

UMTRI

# RESEARCH REVIEW

• UNIVERSITY OF MICHIGAN TRANSPORTATION RESEARCH INSTITUTE • JANUARY–JUNE 2009 • VOLUME 40, NUMBERS 1 AND 2 •



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## Field Tests Evaluate Integrated Safety System

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• UNIVERSITY OF MICHIGAN TRANSPORTATION RESEARCH INSTITUTE • JANUARY–JUNE 2009 • VOLUME 40, NUMBERS 1 AND 2 •

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## Editor's Note

The *UMTRI Research Review* will be published only three times in 2009, with issues 1 and 2 combined. The remaining two issues, numbers 3 and 4, will be published in the third and fourth quarters of the year, respectively. We apologize for any inconvenience this deviation from our normal publishing schedule might cause our subscribers, especially libraries.

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## UMTRI's Strategic Intent

To be the leader in transportation systems research integrating vehicles, people, and infrastructure to achieve a highway transportation system where:

- Fatalities and injuries are eliminated
- People and goods flow efficiently
- Reliance on nonrenewable energy is reduced

# Field Tests Evaluate Integrated Safety System

Building on more than two years of research and development, UMTRI began field testing a state-of-the-art integrated crash-warning system for passenger cars in April.

The testing is part of UMTRI's Integrated Vehicle-Based Safety Systems (IVBSS) program, a cooperative agreement with the U.S. Department of Transportation. The system integrates a suite of safety features including forward collision, road departure warnings, lane-change/merge alerts, and curve-speed warnings. System development was led by Visteon, with support from Takata.

According to Jim Sayer, IVBSS program director and UMTRI associate research scientist, the integrated system combines detection systems that together provide drivers with improved situational awareness of a vehicle's surroundings.

"In theory, the more sensor data you have, the more knowledge you have about the driving condition," explains Sayer. "Key to our research is whether the levels of performance that can be achieved through integration will lead to good customer acceptance and willingness to purchase."

To gather the data, sixteen passenger cars were equipped with the integrated safety system. Over the next twelve months, 108 randomly sampled, licensed drivers in southeast Michigan will drive the cars in place of their personal vehicles. Each car is equipped

with a data-acquisition system so researchers can record and collect extensive data on driver actions and response while using the system in a naturalistic context.

## A Suite of Sensors

The IVBSS system uses information gathered by inertial, video, and radar sensors, complemented by a global positioning system (GPS) and digital mapping. All systems include software that allows the system to interact with the vehicle to monitor vehicle speed and acceleration along with driver steering, brake, and throttle inputs. In all, over 600 individual channels of data are collected from the vehicle, including five video channels.

When sensors detect a threat, the system warns drivers in one of several ways—an audible tone emitted from a headrest, visual icons on side mirrors, or haptic cues (either a brake pulse or seat vibration). A visual display on the center console aids drivers in interpreting the warning when learning how the system operates.

The emphasis, explains Sayer, is on the auditory warnings. The tones



UMTRI/IVBSS PROGRAM

*The integrated safety system notifies drivers of hazards via auditory, visual, and haptic cues from side mirrors, seats, and headrests. Dashboard lights indicate which alert has occurred.*

are directional and come from the perceived location of the threat and also indicate the type of threat. A longitudinal warning, indicated by three consecutive beeps, signals a threat in front of the vehicle and the driver's need to reduce speed. A lateral threat, indicated by the sound of a tire driving on a rumble strip, signals an inadvertent lane change or lane departure that may require corrective steering action.

Researchers are tracking the number and type of warnings given to each driver as well as their response. After six weeks of driving (four weeks with the safety system activated), drivers return the cars to UMTRI and undergo a short debriefing based on preliminary data.

"We're able to immediately tap into the data-acquisition system on board,

*continued...*

*Continued from page 1*

or ‘the black box,’ when the vehicle is returned,” explains Sayer. “We show each driver examples of the warnings they were given and ask them a series of questions: Was the warning useful? How useful? What would you change about it?” Researchers will also measure positive and negative behavioral changes, adds Sayer, such as an increase in turn-signal use, or less frequent use of mirrors: “One of the most interesting questions is whether there is any risk compensation... whether driver behavior changes for the worse as a result of having the system.”

