

UMTRI

RESEARCH REVIEW

• UNIVERSITY OF MICHIGAN TRANSPORTATION RESEARCH INSTITUTE • JULY-SEPTEMBER 2014 • VOLUME 45, NUMBER 3 •



Connected Vehicles 101: Learning through Experience

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Cover Image: Instructor Kim Garber explains vehicle systems to MITE students. Credit: Francine Romine, UMTRI

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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

Connected Vehicles 101: Learning through Experience

A working visit to UMTRI—including a hands-on introduction to connected-vehicle technology—was part of the itinerary for thirty teenagers who visited the University of Michigan for two weeks this summer. The students came from high schools in Detroit, Southfield, and Grand Rapids to take part in the Michigan Introduction to Technology and Engineering (MITE) program, which is sponsored by the College of Engineering.

Hans Sowder of the U-M Center for Engineering Diversity and Outreach (CEDO), K-12 programs, worked with several UMTRI researchers to develop the special curriculum with an eye toward maximizing educational interaction.

“The whole concept of vehicles communicating with one another is a very relevant, present-day topic: How do you improve transportation efficiency and reduce vehicle crashes through technology? These are some of the big questions that engineers are tackling,” said Sowder.

UMTRI electronics engineer Mark Gilbert coordinated much of the students’ visit to UMTRI.

“We wanted to introduce the students to connected-vehicle technology, provide some hands-on experience, and get them thinking about what it means for the future,” said Gilbert.

Circuit Boards and Segways

Among their activities, students spent time at UMTRI helping technicians install aftermarket safety devices (ASDs) in vehicles. The devices are similar to those used in the Safety



FRANCINE ROMINE, UMTRI

UMTRI engineer Mark Gilbert explains a V2V communication device.

Pilot Model Deployment, the UMTRI-led connected-vehicle program.

UMTRI engineer Dillon Funkhouser then led the students on a tour of the connected-vehicle test route in northeast Ann Arbor. Back at UMTRI, students gathered data on vehicle systems and worked with basic electronic circuits. They also had the opportunity to experience UMTRI’s state-of-the-art driving simulator and learn about the specific math and computer skills required to operate the high-tech equipment.

The highlight of the visit, however, may well have been the final activity—a Segway tour around north campus, complete with fully operational, vehicle-to-vehicle (V2V) communication devices. The devices were borrowed from the Safety Pilot Model Deployment program and featured the same hardware as is currently deployed in the field. The devices collected such data as path, speed, and heading, similar to the data collected by the ASD devices used in the Safety Pilot, but without driver alerts.

After the tour, Gilbert and colleagues downloaded the data and generated datasets for the students to analyze and try their hand at conducting various mathematical calculations.

“I think this was an exceptional experience for the students,” commented Mike Oelke, recruitment and admissions counselor in the College of Engineering, who facilitated use of the Segways.



FRANCINE ROMINE, UMTRI

MITE students work on electronic circuit boards.

Continued on page 2

MARK GILBERT, UMTRI



A MITE student rides a Segway equipped with a V2V communication device.

Putting Knowledge to the Test

The UMTRI activities culminated when students put their knowledge to the test in a small-group, product-development activity and poster competition. Each group of students developed a product idea incorporating dedicated short-range communication (DSRC), employed in V2V communication. The groups then gave presentations on what they had learned about DSRC technology and their product ideas. They also created displays that demonstrated the technology and the product. Displays were judged

by a variety of individuals including Gilbert and UMTRI colleague Debra Bezzina.

“We asked them: what would you do with connected-vehicle technology?” said Gilbert. “We got everything from science fiction to practical applications like traffic-signal preemption for buses. It was very interesting. They came up with some good, real-world ideas.”

Bezzina noted how quickly the students understood the information.

“I was amazed at how well the students were able to grasp the concept of the technology and generate creative product solutions—some of which are currently being pursued by real world companies,” said Bezzina.



FRANCINE ROMINE, UMTRI



UMTRI technicians Ken Winzeler (front) and John Koch install V2V communication devices on Segways.

