

RESEARCH REVIEW

• UNIVERSITY OF MICHIGAN TRANSPORTATION RESEARCH INSTITUTE • January–MARCH 2011 • VOLUME 42, NUMBER 1 •



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Multilayered Approach Using GIS to Support Transportation Research

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UMTRI RESEARCH REVIEW

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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

Multilayered Approach

Using GIS to Support Transportation Research

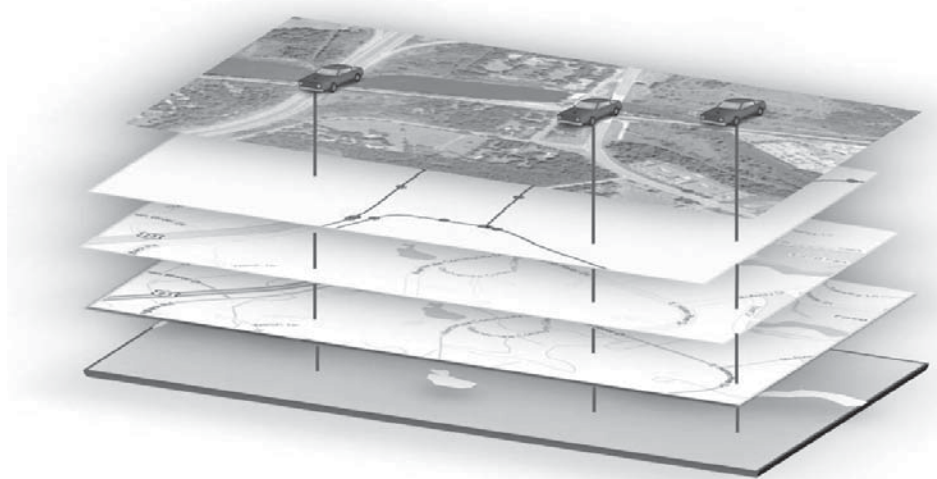
It's not uncommon these days for drivers to use Global Positioning System (GPS) devices to pinpoint the exact location of their vehicles. The GPS coordinates help drivers navigate unfamiliar routes, in essence providing a means to an end. For UMTRI senior research engineer Michelle Barnes, however, this spatial data is just the beginning.

Barnes, a researcher in UMTRI's Vehicle Systems and Control Group, uses GPS coordinates to spatially join data from multiple sources to create a detailed picture of the context surrounding a vehicle at any given moment. Those contextual details provide a wealth of new information that supports many UMTRI research projects.

Geographic information can include road data—such as number of lanes, traffic volume, setting (urban or rural), functional class, and speed limit—as well as weather conditions and historical crash data for the area.

Using Geographic Information System (GIS) software, researchers can fuse, or integrate, multiple data sources. Barnes likens the process to creating a “futuristic pin map” that contains detailed information about each pin.

“GPS alone doesn't tell the whole story,” says Barnes, “but when you fuse spatial data with information about the driver, the vehicle, road characteristics, and crash data, a multidimensional picture begins to emerge.”



MICHELLE BARNES, UMTRI VEHICLE SYSTEMS AND CONTROL GROUP

Using GIS software, researchers can join road data—such as number of lanes and traffic volume—with geographic location, driver information, and vehicle data.

Fusing Data

Key to that picture is UMTRI's extensive naturalistic driving data, which includes general driver characteristics and vehicle data, such as speed and braking, gathered during the course of research. This valuable information can be used in ways that were not possible even a few years ago. For instance, as new vehicles are equipped with radar and other sensors, they're better able to detect external objects such as lane markers, other vehicles, and infrastructure.

In a recent application, Barnes and colleagues used GIS to fuse naturalistic driving data and geographic data to help analyze results of the Integrated Vehicle-Based Safety System (IVBSS) program.

IVBSS is a \$32 million cooperative agreement with the U.S. Department of Transportation, UMTRI, and industry

partners to test an integrated system of crash-warning technologies. The technologies, which alert drivers to the risk of lane departure and forward collision, were tested on passenger cars and heavy trucks during 2009 and 2010. The dataset for the IVBSS program includes more than 800,000 miles driven, 46,000 trips, 20,000 hours of driving, and 1,100 data channels.

IVBSS project director, UMTRI associate research scientist Jim Sayer, was specifically interested in understanding what roadway circumstances triggered activation of the onboard safety devices.

“It's becoming increasingly important to understand the topography, the infrastructure, and traffic control devices along a roadway to understand why crashes occur and how these elements impact future safety systems,” he explains.

continued...