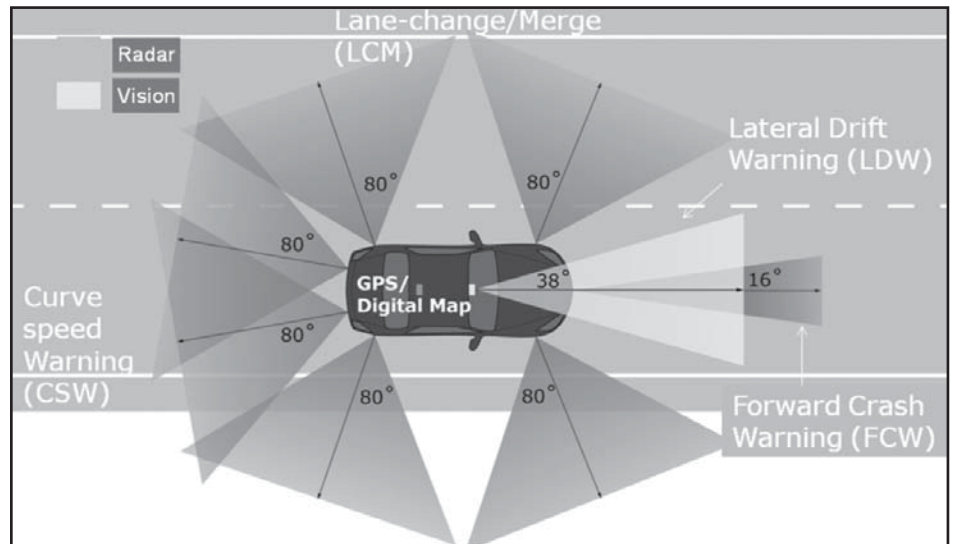
**IVBSS Initiative: Phase Two**

The field-testing is part of the second phase of the four-year IVBSS initiative. More than two years of research, development and pilot testing went into developing the integrated safety system.

Sayer and his team launched a similar test of the system for commercial trucks in January of this year. Completion of the truck testing is expected in December 2009. Field testing of the passenger cars will continue through March 2010. The passenger car study is expected to yield data from an estimated 272,000 miles of driving. The study of commercial trucks will yield data from 750,000 miles of driving.

Researchers will use data gathered in the field tests to evaluate the potential safety benefits of integrating multiple crash-warning systems.

In addition to UMTRI, IVBSS program partners include Visteon Corporation, Eaton Corporation, Honda R&D Americas, Inc., Takata Corporation, International Truck and Engine Corporation, Con-way Freight, Battelle, and the Michigan Department



*This image shows the sensor coverage provided by the IVBSS system on a passenger car.*

of Transportation. The National Highway Traffic Safety Administration (NHTSA) and the Federal Motor Carrier Safety Administration (FMCSA) are conducting the IVBSS initiative, funded as part of the U.S. DOT’s Research and Innovative Technology Administration’s (RITA) Intelligent Transportation Systems (ITS) Joint Program Office.

For more information on the IVBSS program, or to read pilot test summary reports, visit <http://umtri.umich.edu/divisionPage.plp?pageID=249> **RR**

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**“Key to our research is whether the levels of performance that can be achieved through integration will lead to good customer acceptance and willingness to purchase.”**

**—Jim Sayer, IVBSS Program Director**

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# UMTRI to Participate in Bridge Monitoring Grant

Researchers at the University of Michigan, including several UMTRI staff members, are leading a \$19 million project to better monitor the health of bridges. Over the next five years, they will create the ultimate system for monitoring bridge infrastructure, and install and test it on several bridges.

The bridge-monitoring system is envisioned to include several different types of surface and penetrating sensors to detect cracks, corrosion, and other signs of weakness. The system would also measure the effects of heavy trucks on bridges, which is not a common practice.

The bridge-monitoring system would place data-gathering devices, such as enhanced antennas, on bridges and trucks and use a wireless network to transfer the information gathered to both inspectors onsite and decision makers at remote office locations.