Getting Excited about Engineering

The Michigan Introduction to Technology & Engineering (MITE) program is geared toward ninth- and tenth-grade students and is designed to “excite, engage, educate and empower” participants with an integrated curriculum that centers on an engineering-based project. The MITE program takes place in July and has up to forty student participants.

MITE students attend four key, academic-support classes: technical communications, engineering math, professional development, and engineering concepts, which are designed to support the project on which the students are focused while working in partnership with their in-school experience of those subject areas. Students also participate in workshops on entrepreneurship, cultural engagement, and preparing for college, in addition to guided tours of the college and university facilities and outdoor recreational activities.

MITE is one of several programs for middle- and high-school students offered through the Center for Engineering Diversity and Outreach (CEDO), Summer Engineering Academy. For more information, see <http://cedo.engin.umich.edu/summer-engineering-academy/>.



A MITE student operates the UMTRI driving simulator.

U-M Mobility Transformation Center Announces Founding Corporate Partners

A select group of companies will be the founding partners in the University of Michigan's Mobility Transformation Center (MTC), a major public-private R&D initiative that aims to revolutionize the movement of people and goods in society, the university announced September 5.

Spanning such sectors as auto manufacturing, suppliers, ITS, insurance, telecommunications, data management, and mobility services, the MTC's Leadership Circle will join with government and academic partners to lay the foundations for a commercially viable system of connected and automated vehicles. Plans call for implementing a working system in Ann Arbor by 2021.

"We are on the threshold of a transformation in mobility that the world hasn't seen since the introduction of the automobile a century ago," said Dr. Peter Sweatman, director of the MTC. "Our founding Leadership Circle provides a unique nucleus for collaboration, deployment, and rapid learning in connected and automated mobility."

Connected-vehicle technology has been employed extensively by UMTRI in the USDOT's Safety Pilot Model Deployment in Ann Arbor. The results have been used to support the recent announcement of an advanced notice of proposed rulemaking by the National Highway Traffic Safety Administration. (*See page 4.*) Connected-vehicle technology, including vehicles that can communicate with one another (V2V) and with the surrounding infrastructure (V2I), has the potential to avoid the majority of serious crashes when extensively deployed.

With the help of the Michigan Economic

Development Corporation (MEDC), MTC is building on this two-year deployment of approximately 3,000 vehicles to create a major V2V deployment of 9,000 vehicles in Ann Arbor. The center is also working with the Michigan Department of Transportation (MDOT) and industrial partners to provide sufficient V2I infrastructure in southeast Michigan to support an unprecedented deployment of 20,000 connected vehicles.

"This is the next big thing for the state that put the world on wheels," said MDOT Director Kirk T. Steudle. "We are thrilled to join our partners in private industry and the University of Michigan in supporting groundbreaking research to keep our state in the lead in building the safest and most efficient vehicles in the world."



In addition to their definitive role for safety, connected vehicles will accelerate the deployment of one of the most exciting concepts in transportation today: vehicle automation. To make the most of this convergence, MTC is developing an off-roadway facility for testing connected and automated vehicles.

Occupying thirty-two acres on U-M's North Campus Research Complex, the Mobility Transformation Facility (MTF) will be a unique off-roadway cityscape with the broad range of complexities that vehicles encounter in urban and suburban environments. Scheduled to be completed in 2015, it includes four lane-miles of roads with intersections, roadway markings, traffic signs and signals, sidewalks, simulated buildings, streetlights, parked cars, and obstacles such as construction barriers. This facility was designed and is being constructed in partnership with MDOT and will be available to Leadership Circle members to work collectively on big-system issues as well as on specific technological developments.

Continued on page 4

UMTRI BRIEFS

With the goal of accelerating progress in the development and implementation of connected and automated technology, Leadership Circle members will work together to identify emerging opportunities as well as the barriers to realizing them, anticipate and help shape key standards and regulations, and help guide the direction of the research.

Founding members of the Leadership Circle are each committing a total of \$1 million over three years to create a vibrant R&D ecosystem, and to support the MTC and its programs. A broader range of companies will engage in the work of the center as affiliates.