Close-up View

Spatial data can also include information on population density, land use, buildings, and intersections, depending on the availability of databases. This information may be useful, for instance, in an urban setting where the footprint of a building impacts a car's ability to recognize a traffic signal or approaching vehicles. "For some urban areas, we have the ability to zoom in to the level of the vehicle to see what's going on," says Barnes.



In a current project, Barnes is working with assistant research scientist Carol Flannagan, who comanages UMTRI's Transportation Data Center, on a project for German automaker Audi to identify "accident hot spots" in urban areas. The research requires integrating a host of disparate data sources to create a close-up view of urban areas and how vehicles travel within them.

"In this instance, we'll help identify scenarios that make up most of the potential crash problem that an

urban driver is likely to come across," explains Flannagan.

The research is part of a larger

effort involving three other research universities to assist Audi in developing new driver-assistance technologies for the urban setting.

GIS and data-fusion techniques have also been used at UMTRI to support research on identifying crash surrogates and in the analysis of results gathered during vehicle field-testing.

In essence, explains Barnes, virtually anything that can be linked to a fixed location can be integrated to reveal new information and data patterns. The range of possible areas of inquiry for researchers has grown substantially since the advent of GIS.

RR

UMTRI Collaborates with Toyota on New Safety Research Center

UMTRI is one of three charter partners in a new, advanced-safety research center that will help reduce the number of traffic fatalities and injuries on America's roads.

The Collaborative Safety Research Center will be based at the Toyota Technical Center in Ann Arbor and will involve Toyota researchers and engineers from North America and Japan, as well as UMTRI researchers and those from the Virginia Tech Transportation Institute and the Children's Hospital of Philadelphia Research Institute. Toyota will commit \$50 million over the next five years to fund the center.

Research at the new center will focus on integrated ways to enhance safety, involving the vehicle, driver, and traffic environment. Initial areas of emphasis will include reducing the risk of driver distraction (a growing cause of accidents), helping to protect the most vulnerable traffic populations (including children, teens and seniors), and conducting in-depth analyses of available accident and human-behavior data to support efforts to evaluate and speed deployment of active-safety systems.

UMTRI will be involved on a multidisciplinary project to assess the potential benefits of advanced-safety systems in a systematic way, combining researchers' expertise in driver behavior, crash data analysis and driver modeling.

"U-M is prominent in automotive-safety research and injury prevention across UMTRI, the Medical School, the School of Public Health and the College of Engineering, and this Toyota initiative will bring new energy to our joint efforts," said UMTRI director Peter Sweatman. "UMTRI will work closely with Toyota to coordinate opportunities for all of these university programs to collaborate in the new safety-research center."

Chuck Gulash, a senior executive engineer at the Toyota Technical Center, will serve as director of the Collaborative Safety Research Center.

"We have a long history of working closely with North American partners to achieve our safety objectives, and our new collaborative research initiative will build on this tradition," Gulash said. "We intend to publish as much of the research as possible so that it is available to federal agencies, the industry and academia."

In addition to UMTRI's research in advanced-safety systems, other initial projects at the Collaborative Safety Research Center include research by the Virginia Tech Transportation Institute on the effectiveness of an electronic coaching and monitoring system for newly licensed teenage drivers to help reduce unsafe driving behaviors, and a pilot study by the Children's Hospital of Philadelphia Research Institute to create America's first publicly available national crash-surveillance system focused on child vehicle occupants.

COURTESY OF CHUCK GULASH



Chuck Gulash, a senior executive engineer at the Toyota Technical Center, will serve as director of the Collaborative Safety Research Center.



UMTRI Researchers Participate in 90th TRB Meeting

UMTRI researchers and staff joined transportation professionals from around the world in Washington, D.C., January 23-27, for the 90th annual meeting of the Transportation Research Board (TRB).

The TRB annual meeting program covers all transportation modes, with more than 4,000 presentations in nearly 650 sessions and workshops addressing a wide variety of topics. The theme for this year's meeting was Transportation,

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Livability, and Economic Development in a Changing World.

The following UMTRI researchers presented papers and presided over sessions and committee meetings covering a range of topics representing UMTRI's research disciplines.