Funded in large part by the National Institute of Standards and Technology (NIST)'s Technology Innovation Program (TIP), the project involves fourteen researchers from the University of Michigan (U-M) College of Engineering and UMTRI, as well as engineers from five private firms in New York, California, and Michigan. The remaining funding comes from cost sharing among the entities involved and the Michigan Department of Transportation (MDOT). MDOT is providing unfettered access to state bridges to serve as high-visibility test sites for showcasing the technology.

“This project will accelerate the field of structural-health monitoring and ultimately improve the safety of the nation’s aging bridges and other infrastructures,” says Jerome Lynch, principal investigator on the project and assistant professor in the U-M Department of Civil and Environmental Engineering. “We want to develop new technologies to create a two-way conduit of information between the bridge official and the bridge. We are excited to collaborate on

these transformative technologies with partners like MDOT, who could use them immediately to improve bridge inspection processes.”

Four types of sensors will contribute to gathering data. Victor Li, E. Benjamin Wylie Collegiate Professor of Civil and Environmental Engineering, has developed a high-performance, fiber-reinforced, bendable concrete that’s more durable than traditional concrete and also conducts electricity. Researchers would measure changes in conductivity, which would signal weaknesses in the bridge. On test bridges, the deck would be replaced with this concrete.

Lynch and a colleague are developing a carbon, nanotube-based, sensing “skin” that would be glued or painted onto bridge “hot spots” to detect cracks and corrosion invisible to the human eye. The skin’s perimeter is lined with electrodes that run a current over the skin to read what’s happening underneath, based on changes in the electrical resistance.

Low-power, low-cost, wireless nodes could look for classical damage responses like strain and changes in vibration. These nodes would harvest energy from vibrations on the bridge or even radio waves in the air. These nodes are being developed by Dennis Sylvester, an associate professor in the U-M Department of Electrical Engineering and Computer Science, and Khalil Najafi, Schlumberger Professor of Engineering, Arthur F.

*continued...*

JEROME LYNCH



*The Gi-Lu Bridge in Taiwan was instrumented in 2007 to collect and analyze ambient vibration data.*

Thurnau Professor, and chair of the Electrical and Computer Engineering Division of U-M's Department of Electrical Engineering and Computer Science.

Sensors will also be housed in the vehicles that travel on the bridge. UMTRI researchers will outfit a test vehicle to measure the bridge's reaction to the load the vehicle imposes, which is not currently known. Understanding how vehicles, especially trucks, affect bridges is a critical piece of information that could help predict the structure's lifetime. This effort is led by Tim Gordon, research professor and head of UMTRI's Engineering Research Division. Other UMTRI team members include senior research associate Steven Karamihas, research scientist Ralph Robinson, and business development manager Todd Anuskiewicz.

Today, bridge inspectors rely mostly on their eyes to determine if a structure is sound. "Our work will add to what is currently done, not replace it," Gordon said. "The infrastructure problem and the feasibility of new monitoring strategies are emerging at the same time. We believe we have ways of testing the performance of bridges as integrated structures, not just by inspecting their components."

Other parts of the system will organize data into meaningful displays and communicate it from the sensors to the inspector. Vineet Kamat, assistant professor in U-M's Department of Civil and Environmental Engineering, will lead the human-infrastructure interaction effort.

"The technologies from this project could prove very beneficial to the citizens of Michigan in the longer-lasting, smarter, safer, and ultimately more sustainable roadways," says MDOT Director Kirk Steudle. "Recognizing that our nation's infrastructure is the backbone of our economy, this type of innovative research is critical to the future of Michigan and the United States. MDOT is pleased to partner with the University of Michigan on this important engineering project."

Lynch says that if this setup were installed on all bridges, researchers could then make statistical comparisons among bridges. This would help them determine if, for example, all suspension bridges developed certain dangerous signs of wear after a certain age.

Additional U-M researchers include associate professor Mingyan Liu, professor Amir Mortazawi, associate professor Michael Flynn, and professor Atul Prakash from the Department of Electrical Engineering and Computer Science, and professor Amit Ghosh from the Department of Materials Science and Engineering. Engineering firm partners are Weidlinger Associates (New York), SC Solutions (California), LFL Associates (Ann Arbor), Monarch Antenna (Ann Arbor), and Prospect Solutions (New York).