The founding members of the MTC Leadership Circle are: Delphi Automotive PLC; DENSO Corporation; Econolite Group, Inc.; Ford Motor Co.; General Motors Co.; Honda Motor Co., Ltd; Iteris, Inc.; Nissan Motor Co., Ltd; Robert Bosch LLC; State Farm Mutual Automobile Insurance Company; Toyota Motor Co.; Verizon Communications, Inc.; and Xerox Corp. **RR**

V2V on the Horizon

NHTSA releases advance notice of proposed rulemaking on V2V communication technology

The U.S. Department of Transportation’s (DOT) National Highway Traffic Safety Administration (NHTSA) released an advance notice of proposed rulemaking (ANPRM) on vehicle-to-vehicle (V2V) communications technology and a supporting comprehensive research report on August 18.

The report includes analysis of the department’s

research findings in several key areas including technical feasibility, privacy and security, and preliminary estimates on costs and safety benefits, while the ANPRM seeks public input on these findings to support the department’s regulatory work to eventually require V2V devices in new light vehicles.

“Safety is our top priority, and V2V technology represents the next great advance in saving lives,” said U.S. Transportation Secretary Anthony Foxx. “This technology could move us from helping people survive crashes to helping them avoid crashes altogether – saving lives, saving money and even saving fuel thanks to the widespread benefits it offers.”

UMTRI director Peter Sweatman said the news represents a significant step forward for road safety.

“We share NHTSA’s optimism that connected-vehicle technology holds significant promise in making the nation’s roadways safer for all road users,” said Sweatman. “We expect that these actions send a clear signal to a broad range of industries that wireless communication between vehicles, the roadway, and all road users is a significant and irreplaceable step forward for safety.”

“We are also proud to have played a role as test conductor of the Safety Pilot Model Deployment, being responsible for collecting data that served as part of the basis for the USDOT’s report and rule-making notice,” said Sweatman.

The NHTSA report includes preliminary estimates of safety benefits that show two safety applications – left turn assist (LTA) and intersection movement assist (IMA) – could prevent up to 592,000 crashes and save 1,083 lives per year. Put another way, V2V technology, by providing advance warning, could help drivers avoid more than half of these types of crashes that would otherwise occur. LTA warns drivers not to turn left in front of another vehicle traveling in the opposite direction, and IMA warns them if it is not safe to enter an intersection due to a high probability of colliding with one or more vehicles. Additional applications could also help drivers avoid imminent danger through forward-collision, blind-spot, do-not-pass, and stop-light/stop-sign warnings.

The ANPRM will help DOT and NHTSA gather significant input from the public and stakeholders as NHTSA works to deliver a Notice of Proposed Rulemaking by 2016. **RR**



USDOT

Research Shows State's Texting Ban Does Not Reduce Crash Risk

After four years on the books, Michigan's ban on texting while driving does not increase traffic safety, according to research published recently in the *Journal of Adolescent Health*.

Researchers led by Johnathon Ehsani, formerly of UMTRI, analyzed seven years of state crash data spanning before and after the introduction of the state's text messaging restriction to determine the effects of the ban. The team hypothesized that the texting ban would be followed by a reduction in crashes of all severities for drivers aged 16 to 50 years. Instead, they found almost the opposite to be true.

"Michigan's texting restriction did not have a sizable impact on crashes," said Ehsani of the Eunice Kennedy Shriver National Institute of Child Health and Human Development. "Across all age groups, we found that changes in crash rates and trends were small and generally not significant. Of the effects that were significant, most showed an increase in crash risk."

On the positive side, the researchers found significant decreases in less severe crashes, labeled in the state data as possible injury crashes or property damage only (PDO) crashes.

Nationally, government agencies and safety advocates have endorsed restrictions on cell phone use for talking and texting, including an outright ban for all drivers younger than eighteen years of age. To date, over forty states have passed legislation restricting all cell phone use for sixteen- and seventeen-year-old drivers, and at least ten states have restricted handheld cell phone use for all drivers. Michigan's texting ban went into effect in July 2010.

"We thought teen drivers would be most affected by the restrictions," said UMTRI research professor Ray Bingham, co-investigator of the study. "What we found was that the policy by itself is not effective in reducing crash risk. This is consistent with other evaluations of texting bans."