Ray Bingham, head of UMTRI's Young Driver Behavior and Injury Prevention Group, presented the poster "Motor Vehicle-Related Fatalities Under Age 20: Contribution of Teen Driver Crashes," coauthored by **Andrea Barretto**, **Jennifer Zakrajsek**, and **Jean Shope**. He also presented "Findings from National Survey of Parents' and Teens' Experience of Licensure Under Graduated Driver Licensing," coauthored by **Jean Shope**, and he attended the TRB Committee on Alcohol, Other Drugs, and Transportation, and the Subcommittee on Young Drivers.

David Eby, head of the Behavioral Sciences Group, participated in the meeting of the Committee on Safe Mobility of Older Persons, of which he is a member. He and **Renée St. Louis** attended the Occupant Protection Committee meeting where Renée presented "How States Have Recently Changed from Secondary to Primary Seat Belt Enforcement."

Steve Karamihas, senior research associate in the Vehicle Systems and Control Group, gave a demonstration of the "Optimal WIM Site Locator" in conjunction with George K. Chang of Transtec Group, Inc. He also presented "Benchmark Profile Measurement."

Lidia P. Kostyniuk, research scientist in the Vehicle Systems and Control Group, presented the posters "What Difference Does a Commercial Driver's License Make? Commercial Motor Vehicle Driver History and Crash Involvements," coauthored by **Daniel Blower**, and "Analysis of Crash Rates and Surrogate Events: Unified Approach," coauthored by **Timothy J. Gordon**, **Paul E. Green**, **Michelle Barnes**, **Daniel Blower**, **Adam D. Blankenspoor**, and **Scott Bogard**.

Lisa Molnar, lead research associate in the Behavioral Sciences Group, is a member of the Operator Education and Regulation Committee, and she participated in that committee meeting. She was a coauthor with Jude Charlton from Monash University Accident Research Centre on

the presentation "Self-Regulation, Self-Screening Instruments, and Safe Driving Practices" given by Dr. Charlton at the human factors workshop titled "Managing And Improving Safe Mobility Of Seniors: Identifying Interventions That Work." She and **David Eby** were also among several authors on a poster entitled "Do Memory-Impaired Drivers and Their Family Members Agree on Driving Ability and Behaviors?"

Nichole Ritchie Orton of UMTRI's Biosciences Group presented the poster "Drive Safe: Safety Tips for Wheelchair-Seated Drivers."

Jean Shope, research professor and UMTRI associate director, presided as chair of the TRB Committee on Alcohol, Other Drugs, and Transportation, and served as the elected secretary of the International Council on Alcohol, Drugs, and Traffic Safety at their Foundation Board and Executive Board meetings. She also attended the meeting of the Subcommittee on Young Drivers, of which she is a member. Jean also participated in an advisory panel for the Pacific Institute for Research and Evaluation's Impaired Driving Center and was coauthor on two presentations (listed previously).

Michael Sivak, research professor and head of UMTRI's Human Factors Group, and traffic behavior expert David Shinar organized a human factors workshop titled How Flat is the World? As part of the workshop, Sivak presented "An Application of the Concept of Total Harm to Road Safety in China, India, and Brazil."

Bob Sweet, UMTRI information resources manager, presided as chair of the TRB Information Services Committee meeting. He also attended meetings of the Library and Information Science for Transportation (LIST) Committee, and LIST's Transportation Research Thesaurus Subcommittee.

John Woodrooffe, research scientist in the Vehicle Safety Analytics Group, presented "Relationship Between Size and Weight and Greener Trucking" and "Canadian Truck Size and Weight Policy Development: Are There Lessons for the United States?"

Susan Zielinski, managing director of SMART, presented "Public-Private Innovation: Implementing Seamless Mobility Linking Modes, Services, Technologies, Design, Policy, and New Business Models." **RR**

Conference Highlights Automotive Safety

A steady decline in traffic fatalities over the past several decades is good news, but the number of people killed in motor-vehicle crashes is still “way too high,” said John Maddox of the National Highway Traffic Safety Administration (NHTSA). Maddox was the keynote speaker at a February 16 automotive-safety conference hosted by UMTRI at the University of Michigan.



“We have a lot of work to do,” Maddox told about eighty conference participants. He went on to highlight NHTSA’s strategic areas and programs that play a

key role in improving traffic safety including driver monitoring and support systems for crash avoidance, connected vehicles, pedestrian safety with relation to quiet electric vehicles, and addressing the problem of driver distraction.

UMTRI research professor Paul Green also highlighted the problem of driver distraction. He stressed the importance of distinguishing between distracted drivers, whose attention is diverted away from driving, and driver workload, which refers to the tasks a driver may be attempting at any given time. “How do you determine what’s too much for people to do?” asked Green, who emphasized the need for performance criteria.