The University has taken steps to protect the intellectual property relating to this project thus far, and plans to find commercialization partners in order to bring the technology to market. **RR**

## M-CASTL Conference Addresses Range of Issues

The Michigan Center for Advancing Safe Transportation throughout the Lifespan (M-CASTL) hosted the second annual Transportation Research and Education Conference on April 7 at the University of Michigan (U-M) Union in Ann Arbor. About 160 people attended the dynamic one-day event, which covered a range of issues related to safety and mobility and featured several UMTRI researchers.



David W. Eby, director of M-CASTL and head of UMTRI's Social and Behavioral Analysis Division, welcomed guests and introduced featured speakers. Dr. James Jackson, director of the U-M Institute for Social Research gave the opening keynote address by emphasizing the importance of multidisciplinary research and education.

"It's not enough that we have different types of engineers working on transportation and highway safety," said Jackson. "Instead it takes a

complex array of social, biological, and behavioral approaches and scientists working hand in hand with engineers of all sorts to effect a safe driving environment for all of us over the life course and the individual life span.”

Keynote speakers also included Dr. Richard Marottoli, medical director, The Dorothy Adler Geriatric Assessment Center, Yale School of Medicine, and Dr. Joseph Coughlin of the Massachusetts Institute of Technology AgeLab and New England University Transportation Center.

The conference featured two sets of concurrent sessions addressing a wide range of topics. Sessions included Vehicle-Based Technology, Education and Training, Licensing Issues,

Distracted Driving, Roadway Design, and Transitioning (from driving to nondriving).

The conference was sponsored by U-M Office of the Vice President for Research, Telcordia, UMTRI, Driving Evaluation Education Research Center, Center for Multimodal Solutions for Congestion Mitigation at the University of Florida, and the University Transportation Center at MIT.

Presentations and videos from the conference are available on the M-CASTL website: <http://m-castl.org/node/49>. 

## Conference Explores China's Automotive Industry

UMTRI's Automotive Analysis Division hosted a one-day conference at the University of Michigan on April 16 titled “Inside China: Understanding China's Current and Future Automotive Industry.” The University of Michigan Center for Chinese Studies sponsored the event.

Bruce M. Belzowski, assistant research scientist, welcomed participants to the conference and gave an overview of China's automotive industry, which is poised to overtake the United States as the world's largest auto market in 2009.

“This is the second year of our Inside China auto conference, and we continue to tap into university research and manufacturer and supplier insights into the constantly changing Chinese auto industry,” says Belzowski. “The interactions of labor, safety, infrastructure, fuel, and emis-


sions with the industry as well as the automakers, suppliers, dealers, and consumers make studying China fascinating and challenging.”

Conference topics included sales and marketing strategies of multinational and domestic auto manufacturers, local and global strategies of manufacturers and suppliers, the role of government in the Chinese auto industry, new labor developments in China and how they are affecting the auto industry, and China's future fuel and vehicle alternatives.

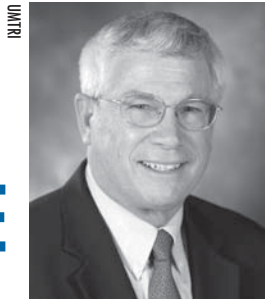
### Focus on the Future

The conference is part of the division's “Focus on the Future” conference series, designed to bring participants up to date on important topics affecting the industry and to provide expert opinions about the future direction.

The next event in the series, “Powertrain Strategies for the 21st Century: How Will Manufacturers and Suppliers Meet the Government's New Fuel Economy and Emissions Requirements?” is scheduled for July 15, 2009.

For presentations and upcoming conference information, see: [www.umtri.umich.edu/divisionPage.php?pageID=47](http://www.umtri.umich.edu/divisionPage.php?pageID=47) 

## Larry Schneider Named AIMBE Fellow



Larry Schneider, research professor and head of UMTRI's Biosciences Division, was elected as a Fellow in the American Institute for Medical and Biological Engineering (AIMBE) for outstanding biomechanics research, producing national vehicle safety standards for children and adult occupants, and improved safety for handicapped individuals.

