

RESEARCH REVIEW

• UNIVERSITY OF MICHIGAN TRANSPORTATION RESEARCH INSTITUTE • JANUARY–MARCH 2010 • VOLUME 41, NUMBER 1 •



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On the Road to Smooth Pavement

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UMTRI

RESEARCH REVIEW

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Cover Photography: Engineer Chris Winkler watches UMTRI's benchmark profiler in action. Photo by Steve Karamihas, 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
-

On the Road to Smooth Pavement

UMTRI engineers refine road quality measurement system

Before a new road is open to the public, contractors often use precision instruments to measure pavement quality and smoothness. The instruments, called road profilers, detect even small imperfections, which can affect ride quality for the average driver.

grown, many states are now using the instruments to monitor and evaluate contractor compliance with smoothness specifications,” says Karamihas. “The resulting measurements are often tied to bonuses or penalties for the contractor.”

With so much at stake, quality control has become increasingly critical. In 2005, a pooled fund study established by the Federal Highway Administration (FHWA) outlined the need to validate the accuracy of profiling devices by establishing a reference profile, or comparative benchmark.

During the past five years, Karamihas and UMTRI engineers Chris Winkler, Mike Hagan, and Mark Gilbert have been researching, developing, and testing an instrument that meets that need. With funding from FHWA Pooled Fund Study TPF-5(063), the team designed and built a low-speed, road-profiling machine that provides a reference measurement to verify the output of production profilers.

Known in industry circles as the benchmark profiler, the instrument resembles a small copy machine on wheels and scans pavement at about one foot every two seconds.

Traditionally, highway agencies verified the output of profiling devices using a very precise surveyor’s rod and level. The benchmark profiler employs the same concept, explains Karamihas, with important improvements and automation:

“A rod and level establishes the elevation at a given location by using a vertical rod to measure the distance of the road beneath a stable reference height. The benchmark profiler does the same thing automatically. It uses one Cognex machine vision system to establish the height of the device relative to a sweeping reference laser and another Cognex vision system to pilot the device very accurately along the track of interest. A Roline™ 1130 line laser, provided by LMI/Selcom, is used to establish the height of the road beneath the device.”

The output is a high-resolution scan of the road surface that can serve as the benchmark measurement for establishing the accuracy of other profilers.

UMTRI’s benchmark profiler was put through its paces for the first time at the Minnesota Department of Transportation’s MnROAD research facility in Monticello and at a concrete



UMTRI’s benchmark profiler.

Road profilers come in all shapes and sizes, from wheeled instruments pushed at walking speed to high-speed profilers mounted on vehicles or trailers. Most production profilers use a combination of lasers and accelerometers to measure the profile of a road. In turn, they estimate the effect on ride quality using the International Roughness Index (IRI).

The challenge, explains UMTRI senior research associate Steve Karamihas, is that measurements taken by road profilers can differ from one device to the next, creating discrepancies that have financial implications.

“As the market for profilers has

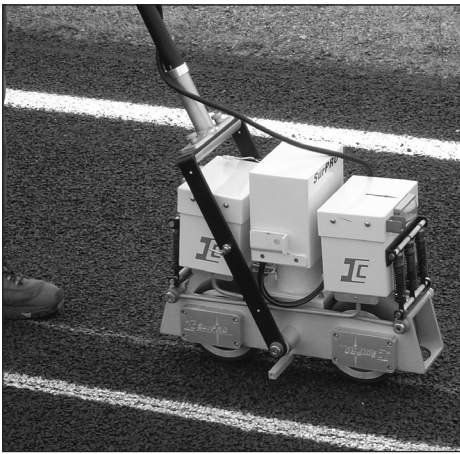


UMTRI engineers Scott Bogard and Chris Winkler operate UMTRI’s benchmark profiler.

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Continued from page 1

BOB ORTHMEYER/HMVA



Walking profiler, ICC SurPRO.

construction site in Wisconsin in October 2009. The benchmark profiler and six reference profilers of various designs tested their repeatability (consistency across multiple trials), reproducibility, and accuracy on six pavement sections.

Karamihas presented the results at the annual meeting of the Road Profiler Users' Group held in Atlanta in December 2009. Much of the analysis had just been completed that same week.

"It was all very theatrical," he recalls. "We brought the benchmark profiler with us and were able to demonstrate it live at the conference site, then remove the cover to display the key components and present the design. During the technical session,

I was able to present repeatability results as good as any I've ever seen. More importantly, the device lived up to some very stringent, but critical, requirements written at the start of the design phase."