Alan Korn of MeritorWabco discussed safety issues related to the heavy truck industry. He noted that heavy trucks are much more prone to roll over around curves than passenger cars and sport-utility vehicles, and he cited several technologies that are helping to address the problem including antilock braking systems (ABS), automatic traction control, and ABS-based stability control. Korn said he expects continued development of these vehicle control systems in the future. However, he added, “These systems are meant to be an aid to drivers, not a replacement.”


UMTRI’s Jonathan Rupp, assistant research scientist in the Biosciences Group, noted the recent decline in traffic fatalities and attributed

the improvement to a number of factors including advancements in vehicle structures (such as stiffening of the occupant compartment), infrastructure improvements, and the use of seatbelts and airbags.

Despite the advancements, Rupp noted that motor-vehicle crashes are the leading cause of death for people between the ages of 4 and 34. There are approximately 34,000 fatalities and 2.1 million injuries each year in road-traffic crashes. The annual economic cost is estimated at \$231 billion.

Improvements in vehicle structures, new safety technologies such as electronic stability control, and enhancements in vehicle restraint systems will all play a role in improving automotive safety in the future, Rupp said. However, he added, new technologies, which are slow to penetrate into the vehicle fleet, are only part of the solution to preventing crash-induced injuries. Behavioral changes—such as increases in seat-belt use and decreases in intoxicated driving—are critically important, as these changes can have immediate effects.

Other speakers at the daylong conference included Kurt Fischer of TRW, who provided a safety supplier’s perspective on the business side of safety as well as future product trends, and Jennifer Timian of NHTSA, who discussed the automotive recall process and the recent history of recalls. Timian emphasized that the manufacturer always performs the recall, but NHTSA takes responsibility to assist in the success of the recall campaigns. She also highlighted NHTSA’s new automotive recall notification system, www.safercar.gov, where auto owners can sign up to be notified of any recalls on their vehicles.

UMTRI assistant research scientist Bruce Belzowski moderated the conference, which was part of UMTRI’s Focus on the Future conference series. The next event in the series is scheduled for April 20. For details, see <http://www.umtri.umich.edu/divisionPage.php?pageID=47> 

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Changes to State GDL Law Will Benefit Teen Driver Safety

The Michigan legislature recently approved changes to the state law addressing graduated driver licensing, placing new restrictions on novice teen drivers.

Effective March 30, the nighttime driving restriction for new drivers with a level 2 graduated drivers license (GDL) is 10 p.m. In addition, drivers with a level 2 GDL cannot have more than one passenger under the age of 21, except if the passengers are members of the driver's immediate family, or if the trip being taken is to or from school or a school-sponsored event.

Research professor Ray Bingham, head of UMTRI's Young Driver Behavior and Injury Prevention Group, gave testimony last June in support of the changes, summarized in House Bill 4493.

"Driving with a teenage passenger and driving at night are two of the most dangerous conditions teens face in the first months of learning to drive," said Bingham. "By placing limits on the number of passengers teens can carry, this revised GDL law will, without a doubt, reduce crashes and save lives in Michigan."

The three levels of a graduated drivers license include learner (driving only with supervision), intermediate (driving unsupervised with restrictions), and full (no restrictions).

For more information on UMTRI's Young Driver Behavior and Injury Prevention Group, see <http://www.umtri.umich.edu/divisionPage.php?pageID=293> **RR**

New U-M Injury Center Strengthens Capacity in Injury Research

A new University of Michigan Injury Center has grown out of efforts at the U-M School of Public Health (SPH), Medical School, and UMTRI.

The former U-M Center for the Prevention of Injury among Youth and the Emergency Medicine's Injury Research Center have merged in order to build and strengthen capacity in injury research at the University of Michigan. The Injury Center will develop innovative methods, programs, and policies to prevent injuries and violence through research, education, and outreach.

The Center faculty's core research strengths currently focus on injury-related interventions, especially those utilizing computer- and media-based technology, in the areas of transportation, violence, and adolescents/young adults. Other areas of injury are of interest for future work.

"It's exciting to see increasing interest and support for injury research and prevention at the U-M," said UMTRI associate director Jean Shope. "The partnership of UMTRI, SPH, and the Med School in funding the new center will enhance our ongoing research and teaching, and position us well to become leaders in reducing the huge societal burden caused by all types of injuries."

