclists, and vehicles with two or more persons are permitted to use it for free). Such lanes generate revenue for construction, maintenance, operation, and transit service, and allow commuters to travel at higher speeds and enjoy improved trip time reliability. In Minnesota, I-35W and I-394 MnPASS are examples of HOV and HOT lanes. However, the conversion of general-purpose lanes to HOT lanes has historically encountered resistance due to the perception that the "free" lanes have already been paid for and that tolling facilities make users pay twice.

Research participants included two groups of peak period drivers, one group of non-peak period drivers, one group of transit users (bus or light rail), one group of MnPASS users, and one group of business owners and managers whose employees regularly drive on local freeways for their work. Groups began by sharing their experiences on Twin Cities freeways and their commuting patterns. They perceived that the effects of the recession had resulted in less traffic during peak commuting hours, particularly during their morning commute; however, they also felt that the amount of traffic in the afternoons has increased over the past five years.

Groups then discussed three potential Flexible and Efficient Express (FEE)-based freeway configurations designed to reduce congestion:

- FEE Lane: during rush hours, the left general-purpose lane would convert to a toll lane and the right shoulder would convert to a general-purpose lane, with a fee charged in the FEE lane for all motorists except buses.
- FEE Lanes with Credits: an additional general-purpose lane would convert to a toll lane, creating two FEE lanes; all metropolitan-area motorists would be given credits for free use of the FEE lanes.
- FEE Highway with Credits: all general-purpose lanes, including the shoulder, would be converted to FEE lanes during peak periods; motorists would be provided more credits than under the FEE Lanes with Credits scenario.

Lari and Aultman found that participants were generally amenable to the introduction of HOT lanes. When presented with the three FEE lane options, nearly all preferred the first FEE lane configuration (opening a single FEE lane on all major highways), presumably because they have already seen it successfully implemented (as on I-394).

Participants also liked being able to choose whether or not to drive on a FEE lane, as well as the concept of improved throughput. Primary concerns across all participants were uniformity and the ability of drivers to understand the new system. In the latter two FEE lane scenarios (FEE Lanes with Credits and FEE Highways with Credits), participants voiced concerns about the difficulties of administering a credit method, resistance to and ability to afford the fees, and the equity of the system.

A final report on the project, *Study of Public Acceptance of Tolling with New Capacity and Credits: Concepts of FAST Miles and FEE Lanes* (Mn/DOT 2010-27), is available from the CTS Web site.

Hiawatha line improves workers' access to low-wage jobs

A new research report by University of Minnesota assistant professor **Yingling Fan** and researchers **Andrew Guthrie** and **Rose Teng** of the University of Minnesota's Hubert H. Humphrey Institute of Public Affairs describes how the Hiawatha light-rail transit (LRT) line linking downtown Minneapolis, the May 2010 *Research E-News*.

The research was conducted under the auspices of the Transitway Impacts Research Program, sponsored by a coalition of federal, state, regional, and local governments and nonprofit organizations.

In her study of job access, Fan found that residents of areas near light-rail stations could reach approximately 14,000 more low-wage jobs within 30 minutes of transit travel after construction of the Hiawatha line and related transit system improvements, and that areas with direct light-rail/bus connections could access roughly 4,000 more jobs.

Further, Fan found that the number of low-wage jobs located near station areas has also increased. She estimates that more than 5,000 such jobs have been brought into areas near downtown Minneapolis and suburban Bloomington stations. Low-wage workers are also choosing to locate near LRT stations to take advantage of the line's transportation benefits.

The full report *Impact of Twin Cities Transitways on Regional Labor Market Accessibility: A Transportation Equity Perspectiv*e (CTS 10-06) and *How Light-Rail Transit Improves Job Access for Low-Wage Workers* (CTS Research Brief 2010-02) are available from the Transitway Impacts Research Program Web site.

Transportation Safety

CERS survey finds drivers take more risks on rural highways

While Americans are much more likely to die on rural highways than urban freeways, a national study by the University of Minnesota's Center for Excellence in Rural Safety (CERS) found that they feel much more relaxed and prone to risk-taking on rural highways.