Interpreting the Data

Results of the study—the small increases in the most severe crash types and the decrease in the least severe crash types—following the introduction of the texting restriction are challenging to interpret in the absence of data on driver behavior.

"It may be that drivers are compensating in a way that distracts them even more," explains Bingham, "but we have no data to indicate what that might be. A good guess is that the ban encourages drivers to engage in other distractions that take their eyes off the road for longer periods at a time."

Bingham, head of UMTRI's Young Driver Behavior and Injury Prevention Group and professor in the U-M School of Public Health, says one thing is certain: legislation alone isn't enough.

"Just passing a ban doesn't do it," says Bingham. "It's never enough just to have a law in place. There are other elements that have to go with it. These include public education and the use of persuasive approaches that encourage the avoidance of all distractions including texting while driving."

The next steps for this line of research, says Bingham, are taking different approaches—possibly conducting driver surveys or analyzing naturalistic driving behavior—to further explore the link between texting restrictions and crash reduction.

For current information on state texting laws, see www.distraction.gov/content/get-the-facts/state-laws.html **RR**



UMTRI YOUNG DRIVER BEHAVIOR AND INJURY PREVENTION GROUP

New Faculty Researchers Join UMTRI



Robert C. Hampshire

Robert C. Hampshire joined UMTRI in September 2014. Robert is an assistant research professor in UMTRI's Human Factors Group. He was previously an assistant professor of operations research and public policy at

the H. John Heinz III College at Carnegie Mellon University. He received a PhD in operations research and financial engineering from Princeton University in 2007.

Hampshire's research focuses on management, modeling, and optimization of services. His work considers mobility services such as smart parking, connected vehicles, ride sharing, bike sharing, car sharing and person-to-person car sharing. This work is supported by the National Science Foundation, Department of Transportation, and several nonprofit foundations. He uses stochastic modeling, simulation, and dynamic optimization to develop design and management strategies. More specifically, his methodological interests are: dynamic control of transient stochastic systems, queuing networks with time-varying rates, and asymptotic approximations (strong approximations).



Henry Liu, Engineering Systems

Henry Liu joined UMTRI in September 2014. He is a research professor in UMTRI's Engineering Systems Group. He is also a professor in the U-M Department of Civil

and Environmental Engineering. Prior to joining the University of Michigan, Liu was an associate professor of civil engineering at the University of Minnesota, Twin Cities. He received his Ph.D. degree in civil and environmental engineering from the University of Wisconsin at Madison in 2000.

Liu's research interests are in the area of traffic-network monitoring, modeling, and control, which includes traffic-flow modeling and simulation,

traffic-signal operations, network traffic assignment, and mobility and safety applications with connected vehicles. On these topics, he has published more than sixty articles in peer-reviewed journals. Liu's research has been funded mainly by the National Science Foundation, U.S. Department of Transportation (USDOT), Minnesota DOT and California DOT, with research expenditures exceeding \$5 million in the last ten years. Dr. Liu is an associate editor for *Transportation Research Part C, Journal of Intelligent Transportation Systems, Network and Spatial Economics*, and *Transportmetrica Part B*.

Blower Chosen as Chair of Michigan Truck Safety Commission



UMTRI associate research scientist Daniel Blower was recently chosen as incoming chair of the Michigan Truck Safety Commission.

Blower was first appointed to the eleven-member commission by Michigan Governor Rick Snyder in 2011 and was recently reappointed to a second term, confirmed by the Michigan Senate. He was nominated and approved as incoming chair at the group's September meeting and will begin his term as chair on November 9, 2014.

"It is a quite a personal honor to be nominated as chair of the Michigan Truck Safety Commission," said Blower. "It is also a reflection of the stature that UMTRI commands and the high regard for the work that UMTRI has done for the State of Michigan, particularly with the Michigan Office of Highway Safety Planning."

Blower is an associate research scientist in UMTRI's Vehicle Safety Analytics Group. He began at UMTRI over twenty-five years ago, working on the Trucks Involved in Fatal Accidents project. Medium and heavy trucks have been a primary research emphasis, but he has also directed projects on traffic-safety issues related to light vehicles. Blower's current primary area of interest is traffic-

crash causation.