Visit the website at <http://www.med.umich.edu/em/injurycenter/> **RR**

Shinar Highlights Problem of Aggressive Driving

Traffic behavior expert David Shinar visited the University of Michigan and UMTRI on January 19. Dr. Shinar is the George Shrut Professor of Human Performance Management, Department of Industrial Engineering and Management, Ben Gurion University of the Negev, Israel.

Shinar authored the book *Traffic Safety and Human Behavior*, cited by Dr. David Sleet of the National Center for Injury Prevention and Control, Centers for Disease Control and Prevention, as “the best current source of information on traffic safety and behavior by a leading authority.”



COURTESY OF DAVID SHINAR

During his visit to U-M, Shinar discussed shared research interests with staff at UMTRI and later presented research findings on aggressive driving at the School of Public Health. His presentation, “Aggression on the Road: Is it Aggressive Drivers or Driver Aggression?” was part of the OVPR Distinguished Faculty and Graduate Student Seminar Series on injury prevention.

The concept of aggressive driving is not a new phenomenon, Shinar said. He cited a 2003 Gallup Europe survey of 13,000 drivers in twenty-three counties who answered questions about aggressive driving behavior. Overall, the percentage of drivers who are “sometimes very annoyed by the behavior of other drivers” is generally high but varied by country. In the United States, seventy-seven percent agreed with the statement.

While many of those surveyed said they were annoyed by aggressive drivers, a much lower percentage admitted to driving aggressively themselves. In addition, people’s perceptions of their own driving skill is generally high. What is considered to be “very irritating” also varied by country,

with traffic maneuvers such as double parking and passing on the right accepted in some countries but not in others.

The definition of aggressive driving also varies, said Shinar, who presented several definitions including a theory-based definition that divides aggressive driving into two types—instrumental (proceeding in traffic to achieve a goal, via weaving or running red lights, for example) and hostile (venting anger, manifested in behaviors like honking and tailgating).

Shinar noted that studies show that driver aggression is closely related to general aggression, and that anger breeds aggression. In one study, drivers were asked to relive angry moments just prior to driving in a simulator. The probability of running a traffic light was higher when subjects were angry, Shinar said, adding, “People behave very differently when they’re angry.”

He also addressed the question of why aggressive driving seems so common now, noting that the perception worldwide is that aggressive driving has increased.

“Are drivers more aggressive?” Shinar asked, “or is the situation more frustrating?” He pointed out that with the increase in traffic congestion over time, the number of people affected by aggressive drivers also rises. “As congestion increases, more and more people are affected,” Shinar said. “This triggers more and more people to respond.”

In concluding remarks, Shinar suggested that effective ways to reduce driver aggression should include engineering through highway and traffic design to eliminate delays. Strategies might include increased use of roadways with passing lanes, traffic-calming strategies, and roundabouts to facilitate safe traffic flow.

For more information about Dr. Shinar’s presentation or others featured in the OVPR Distinguished Faculty and Student Seminar Series, see www.med.umich.edu/em/injurycenter/seminars.htm 

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 to inquire about the availability of other publications listed here.

Journal Articles

Blower, D.F.; Green, P.E. 2010. "Motor Carrier Type and Driver History in Fatal Bus Crashes." *Transportation Research Record*, vol. 2194, pp. 37-43, DOI: 10.3141/2194-05.

Hu, J.; Klinich, K.D.; Miller, C.S.; Rupp, J.D.; Nazmi, G.; Pearlman, M.D.; Schneider, L.W. 2010. "A Stochastic Visco-Hyperelastic Model of Human Placenta Tissue for Finite-Element Crash Simulations." *Annals of Biomedical Engineering*, vol. 39, no. 3, pp. 1074-1083, DOI: 10.1007/s10439-010-0222-0.

Hu, J.; Ma, C.; Chou, C.C.; Yang, H.H. 2010. "Finite Element Analysis of Occupant Head and Neck Injury Mechanism during Rollover Crashes." *International Journal of Vehicle Design*, vol. 54, no. 3, pp. 238-261, DOI 10.1504/IJVD.2010.036129.

Kim, H.; Reed, M.P.; Martin, B.J. 2010. "A Model of Head Movement Contribution for Gaze Transitions." *Ergonomics*, vol. 53, no. 4, pp. 447-457, DOI 10.1080/0014013090348371.

Klinich, K.D.; Reed, M.P.; Manary, M.A.; Orton, N.R. 2010. "Development and Testing of a More Realistic Pelvis for the Hybrid III 6YO ATD." *Traffic Injury Prevention*, vol. 11, no. 6, pp. 606-612, DOI: 10.1080/15389588.2010.506502.