"Americans are taking unnecessary risks on rural roads," CERS director **Lee Munnich** said. "They're more relaxed and comfortable with risk-taking on the roads where they are most likely to be killed. We have a lot of education to do."

Rural roads are particularly perilous. While U.S. Census figures show that about one out of five (21 percent)

Americans live in rural areas, the Federal Highway Administration has found that about six out of 10 (57 percent) highway deaths occur on roads that it considers rural. But Americans don't seem to understand the risk on rural highways, according to the findings.

For instance, 69 percent of Americans responded that they felt safe on multilane freeways in urban areas, while 79 percent felt safe on two-lane highways in rural areas.

Rural highways are also the most likely place for people to feel relaxed, with 38 percent responding that they feel relaxed on rural highways and just 19 percent feeling relaxed on urban freeways. Among rural residents, 69 percent felt relaxed on rural highways, versus just 13 percent who felt relaxed on urban freeways.

This feeling of relaxation and safety seems to lead to more risk taking on the more dangerous rural highways. For instance, Americans are more likely to feel safe eating, using a cell phone, and drinking and driving on rural highways than they are on urban freeways. This is particularly true of rural residents. For instance, among rural residents, 44 percent said they feel safe using a cell phone on a rural highway versus 14 percent who feel safe using a cell phone on an urban freeway.

The exception to this trend of Americans feeling more comfortable engaging in risky driving behaviors on rural highways is speeding. About half of Americans feel safe speeding on urban freeways (47 percent), while a third feel safe speeding on rural highways.

The survey, sponsored by CERS and conducted this spring by Critical Insights of Portland, Maine, also found that drivers mistakenly believe winter is the most dangerous travel time and that an overwhelming majority of Americans want lawmakers to enact strong safety policies.

Complete details about the findings of the survey are available on the CERS Web site.

CERS, established by the 2005 federal transportation act, is a joint program between the Humphrey Institute and CTS, and is sponsored by the Federal Highway Administration.

Excerpted from the September 2010 Rural Safety News.

Transit, Bicyling, and Walking

TCRP research publications available online

The federal Transit Cooperative Research Program (TCRP), administered by the Transportation Research Board, provides practical transit research to address technical and operational issues. TCRP emphasizes putting research results into the hands of organizations and individuals that can use them to solve problems.

Recent TCRP publications include:

- *A Methodology for Performance Measurement and Peer Comparison in the Public Transportation Industry* (TCRP Report 141)
- *Reconciling Security, Disclosure, and Record-Retention Requirements in Transit Procurements* (TCRP Legal Research Digest 32)

Transportation Infrastructure

Asphalt mixtures tested at MnROAD to determine air void content

The MnROAD research facility

In the summer of 2008, several test sections of Mn/DOT's MnROAD facility were resurfaced with hot-mix asphalt to obtain more information about certain properties of pavement materials. Potential areas of study ranged from the construction and application process to the end of the pavement's useful life. One such measure studied was the percentage of air voids in a pavement mixture, an effort headed by **Mugurel Turos**, **Ki Hoon Moon**, and **Mihai Marasteanu** from the University of Minnesota's civil engineering department. In this Mn/DOT-funded project, 342 mixture samples from 145 cores of different asphalt mixtures were extracted from various cells at MnROAD and studied through digital imaging and ultrasonic testing.

Air voids were determined under test procedure AASHTO T166, "Bulk Specific Gravity of Compacted Asphalt Mixtures Using Saturated Surface-Dry Specimens." Additional analysis was completed through digital imaging and ultrasonic testing. In the former, samples were scanned and processed by an image-processing tool that translated a scanned image into a binary image. Asphalt mixture aggregates larger than 75 microns are indicated by white pixels and aggregates smaller than 75 microns are made up of black pixels, allowing for the ability to calculate the VMA (voids in mineral aggregates) of a mix. In the latter, a section of MnROAD was tested using an ultrasound tomography device to supplement ground penetrating radar (GPR) measurements, as research by the University of Minnesota has suggested that lower shear wave velocity is caused by increased air voids. Researchers measured the shear wave velocity and the corresponding pavement thickness across two cells on the low-volume loop of the MnROAD facility.