The next step, says Karamihas, will be for the team to take what they've learned from the October 2009 testing to improve the benchmark profiler in preparation for another experiment, tentatively planned for June 2010.

Karamihas emphasizes that the ulti-



Gomaco GSI profiler.

mate goal is to help provide smoother and longer lasting roads to the public. An accurate, relevant measurement system is a critical part of that process.

For more information on road roughness, visit UMTRI's Road Roughness website at www.umtri.umich.edu/divisionPage.php?pageID=62 

Avoiding Localized Roughness

Road profilers allow contractors to assess the overall roughness of a road as well as "localized roughness," or isolated sections of flawed pavement.

Localized roughness can be caused by a number of factors during construction, such as when a material delivery vehicle accidentally nudges a paver (causing a bump in pavement), or when a paver stops temporarily (causing a dip in pavement).

When contractors use road profilers during construction, explains Karamihas, they have access to real-time measurements that allow them to identify and fix problem sections on site, helping to avoid expensive fixes after project completion.



High-speed profilers.

GEORGE CHANG/TRANSPEC GROUP



Digital level used for reference measurements.

GERARDO ELIUNISCH/UMTRI

Auto Show Display Features Biosciences Research

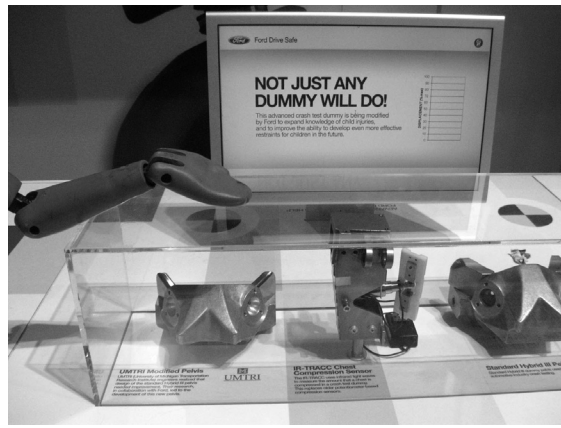
As part of its touring auto-show display, Ford Motor Company is showcasing new crash-dummy components developed in collaboration with UMTRI and the National Highway Traffic Safety Administration (NHTSA).

Research associate professor Matthew Reed and assistant research scientist Kathleen Klinich of UMTRI's Biosciences Group used medical imaging data to develop new specifications for the pelvis of a Hybrid-III crash-test dummy that represents a typical six-year-old child.

The new specifications govern size and shape. To obtain the new proportions, Reed and Klinich conducted a statistical analysis of the size and shape of pelvic bones of children from 5 to 12 years of age based on medical images, and then calculated the average pelvis size and shape for children similar in size to the crash-test dummy.

The new pelvis allows the dummy to simulate more accurately the interaction between a child and a seat belt. During frontal collisions, the lap portion of the seat belt should exert force on the bony pelvis, explained Reed, not on the soft abdomen.

"Belt pressure on the abdomen can cause injuries to the abdominal organs and spine fractures resulting in spinal-cord injury," said Reed.



CHRIS WINKLER/UMTRI

Biosciences research displayed at the 2010 North American Auto Show.

"The new pelvis design improves the sensitivity of the dummy to belt designs that put the abdomen and spine at risk. This makes the dummy respond to seatbelts more like a child would respond."

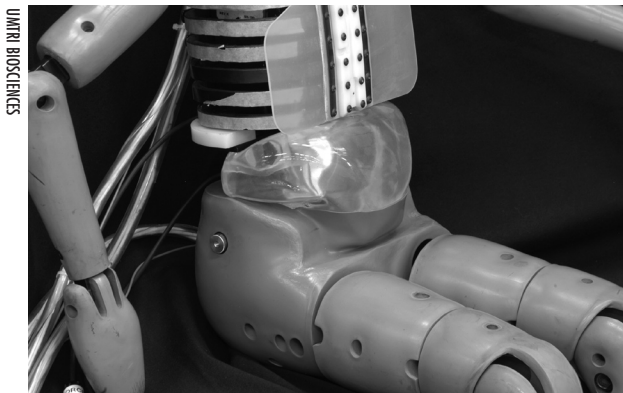
The modified dummy, which also features an instrumented abdomen developed by Ford, will be used to test the performance of belt-positioning booster seats and vehicle seatbelts.

