Minnesota Traffic Observatory opens its eyes on complex transportation issues

Astronomers call it “first light”—the moment when a new telescope captures its first images of the cosmos. A different kind of first light was celebrated in May, when the Minnesota Traffic Observatory opened its eyes on the Twin Cities’ traffic network and gave researchers a powerful new set of tools for studying complex traffic systems.

Standing in front of a wall-sized projection screen displaying live video from several traffic cameras overlooking the I-94/35W Commons freeway interchange area, MTO director John Hourdos talked about how he hopes the Observatory will help researchers studying complex traffic systems.

“Instead of looking at just one or two locations, the Observatory offers the ability to look at large systems where many different parts interact,” he explained.

A joint effort of the ITS Institute and the Department of Civil Engineering, the Observatory boasts the ability to integrate real-time traffic data with state-of-the-art simulation systems, making it possible to analyze existing conditions and compare real-world observations with the results of simulated conditions.

Hourdos gained considerable experience in both traffic monitoring and simulation during his doctoral research, carried out largely in the MTO’s predecessor facility, the ITS Laboratory. He worked with civil engineering professor Panos Michalopoulos, ITS Lab manager Ted Morris and educational systems engineer Chen-Fu Liao on video-based data gathering for monitoring vehicle movements.

Much of the work carried out in the ITS Laboratory laid the foundations for establishing the Minnesota Traffic Observatory, according to ITS Institute director Max Donath. With Morris and Liao joining Hourdos in the new facility, the MTO builds on its predecessor’s successes and adds new capabilities to work with researchers from a wide range of fields.

Windows on the world

The power of an observatory lies in what it can see, and researchers in the MTO have access to a wide array of information. Data from thousands of pavement-embedded loop detectors throughout the Twin Cities traffic system, processed and archived by the University’s Transportation Data Research Laboratory (See Summer 2005 Sensor).

In addition to data from the thousands of pavement-embedded loop detectors throughout the Twin Cities traffic system, the Observatory exploits the advantages of video-based traffic monitoring.

Video feeds flow into the observatory from an extensive network of traffic cameras. The observatory is connected by fiber-optic lines to the Minnesota Department of Transportation’s traffic operations center, allowing it to capture live feeds from up to 16 of the more than 300 cameras the agency uses to monitor the metropolitan freeway system.

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Observatory research improves safety on I-94

Last October a double white line was painted on a stretch of I-94 in downtown Minneapolis to guide merging behavior. The new striping extends the acceleration lane of an incoming double ramp by roughly 700 feet.

Despite a constant stream of violations, said John Hourdos, director of the Minnesota Traffic Observatory (MTO), the markings have shown some success.

The most important effect of the markings is that crash severity has been reduced, Hourdos said. Five- and six-car crashes have been eliminated, and the number of three- and four-car crashes has been cut in half. The right lane flows more smoothly, reducing the likelihood of multi-vehicle crashes, while congestion in the right lane shrank about 30 minutes before and after the afternoon peak period.

“In respect of crash location, we see that the system has reduced the crashes at the originally high point of Portland [Avenue] and upstream,” Hourdos said. “Unfortunately, it pushed those crashes a little bit further, closer to the new merge point.” At this time it’s unknown if this is a permanent effect or if it can be remedied with greater enforcement.

At certain times of the day, Hourdos said, the flow at this crash-prone area reaches 2,700 vehicles per hour, per lane, resulting in “very dense, very fast-moving traffic.” Mn/DOT turned to the MTO several years ago for an analysis and possible solutions. For the work, the MTO designed and employed observation sta-

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Traffic modeling to improve wilderness experience

A single public road winds through the six million acres of unspoiled Alaskan wilderness that make up Denali National Park and Preserve, one of the crown jewels of the United States’ national park system. For thousands of visitors every year, this road offers their best chance to view and photograph the wildlife for which the park is famous. The road also provides access to the park interior for campers and hikers.

Faced with an ever-increasing demand from visitors eager to come face to face with Denali’s wildlife, the National Park Service turned to the Minnesota Traffic Observatory and the ITS Institute to help balance the transportation demand from park visitors with the need to protect and preserve the natural habitat of the area’s wildlife.

In order to maintain the uniquely unspoiled experience, traffic on the park road is limited to bus tours operated by designated tour operators. Adding more tours in response to increasing demand runs the risk of degrading the visitor experience by driving away the very wildlife that visitors have journeyed so far to encounter, or by diminishing scenic views with unsightly traffic jams.