On the Michigan Truck Safety Commission, Blower represents Michigan's four-year colleges and universities. As chair, he will serve a two-year term, replacing outgoing chair Fred Bueter of the Michigan Secretary of State office.

The Michigan Truck Safety Commission is committed to enhancing truck and truck-driver safety by providing truck-driver education and training, heightening all drivers' awareness of the operational characteristics and limitations of trucks, initiating data collection and research, and supporting enforcement of motor-carrier safety laws.

ITS China Leadership Visit



Leadership delegates from ITS China visited UMTRI on September 9. Shown from the left are Guizhen Yu of Beihang University; Yong Zhu, Chairman of Eagle Software Co., Ltd; Zhifang Chen, Chairman of Beijing Yesway Information Technology Co., Ltd; Yunpeng Wang of Beihang University; Henry Liu of UMTRI; Diange Yang of Tsinghua University; Zhongze Wu, Chairman of ITS China, Former Vice Minister of Science and Technology, China; Jizhen Guan, Secretary of ITS China, Chairman of Beijing STONE ITS Co., Ltd; Jim Sayer of UMTRI; Zhiheng Li of Tsinghua University; Jincal Yang, Managing Director of ITS China, Chairman of ITS Shenzhen; Chunquan Yu, Managing Director of ITS China, Former Chief of Beijing Traffic Management Bureau; Jingwen Hu of UMTRI; and a U-M student.

Leading Injury Biomechanics Researcher Presents Work with NFL

Richard Kent, deputy director of the University of Virginia's Center for Applied Biomechanics and a leading researcher in injury biomechanics and occupant protection, gave a presentation at UMTRI on September 19 on his use of automotive-safety research principles in recent work with the National Football League (NFL). Professor Kent works with the NFL's Player Health and Safety Committee to study factors related to player safety.



Professor Kent presented lessons learned from the prevention of automotive trauma in the context of sports. Kent highlighted ways in which fundamental science, biomechanics, standards development, and industrial relationships can play a role in injury prevention and how the experience of the automotive medicine community over the past fifty years can speed the development of more effective athletic protection.

Kent views his work with the NFL as a natural extension of the Center for Applied Biomechanics' work on automotive safety. In both cases, researchers are looking for ways to protect against injuries in complex environments.

"The fundamental science behind injury prevention is the same whether you're protecting a driver or an athlete," said Kent in a University of Virginia news release. "Once you understand what causes an injury, you can design effective countermeasures, set standards and guide policies. Just as research has driven continuous improvements in the designs of seatbelts and airbags, we can use the same tools to further protect athletes."

See also <https://news.virginia.edu/content/uva-researcher-leads-nfl-thigh-pad-testing-support-new-mandate>.

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

Buckley, L.; Chapman, R.L.; Sheehan, M. 2014. "Young Driver Distractions: State of the Evidence and Directions for Behavior Change Programs." *Journal of Adolescent Health*, vol. 54, no. 5, May 2014, pp. S16-S21. DOI:10.1016/j.jadohealth.2013.12.021

Cascio, C.N.; Carp, J.; O'Donnell, M.B.; Tinney, F.J.; Bingham, C.R.; Shope, J.T.; Ouimet, M.C.; Pradhan, A.K.; Simons-Morton, B.G.; Falk, E.B. 2014. "Buffering Social Influence: Neural Correlates of Response Inhibition Predict Driving Safety in the Presence of a Peer." *Journal of Cognitive Neuroscience*. Posted online August 6, 2014. DOI:10.1162/jocn_a_00693

Falk, E.B.; Cascio, C.N.; O'Donnell, M.B.; Carp, J.; Tinney, F.J.; Bingham, C.R.; Shope, J.T.; Ouimet, M.C.; Pradhan, A.K.; Simons-Morton, B.G. 2014. "Neural Responses to Exclusion Predict Susceptibility to Social Influence." *Journal of Adolescent Health*, vol. 54, no. 5, May 2014, pp. S22-S31. DOI:10.1016/j.jadohealth.2013.12.035