The work was funded under the ongoing cooperative agreement between NHTSA and UMTRI to support biomechanics research. As part of this work, UMTRI's Biosciences Group is working to improve other aspects of child crash-test-dummy design, including the ribcage, shoulders, and spine.

The improved crash-test dummy will undergo testing by Ford, UMTRI, NHTSA, and other research labs to assess performance and durability.

For more information on research conducted by the Biosciences Group, see

<http://www.umtri.umich.edu/divisionPage.php?pageID=3> **RR**



UMTRI BIOSCIENCES

Pelvis and abdomen of the Hybrid-III crash test dummy.

UMTRI Participates in 89th TRB Meeting

UMTRI researchers and staff joined transportation professionals from around the world in Washington, D.C., January 10-14, for the 89th annual meeting of the Transportation Research Board (TRB). The meeting featured more than 3,000 presentations in nearly 600 sessions.

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

Daniel Blower, associate research scientist in the Vehicle Safety Analytics Group, and **Paul E. Green**, assistant research scientist in the Vehicle Safety Analytics Group, presented "Motor Carrier Type and Driver History in Fatal Bus Crashes."

David W. Eby, research scientist in the Behavioral Sciences Group, presented "Potential Mechanisms Underlying Part-Time Belt Users."

Timothy J. Gordon, research professor in the Vehicle Systems and Control Group, presided over the Vehicle-Highway Automation Committee and sessions on Control and Electrification of Highway Vehicles, and Technical Challenges for Future IntelliDrive Applications. He also presented "Site-Based Data Collection Technique."

Steve Karamihas, senior research associate in the Vehicle Systems and Control Group, presided over a session on Modeling the Interaction Between Pavement and its Loading. He also presented "Update on SHRP2 Real-Time Smoothness Measurement on PCCP During Construction Study (P10-0505)" with Robert Otto Rasmussen and Helga Torres.

Jonathon Rupp, assistant research scientist in the Biosciences Group, presented "Use of Crash Injury Research and Engineering Network Data for Occupant Protection."

Jean Shope, research professor and UMTRI associate director, presided as chair of the TRB Committee on Alcohol, Drugs, and Traffic Safety meeting; served as secretary in Executive and Foundation Board meetings of ICADTS (International Council on Alcohol, Drugs, and Traffic Safety); and copresented "Parental Management of Novice Teenage Drivers" with **Jennifer Zakrajsek**, senior research associate in the Young Driver Behavior and Injury Prevention Group.

Bob Sweet, UMTRI information resources manager, attended the meeting of the TRB Information Services Committee, during which he assumed the position of committee chair. He also attended meetings of the Library and Information Science in Transportation (LIST) Committee and LIST's Transportation Research Thesaurus Subcommittee.

John Woodroffe, research scientist in the Vehicle Safety Analytics Group, presented "Dynamic Stability of Trucks" with Anthony Germanchev, and also presented "Truck Productivity: International Performance Benchmarking" with Klaus-Peter Glaeser and Paul Nordengen. **RR**

Collaboration Key to Auto Industry-Government Relations

Collaboration will be a key factor in the future relationship between the auto industry and the U.S. government, said Michael Vitek, vice president of Mercedes-Benz Technology North America, at a February 17 conference hosted by UMTRI.

The conference, Understanding the New Role of Government in the U.S. Auto Industry, was held at the University of Michigan and sponsored by Mercedes-Benz Technology North America.

“The government role is expanding, but we feel that there has to be a partnership,” said Vitek. “Without collaboration we won’t be successful as an industry.” He added that technology is another key factor, and the government’s new role will also encompass innovation (providing direction and funding) and commercialization (providing funding to develop working technology).

U.S. Rep. John Dingell (D-MI) was among the speakers to address conference attendees. He noted that the complex relationship between the government and the auto industry is now characterized by government recognition of the auto industry as vital to the nation, the workforce, and the economy as is the need for safe, fuel-efficient, clean vehicles.

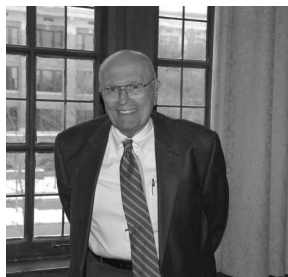
The relationship between the two entities will evolve, Dingell



Michael Vitek Mercedes-Benz.

of Government in the U.S. Auto Industry, was held at the University of Michigan and sponsored by Mercedes-Benz Technology North America.

“The government role is expanding, but we feel that there has to be a partnership,” said Vitek. “Without collaboration we won’t be successful as an industry.”