Schneider is one of ninety-six fellows elected this year. The newly elected fellows were nominated and approved by AIMBE's current Fellows of the College, consisting of more than 900 engineers and scientists. A formal induction ceremony was held during the institute's annual meeting held in February 2009 at the National Academy of Sciences building in Washington, DC.

The newly elected fellows "represent some of the most imaginative and distinguished medical and biological engineers in the field," said AIMBE Executive Director Jennifer Ayers. "Their contributions have had a major impact in biomedical devices and processes, treatment of diseases, and public policy related to all aspects of medical and biological engineering."

Schneider's research interests focus on biomechanics in the automotive environment, including seating and occupant positioning during normal vehicle operation and the study of human impact response and injury tolerance related to improving occupant protection in crash environments through crash investigations and laboratory testing. **RR**

## Gordon Appointed Visiting Professor



Tim Gordon, head of UMTRI's Engineering Research Division, spent two months in Gothenburg, Sweden, as a visiting professor at Chalmers University. The visit was part of Chalmers' Jubilee Professor Scheme, a prestigious program that promotes international collaboration and advanced research.

During his stay, Gordon conducted teaching and research activities related to vehicle dynamics and active safety for light vehicles and heavy trucks. He contributed to a graduate-level course in advanced vehicle dynamics within the automotive engineering master's program and worked with Ph.D. students and their advisors. He also gave a seminar to researchers in the Swedish vehicle-safety community via a collaborative organization of universities and industry called SAFER.

Gordon's visit to Sweden is part of a broader range of collaborations that the Engineering Research Division has been developing with Swedish researchers, particularly in the area of field operational tests.

Gordon has been contributing to projects in Sweden related to control techniques and testing methods for heavy-truck stability enhancement, postimpact stability control to reduce the severity of multiple-collision accidents, and combined brake-and-driving torque arbitration for improved maneuverability in light vehicles. He was also invited to become a member of the scientific advisory panel for a project called QUADRA on driver simulation for safety analysis, funded by the Swedish government.

Gordon holds a joint appointment in the University of Michigan College of Engineering as professor of mechanical engineering. **RR**



# Shope Advances International Collaboration



Research professor and UMTRI Associate Director Jean T. Shope spent two weeks in the Netherlands in April, collaborating with researchers at Maastricht University and presenting research at the International Traffic Medicine Association's 21st World Congress held in The Hague.

During her stay, Shope also attended a daylong research symposium at SWOV, the Institute for Road Safety Research in Leidschendam, where she presented research on parental involvement in teens' early driving. The symposium was organized by senior researcher Divera Twisk, who is pursuing a Ph.D. in social sciences at Maastricht University. Shope, who is cochair of Twisk's dissertation committee, emphasizes the importance of these diverse collaborations.

"International collaboration can be so rewarding—scientifically for the injury-prevention and traffic-safety fields, professionally for one's own development, and personally for the richness of the relationships with colleagues," says Shope. "Bringing different perspectives to bear on a common problem can lead to a better understanding and more innovative solutions."

While visiting Maastricht University, Shope gave a seminar to faculty and doctoral students, presenting research findings from a longitudinal study on the psychosocial and behavioral factors that predict impaired or risky driving, coauthored by UMTRI research professor Ray Bingham and senior research associate Jennifer Zakrajsek. During the International Traffic Medicine Association's 21st World Congress, Shope presented research on substance-involved driving, coauthored by Bingham and U-M doctoral student Jian Zhu.

Dr. Shope is also research professor in the Department of Health Behavior and Health

Education at the University of Michigan School of Public Health, and director of the U-M Center for Injury Prevention among Youth. [RR](#)

# Postdoctoral Fellow Collaborates with UMTRI



Postdoctoral fellow Edmur Pugliesi from Sao Paulo University in Brazil began a three-month stay at UMTRI on April 11, working with Paul Green and his team in the Human Factors Division.

Pugliesi's research focuses on the development and evaluation of interfaces used on in-car navigation systems, especially cartographic communication, driver workload, and the development of driving simulators.