Data analysis was not included in this study, although the results will be used by Mn/DOT researchers to compare air void content in the outer wheel path and between the wheel path, in driving and passing, in inside and outside lanes, and in longitudinal joints.

A final report on the project, *Air Voids Testing for MnROAD Cells* (Mn/DOT 2010-28), is available from the CTS Web site.

New data filtering system at MnROAD facility increases database value, weeds out unusable data

In a recent Mn/DOT funded project at the MnROAD facility, a team of researchers headed by **Randal J. Barnes** of the University of Minnesota's Department of Civil Engineering designed and implemented a data filtering system for the MnROAD temperature database. Fourteen interdependent quantitative tests were developed to identify and flag erroneous, questionable, or exceptional data.

MnROAD has more than 50 test cells up to 500 feet long, which are paved with concrete of varying thickness, asphalt, and aggregate, and differing combinations of surface, base and subbase, subgrade, drainage, and compaction. Forty of MnROAD's cells collect temperature data, which are housed in a large database used to supplement pavement research studies in cold climates. From 1996 to 2007, more than 1,300 temperature sensors generated more than 471 million records, 72% of which are associated with active sensors. However, until recently only small amounts of data have been extracted and analyzed for use in such studies, due to the presence of inaccurate records and the limited

number of tables available.

Fourteen related quantitative tests were applied to the existing temperature data:

- Four identified missing and intermittent data streams,
- Three analyzed the time span from individual sensors and identified outliers,
- Three compared data from sensors embedded in the same pavement types, locations, and depths,
- Four summarized periods of unreliable data.

The filtering system revealed that the majority of the sensors performed well; of the 1,282 sensors studied, 718 produced reliable data more than 99 percent of the time, only 18 produced reliable data less than 50 percent of the time, and only 31 were found to be non-operational.

After an initial analysis, 324 million records were identified as reliable data, and nearly 16 million records from active sensors were identified as incorrect or unreliable. Also, 146 million, or 31.1% of the total, were noted as inactive, incorrect, or unreliable. Possible explanations ranged from defective and deactivated sensors; sensors that had not yet been activated; data gaps, hops, skips, and shifts; and dead, lost, or outlying data.

A variety of statistical tables and graphics were created to illustrate the results and aid in data interpretation. Although this project focused on temperature data, the concepts and tools developed during this project are designed to be extensible to the filtering of ongoing and future data collection efforts at MnROAD.

A final report on the project, *MnROAD Data Mining, Evaluation and Quantification—Phase I* (Mn/DOT 2010-26), is available from the CTS Web site.

Upcoming Events

September 30

CTS Research Seminar: Economic Impact of Airports and Update of Economic Impact Calculator, 3:30 p.m. - 4:30 p.m. CDT, 1130 Mechanical Engineering

October 7

Advanced Transportation Technologies Seminar, 3:30 p.m. - 4:30 p.m. CDT, 1130 Mechanical Engineering

October 7-8

7th Annual AirTAP Fall Forum, Alexandria, MN

October 13

Fuelish Choices: Improving Sustainability of Transportation, Institute on the Environment Frontiers in the Environment, 12:00 p.m. - 1:00 p.m., IonE Seminar Room R380, VoTech Bldg., St. Paul campus

October 14

CTS Research Seminar: Itasca County Area Transportation Study, 3:30 p.m. - 4:30 p.m. CDT, 1130 Mechanical Engineering

October 19

ITS Minnesota Fall Industry Forum, St. Paul, MN

October 21

Advanced Transportation Technologies Seminar: Avoiding the Matrix: How to Build Privacy into Intelligent Transportation Systems, 3:30 p.m. - 4:30 p.m. CDT, 1130 Mechanical Engineering

October 25-26

Minnesota Toward Zero Deaths (TZD) Annual Conference, Crowne Plaza Riverfront Hotel, St. Paul, MN

October 28

CTS Research Seminar: Performance of Pervious Concrete Pavement in a Cold Weather Climate, 3:30 p.m. - 4:30 p.m. CDT, 1130 Mechanical Engineering