U.S. Rep. John Dingell (D-MI).

said, adding that the government should do more to support suppliers, as well as implement a health-care plan that reduces associated costs for the auto industry.

Other speakers at the daylong conference included UMTRI research scientist Walter McManus, who presented results from studies that analyzed customers’ willingness to pay for fuel economy and the projected effects on industry profits.

Patrick Davis, program manager of vehicle technologies at the U.S. Department of Energy (DOE), highlighted automotive-related research initiatives supported by the DOE.

Christopher Grundle, deputy director of the Office of Transportation and Air Quality in the U.S. Environmental Protection Agency (EPA), discussed the expanded role that the EPA is taking in regulating greenhouse gases and fuel economy.

Bob King, vice president of United Auto Workers, discussed the new role that labor is playing in the auto industry, and Itay Michaeli, of Citi Investment Research, explained how financial analysts view the new government-industry relationship.

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 22, 2010.

For more information, see: <http://www.umtri.umich.edu/divisionPage.php?pageID=47> RR

Sweatman Appointed to ITS Program Advisory Committee

COURTESY OF ITS AMERICA



U.S. Transportation Secretary Ray LaHood has appointed UMTRI Director Peter Sweatman as a member of the Intelligent Transportation Systems (ITS) Program Advisory Committee.

The committee is charged with reviewing areas of ITS research being considered for funding by the U.S. Department of Transportation and advising the Secretary on ITS aspects of the Department's strategic plan. The work of the Advisory Committee is supported by the Research and Innovative Technology Administration's ITS Joint Program Office.

In a December 17 letter of appointment, Secretary LaHood said that Sweatman's service will enhance the value of the Committee's role as a forum for national discussion and recommendations on ITS activities.

Sweatman is one of thirteen new appointees to join the twenty-member advisory committee. He will serve a two-year term.

For information on the ITS Program, see www.its.dot.gov/index.htm

ITS: Frequently Asked Questions

What is ITS?

ITS improves transportation safety and mobility and enhances American productivity through the integration of advanced communications technologies into the transportation infrastructure and in vehicles. Intelligent transportation systems (ITS) encompass a broad range of wireless and wire line communications-based information and electronics technologies.

What is the federal role in ITS?

Located in the U.S. Department of Transportation's Research and Innovative Technology Administration, the Intelligent Transportation Systems (ITS) program researches ways that information and communications technologies can improve surface transportation safety and mobility and contribute to America's economic growth. ITS applications focus on both the infrastructure and vehicle as well as integrated applications between the two.

Familiar ITS technologies include electronic toll collection, in-vehicle navigation systems, rear-end collision avoidance systems and dynamic message signs. Technology transfer is also a key element of the ITS program. Research findings and evaluations are published online; a National ITS Architecture and Standards program ensures that states and jurisdictions have the framework they need to deploy interoperable ITS systems; and training on the latest ITS applications is developed and delivered by the program.

What are the current key activities of the federal ITS program?

The major initiatives are:

- IntelliDriveSM
- Next Generation 9-1-1
- Cooperative Intersection Collision Avoidance Systems
- Integrated Vehicle Based Safety Systems
- Integrated Corridor Management Systems
- Clarus
- Emergency Transportation Operations
- Mobility Services for All Americans
- Electronic Freight Manifest
- ITS Operational Testing for Congestion Mitigation

Continuing key activities within the federal ITS program are:

- Commercial Vehicle and Information Systems and Networks Deployment (CVISN)
- 511 Travel Information
- ITS Architecture Implementation

Source: Research and Innovative Technology Administration. See <http://www.its.dot.gov/faqs.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

Alkan, V.; Karamihas, S. M.; Anlas, G. 2009. "Experimental Analysis of Tyre-Enveloping Characteristics at Low Speed." *Vehicle System Dynamics*, vol. 47, no. 5, pp. 575-587, DOI: 10.1080/00423110802251807.

Kostyniuk, L.P.; Molnar, L.J.; Eby, D.W. 2009. "Safe Mobility of Older Drivers: Concerns Expressed by Adult Children." *Topics in Geriatric Rehabilitation*, vol. 25, no. 1, pp. 24-32, DOI: 10.1097/TGR.0b013e318191491f.

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<http://hdl.handle.net/2027.42/64999>

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

Blower, D.; Matteson, A. 2009. Evaluation of 2007 Minnesota Crash Data Reported to the MCMIS Crash File. Report no. UMTRI-2009-14.