Loffredo, M.C.M.; Ebert, S.; Arruda, C.; Reed, M.P. 2010. "Static Analysis of Harness Fit in Forward-Facing Child Restraints." *Brazilian Journal of Biomedical Engineering*, vol. 26, no. 2, pp. 99-104.

Technical Reports

LeBlanc, D.J.; Sivak, M.; Bogard, S. 2010. Using Naturalistic Driving Data to Assess Variations in Fuel Efficiency among Individual Drivers. Report no. UMTRI-2010-34.

The research documented in this report was sponsored by UMTRI's Sustainable Worldwide Transportation program.

Sivak, M.; Schoettle, B. 2010. Drivers on Unfamiliar Roads and Traffic Crashes. Report no. UMTRI-2010-31.

<http://hdl.handle.net/2027.42/78448>

The research documented in this report was sponsored by UMTRI's Sustainable Worldwide Transportation program.

Sivak, M.; Schoettle, B. 2010. Headlamps and Pedestrian Injuries. Report no. UMTRI-2010-6.

<http://hdl.handle.net/2027.42/78421>

The research documented in this report was sponsored by UMTRI's Industry Affiliation Program for Human Factors in Transportation Safety.



CONFERENCES & EVENTS

March

Transportation & Infrastructure Convention
March 9-11, Washington, D.C.
www.transportationsummit.com

Geo-Frontiers 2011
March 13-16; Dallas, Texas
www.trb.org/Calendar

2011 Joint Rail Conference: Shared Corridors,
Shared Interests*
March 16-18; Pueblo, Colorado
www.trb.org/Calendar

Traffic Safety Conference
March 21-23, Austin, Texas
<http://tti.tamu.edu/group/cts/2011-traffic-safety-conference/>

Lifesavers: National Conference on Highway
Safety Priorities
March 27-29; Phoenix, Arizona
www.lifesaversconference.org

Design-Build in Transportation
March 28-30; Kansas City, Missouri
www.dbtranspo.com/

TransITech Conference
March 29-31; Miami, Florida
www.apta.com

Fifth Annual University Network Summit:
Catastrophes and Complex Systems:
TRANSPORTATION
March 30-April 1; Washington, DC
www.trb.org/Calendar

April

ITE Technical Conference and Exhibit
April 3-6, Lake Buena Vista, Florida
www.ite.org/conference

Transforming Transportation Summit
April 7-9, Detroit, Michigan
www.ttrcc.org

APA National Planning Conference
April 9-12; Boston, Massachusetts
www.planning.org/conference/

SAE World Congress
April 12-14; Detroit, Michigan
www.sae.org/congress

May

International Transportation Economic
Development Conference
May 1-3; Charleston, West Virginia
www.trb.org/Calendar

TRB National Transportation Planning
Applications Conference
May 8-12; Reno, Nevada
www.trb-appcon.org/

Transportation Planning, Land Use, and Air
Quality Conference
May 9-10; San Antonio, Texas
www.ucs.iastate.edu/mnet/tpluaq/home.html

3rd Int. Conference on Roundabouts
May 18-20; Carmel, Indiana
www.trb.org/Calendar

Bus and Paratransit Conference
May 22-25; Memphis, Tennessee
www.apta.com

WTS Annual Conference
May 18-20; San Francisco, California
www.wtsinternational.org

June

ITS Canada Conference
June 12-15; Vancouver, Canada
www.itscanada.ca/english/annualconferences.htm

Driving Assessment Conference
June 27-30; Lake Tahoe, California
<http://drivingassessment.uiowa.edu/>

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Transforming Transportation Summit: Economies and Communities

Business and labor leaders, policymakers, innovators, and research scholars from the United States and abroad will convene in Detroit, April 7-9, at the inaugural Summit on Transforming Transportation: Economies and Communities. Participants will collaborate to advance knowledge, systems, and solutions that can transform the future of transportation and revitalize economies and communities in Michigan and beyond.

Program themes will explore sustainability, climate change, and energy efficiency; safety, national security, and resilience related to movement of people and goods; emerging new mobility enterprises and employment trends and opportunities; organized labor and the future of transport; rail and supply chain management; and values, culture, and social science of our transportation choices and systems.

The summit is hosted by Sustainable Mobility and

Accessibility Research and Transformation (SMART) and the University Research Corridor (URC), a collaboration of the University of Michigan, Michigan State University, and Wayne State University.

To register, visit the summit website at www.ttrcc.org