Klinich, K.D.; Flannagan, C.A.C.; Manary, M.A.; Moore, J.L.; Jermakian, J.S. 2014. "Survey of LATCH Vehicle Hardware." *International Journal of Crashworthiness*, vol. 19, no. 5, 2014, pp. 484-499. DOI:10.1080/13588265.2014.915076

Klinich, K.D.; Reed, M.P.; Ebert, S.M.; Rupp, J.D. 2014. "Kinematics of Pediatric Crash Dummies Seated on Vehicle Seats with Realistic Belt Geometry." *Traffic Injury Prevention*, vol. 15, no. 8, 2014, pp. 866-874. DOI:10.1080/15389588.2014.890720

Pradhan, A.K.; Li, K.; Bingham, C.R.; Simons-Morton, B.G.; Ouimet, M.C.; Shope, J.T. 2014. "Peer Passenger Influences on Male Adolescent Drivers' Visual Scanning Behavior during Simulated Driving." *Journal of Adolescent Health*, vol. 54, no. 5, May 2014, pp. S42-S49. DOI:10.1016/j.jadohealth.2014.01.004

Simons-Morton, B.G.; Guo, F.; Klauer, S.G.; Ehsani, J.P.; Pradhan, A.K. 2014. "Keep Your Eyes on the Road: Young Driver Crash Risk Increases According to Duration of Distraction." *Journal of Adolescent Health*, vol. 54, no. 5, May 2014, pp. S61-S67. DOI:10.1016/j.jadohealth.2013.11.021

Technical Reports

Blower, D.F. 2014. Key Pedestrian Collision Scenarios in the U.S. for Effective Collision Avoidance Technologies. Report no. UMTRI-2014-18. <http://hdl.handle.net/2027.42/108383>

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

Schoettle, B.; Sivak, M. 2014. An Overview of CAFE Credits and Incorporation of the Benefits of On-Board Carbon Capture. Report no. UMTRI-2014-15. <http://hdl.handle.net/2027.42/107473>

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

CONFERENCES & EVENTS

October 2014

SAE 2014 Commercial Vehicle Engineering Congress (COMVEC)
October 7-9; Rosemont, Illinois
www.sae.org/events/cvel

IEEE Conference on Intelligent Transportation Systems
October 8-11; Qingdao, China
www.itsc2014.org

Association for the Advancement of Automotive Medicine Conference
October 12-15; Munich, Germany
www.aaam.org/annual-meeting.html

Security at University of Michigan IT (SUMIT) Conference
October 14; Ann Arbor, Michigan
<http://safecomputing.umich.edu/events/>

Biomedical Engineering Society (BMES) annual meeting
October 22-25; San Antonio, Texas
www.bmes.org/annualmeeting

Human Factors and Ergonomics Society (HFES) annual meeting
October 27-31; Chicago, Illinois
www.hfes.org/web/bfesmeetings/2014annualmeeting.html

Green Fleet Conference & Expo
October 29-30; Schaumburg, Illinois
www.greenfleetconference.com

November 2014

International Conference on Connected Vehicles and Expo
November 3-7; Vienna, Austria
www.iccve.org/2014/

58th Stapp Car Crash Conference
November 10-12; San Diego, California
www.stapp.org

AASHTO Annual Meeting
November 20-24; Charlotte, North Carolina
www.aashtoannualmeeting.org/

Sustainable Mobility & Healthy Communities Summit
November 30-December 3; Markham, Ontario
www.actcanada.com/summit2014/summit/home

December 2014

National Accelerated Bridge Construction Conference
December 4-5; Miami, Florida
www.2014abc.fiu.edu/

January 2014

94th Annual TRB Meeting
January 11-15; Washington, D.C.
<http://www.trb.org/AnnualMeeting2015/AnnualMeeting2015.aspx>

New Partners for Smart Growth Conference
January 29-31; Baltimore, Maryland
www.newpartners.org/

February 2014

CERV—Conference on Electric Roads and Vehicles
Feb. 9-10; Park City, Utah
<http://www.cervconference.org/>

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