<http://hdl.handle.net/2027.42/63453>

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

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McManus, W.; Kleinbaum, R. 2009. Fixing Detroit: How Far, How Fast, How Fuel Efficient. Report no. UMTRI-2009-26.

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The research documented in this report was sponsored by the Energy Foundation.

Perchonok, J.; Green, P. 2009. Facilitating Driver Interaction with a Robotic Driving Assistant: Some Insights from the Literature. Report no. UMTRI-2009-21.

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Rupp, J.D.; Flanagan, C.A.; Kuppa, S.M. 2009. Development of New Injury Risk Curves for the Knee/Distal Femur and the Hip for Use in Frontal Impact Testing. Report no. UMTRI-2009-8.

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

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The research documented in this report was sponsored by the Research and Innovative Technology Administration ITS Joint Program Office.

RECENT UMTRI PUBLICATIONS

continued...

RECENT UMTRI PUBLICATIONS

Sayer, J.; LeBlanc, D.; Bogard, S.; Nodine, E.; Najm, W. 2009. Integrated Vehicle-Based Safety Systems Third Annual Report. Report no. UMTRI-2009-30.

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

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<http://hdl.handle.net/2027.42/65000>

The research documented in this report was sponsored by the National Private Truck Council.



CONFERENCES & EVENTS

March

Transportation & Infrastructure Convention
March 10-12, Washington, D.C.
www.transportationsummit.com

ITE Technical Conference and Exhibit
March 14-17, Savannah, Georgia
www.ite.org/conference

Transportation Safety Conference
March 30-31; Overland Park, Kansas
www.kuce.org/programs/transportation

April

National Work Zone Awareness Week
April 2010; nationwide
http://ops.fhwa.dot.gov/wz/outreach/wz_awareness.htm

M-CASTL Transportation Research and Education Conference
April 7; Ann Arbor, Michigan
<http://m-castl.org>

APA National Planning Conference
April 10-13; New Orleans, Louisiana
<http://www.planning.org/conference/>

Transportation and University Communities Conference
April 10-13; Athens, Georgia
www.apta.com/conferences

Lifesavers: National Conference on Highway Safety Priorities
April 11-13; Philadelphia, Pennsylvania
www.lifesaversconference.org

SAE World Congress
April 13-15; Detroit, Michigan
www.sae.org/congress

Design-Build for Transportation Conference
April 21-23; Dallas, Texas
<http://www.designbuildtransportation.com/>

CTS Transportation Research Conference
April 27-28; St. Paul, Minnesota
www.cts.umn.edu/Events/ResearchConf/index.html

May

Bus and Paratransit Conference
May 2-3; Cleveland, Ohio
www.apta.com

ITS America Annual Meeting & Exposition
May 3-5; Houston, Texas
www.itsa.org

ITS Michigan Annual Expo
May 19-20; Dearborn, Michigan
<http://www.itsmichigan.org>

WTS Annual Conference
May 19-21; Washington, D.C.
www.wtsinternational.org

International Conference on Safety and Mobility of Vulnerable Road Users: Pedestrians, Motorcyclists, and Bicyclists
May 30-June 2; Jerusalem, Israel
www.rsa.gov.il/conference

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TRANSPORTATION IDBITS

■ **First state gas tax imposed**

February 25, 1919: Oregon became the first state to impose a tax on gasoline. The funds collected from the one percent tax were used for road construction and maintenance.

■ **Honda's Civic is introduced**

March 1, 1973: The Honda Civic was introduced to the United States market on this day in 1973. Luckily for Honda, the introduction of the small, fuel-efficient car coincided with the oil crisis of the early 1970s, making car owners aware of the advantages of fuel economy.

■ **First numbered highways**

March 2, 1925: The first nationwide highway numbering system was instituted by the joint board of state and federal highway officials appointed by the secretary of agriculture. In order to minimize confusion caused by the array of multiform state-appointed highway signs, the board created the shield-shaped highway number markers that have become a common sight since.

■ **First motor car in "Motor City"**

March 6, 1896: Charles B. King tested his automobile on the streets of Detroit, Michigan, becoming the first man to drive a car in the Motor City.

■ **Mustang unveiled**

March 10, 1964: The first Ford Mustang was produced on this day. The Mustang wasn't released to the public until April 16, 1964. However, one journalist described its unveiling as "the most sensational introduction of modern times." The Mustang was the result of Ford's desire to make a small, sporty car that was inexpensive enough to appeal to young car buyers, an increasingly important market.

Source:

This Day in Automotive History, www.historychannel.com/idih