To gather accurate information on wildlife sightings, the researchers developed a prototype data-logging system to be used by bus drivers. With a touch-sensitive LCD panel and a customized graphical user interface, the system allows drivers to quickly input data on sightings, as well as noting any other reasons for stopping the vehicle along the roadway. This data will be incorporated into a digital map of animal sightings.

The new traffic model being developed by the Minnesota researchers combines traffic demand modeling with data on wildlife movements and habitat requirements gathered by biologists, and indicators that measure the visitors’ quality of experience. Such indicators include, for example, the types of wildlife that visitors encountered, and a visitor’s perception of vehicle ‘crowding’ along the road and at other points of interest. These metrics are being developed by a research team from the University of Vermont. In its complete form, the model will give park managers the ability to carry out scenario-based planning—evaluating the potential impacts of different management plans.

National surface transportation policy committee hears from ITS Institute researchers

As the nation’s surface transportation system faces new challenges and opportunities in the 21st century, informed public policy will be more important than ever for maximizing the benefits of this national resource. That was the message that emerged from testimony by a wide variety of expert witnesses at a field hearing convened by the National Surface Transportation Policy and Revenue Study Commission April 17 and 18 on the University of Minnesota campus.

ITS Institute director Max Donath testified that technology has an important role to play in reducing fatalities and serious injuries on our roads, but it must be combined with a strong policy emphasis on improving safety.

He cited current ITS Institute research efforts including the development of an integrated in-vehicle “black box” data recorder and driver assistance system aimed at helping teen drivers avoid high-risk behavior during their first few months behind the wheel (see Sensor issue XXX). Graduated drivers licensing laws, which grant limited privileges to beginning drivers, were also praised by Donath as an important policy initiative to support safety.

The commission was created by Congress in 2005 under the national transportation funding act known as SAFETEA-LU and charged with the mission of gathering information on issues that will affect the surface transportation system in coming years. Chaired by Secretary of Transportation Mary Peters, the commission is conducting a series of field hearings around the country to receive testimony from transportation experts and members of the public.

The following morning, the commissioners learned about cutting-edge research in driver performance and behavior at the laboratory of the University of Minnesota’s HumanFIRST (Human Factors Interdisciplinary Research in Simulation and Transportation) Program. HumanFIRST director Nic Ward put commission members behind the wheel of the program’s advanced immersive driving simulator, VESTR, and showed how the system is being used to develop crash-reduction strategies tailored to specific problems and needs of high-risk groups, including teen drivers and the elderly.

Members of the commission also toured the I-394 MnPASS system.

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The MTO also relies on a dedicated video-based traffic monitoring system covering the I-94/35W Commons freeway interchange area in Minneapolis, one of the state’s most accident prone freeway areas. Known as “Beholder,” the system was developed by Hourdos and the staff of the ITS Laboratory as a tool to study vehicle movements in areas of complex traffic flow. Using specialized image-processing algorithms, Beholder counts, tracks, and analyzes the movements of vehicles throughout the Commons area, capturing subtle changes in traffic speed and density as traffic flows change over the course of each day.

Traffic flows on arterial streets and intersections can also be studied using a combination of data sources including loop detectors, portable video-based traffic monitoring systems, and traffic signal timing simulations. This approach is key to ongoing ITS Institute research into signal priority for transit vehicles. (see the Summer 2006 Sensor.)

**A model of efficiency**

For Chen-Fu Liao, these data-gathering capabilities provide the ideal foundation for traffic modeling and simulation. Working with members of the University faculty, Liao has developed simulation modules that let students in transportation planning courses investigate the effects of travel demand levels and signal timing schemes. He counts this work among his most important contributions, because it advances the education of new generations of transportation researchers and managers. In the future, Liao plans to develop similar simulation “games” for high-school students as a way of teaching about how the traffic network is managed.

Of course, traffic simulation is an important research tool in its own right, and a large section of the Observatory is dedicated to modeling traffic flows. Most research here focuses on microscopic simulation, in which each virtual vehicle moves independently through an electronic model that replicates a real-world study area. Carefully calibrating these models against real-world data produces highly accurate representations that respond to slight changes in parameters like signal timing—or to sudden disruptions caused by vehicle collisions.

**Seeing the big picture**

Given the complexity of the traffic issues that the Observatory is designed to study, robust visualization tools are of critical importance. In addition to a large projection wall, two innovative pieces of equipment provide researchers with powerful interactive visualization capabilities.