Pugliesi received his Ph.D. in cartographic sciences from Sao Paulo State University in Brazil in 2007. As part of the postgraduate program in the Faculty of Sciences and Technology at the university, Pugliesi contributed to research evaluating the influence of different cartographic representations of in-car navigation systems on visual demand, subjective preference, and navigational error. Findings are summarized in the article "Evaluation of the Cartographic Communication Performance of a Route Guidance and Navigation System," published in the April 2009 issue of the journal *Cartography and Geographic Information Science*.

Pugliesi's research at UMTRI will help evaluate the quality of data derived from driving simulators in terms of visual demand and workload processing. He also hopes to initiate relationships with companies that commercialize in-car driving simulators and to establish international cooperation in order to exchange knowledge and experience. [RR](#)

UMTRI NAMES & FACES

Most UMTRI reports are available in full text online. See the website address at the end of the citation. Please contact the UMTRI Library at 734-764-2171 or [umtridocs@umich.edu](mailto:umtridocs@umich.edu) to inquire about the availability of other publications listed here.

## Book Chapters

Green, P.A. 2008. "Driver Interface Safety and Usability Standards: An Overview." In *Driver Distraction: Theory, Effects, and Mitigation*. Boca Raton, FL: CRC Press.

Smith, M.R.H; Witt, G.J.; Bakowski, D.L.; Leblanc, D.; Lee, J.D. 2008. "Adapting Collision Warnings to Real-Time Estimates of Distraction."

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The research documented in this report was sponsored the Federal Motor Carrier Safety Administration.

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<http://hdl.handle.net/2027.42/60936>

The research documented in this report was sponsored the Federal Motor Carrier Safety Administration.

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<http://hdl.handle.net/2027.42/61517>

The research documented in this report was sponsored the National Highway Traffic Safety Administration.

**RR**

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# CONFERENCES & EVENTS

Southern African Transport Conference  
July 6-9, Pretoria, South Africa  
[www.up.ac.za/academic/civil/satc/](http://www.up.ac.za/academic/civil/satc/)

Minority Transportation Officials Conference  
July 11-14, Dallas, Texas  
[www.comto.org](http://www.comto.org)

WASHTO Annual Meeting (AASHTO)  
July 11-15, Seattle, Washington  
[washto2009.com](http://washto2009.com)

International Forum on Traffic Records &  
Highway Safety Information Systems  
July 12-16, Phoenix, Arizona  
[www.atsip.org](http://www.atsip.org)

National Transportation Management  
Conferences  
July 12-17, Provo, Utah  
[www.transportation.org/meetings/220.aspx](http://www.transportation.org/meetings/220.aspx)

Powertrain Strategies for the 21st Century  
July 15, Ann Arbor, Michigan  
[www.umtri.umich.edu/divisionPage.php?pageID=47](http://www.umtri.umich.edu/divisionPage.php?pageID=47)

Mississippi Valley Conference (AASHTO)  
July 15-17, Grand Rapids, Michigan  
[www.michigan.gov/mvc2009](http://www.michigan.gov/mvc2009)

TRB Joint Summer Meeting  
July 19-22, Seattle, Washington  
[www.trb.org/calendar](http://www.trb.org/calendar)

Annual School Bus Expo  
July 25-29, Reno, Nevada  
[www.schoolbusconference.com](http://www.schoolbusconference.com)

Transportation Planning, Land Use, and Air  
Quality Conference  
July 28-29, Denver, Colorado  
[www.ucs.iastate.edu/mnet/tpluaq/home.html](http://www.ucs.iastate.edu/mnet/tpluaq/home.html)

Directions in Engine-Efficiency and Emissions  
Research (DEER) Conference  
August 3-6, Dearborn, Michigan  
[www1.eere.energy.gov/vehiclesandfuels/resources/conferences/deer/index.html](http://www1.eere.energy.gov/vehiclesandfuels/resources/conferences/deer/index.html)

ITE 2009 Annual Meeting and Exhibit  
August 9-12, San Antonio, Texas  
[www.ite.org/annualmeeting](http://www.ite.org/annualmeeting)

International Symposium on Teen Driver  
Safety  
August 20, Ann Arbor, Michigan  
<http://m-castl.org/node/57>

ITS World Congress 2009  
Sept. 21-25, Stockholm, Sweden  
[www.itsworldcongress.com](http://www.itsworldcongress.com)

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