The GIS/MAP table, built by Hourdos and the Observatory staff, combines the large horizontal working surface of a traditional drafting table with the interactive capabilities of Geographic Information Systems technology. Two ceiling-mounted digital projectors create a seamless image covering the entire surface, which can be manipulated using a tabletop pointing device to pan and zoom in on specific areas. The table allows users to comfortably survey the entirety of a large traffic system and quickly focus in on areas of interest.

The Digital Environment, or DEN, takes a different approach—putting viewers in the center of the action via 3D immersive graphics. Three sides of the cubical structure are made up of large rear-projection screens made of a polarized material that actually transmits two slightly different images; a user wearing specially polarized glasses sees a different image with each eye, producing a realistic sense of three-dimensional space. A tracking system mounted in the DEN’s ceiling adjusts the perspective of the rendered 3D scene to provide an accurate perspective, while a handheld “wand” allows participants the ability to navigate and interact with the scene.

**New opportunities**

For the Observatory’s director, the MTO represents the logical evolution of the ITS Institute’s traffic research capabilities. “There’s so many different kinds of traffic-related research going on today, and the demand for the kind of capabilities the Observatory brings to the table is increasing,” said Hourdos.

**ITS Institute director receives Distinguished Service Award**

The past 29 years “have been an exciting time,” said ITS Institute director Max Donath, accepting the Richard P. Braun Distinguished Service Award. Donath, who joined the University of Minnesota faculty in 1978, has helped make Minnesota a leader in transportation research and has led the ITS Institute since it was established in 1997.

The award, named for the first director of the Center for Transportation Studies, is presented annually to a transportation professional in recognition of outstanding leadership in research and innovation.

To learn more about the Braun Distinguished Service Award and other awards presented annually by CTS, visit www.cts.umn.edu/about/awards/.

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and visited Mn/DOT’s Regional Transportation Management Center, a state-of-the-art facility that integrates traffic operations control, State Patrol dispatch, and maintenance dispatch.

The Minnesota hearing was the last national hearing scheduled by the commission. The commission will now begin preparing recommendations for a new national transportation policy. The recommendations will be presented to Congress in December 2007. Testimony will be available online on the commission’s Web site. For more information, visit www.transportationfortomorrow.org.

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— www.its.umn.edu —
The I-94/35W Commons is an area of complex traffic flows.

The most affordable and easiest solution for Mn/DOT was “to change the merge location of the downstream entrance by extending road markings,” Hourdos said. “So while earlier the dotted line started approximately 500 feet before the curve, now this double white line is reaching out 200 feet after the curve.”

The MTO is continuing its study of the area.

**HumanFIRST director briefs Minnesota Senate committee**

Traffic-related incidents are currently the largest single cause of death for Minnesota residents between the ages of two and 33. This was among the sobering statistics cited by HumanFIRST director Nic Ward in his briefing to the Transportation Finance Budget and Policy Committee of the Minnesota Senate on Jan 30.

In order to reduce the number of fatalities and serious injuries on Minnesota roads, Ward said, his research team at the ITS Institute is focused on developing technologies that help drivers perceive hazards and take appropriate action to stay safe.

Ward also emphasized the importance of changing public attitudes toward traffic safety. “Unsafe parent drivers produce unsafe teen drivers,” he said. Today’s technology, he stated, makes it possible to identify “not only who is driving, but where and how they are driving.” To make the roads safer, Ward argued, we should explore technologies that discourage dangerous behavior behind the wheel.

**UPCOMING EVENTS**

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<th>Event</th>
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<tr>
<td>Aug. 23-24</td>
<td>Second Access to Destinations Conference, University of Minnesota.</td>
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<td>Information at <a href="http://www.cts.umn.edu/access-study/events/conferences/">www.cts.umn.edu/access-study/events/conferences/</a>.</td>
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<tr>
<td>September 17–18</td>
<td>Toward Zero Deaths Conference, Duluth.</td>
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<td></td>
<td>Contact Shirley Mueffelman, 612-624-4754, <a href="mailto:conferences2@cce.umn.edu">conferences2@cce.umn.edu</a>.</td>
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<tr>
<td>October 17</td>
<td>Intelligent Transportation Society of Minnesota Fall Industry Forum.</td>
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<td>For information, contact Electra Sylva, 612-624-3708, <a href="mailto:conferences5@cce.umn.edu">conferences5@cce.umn.edu</a>.</td>
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