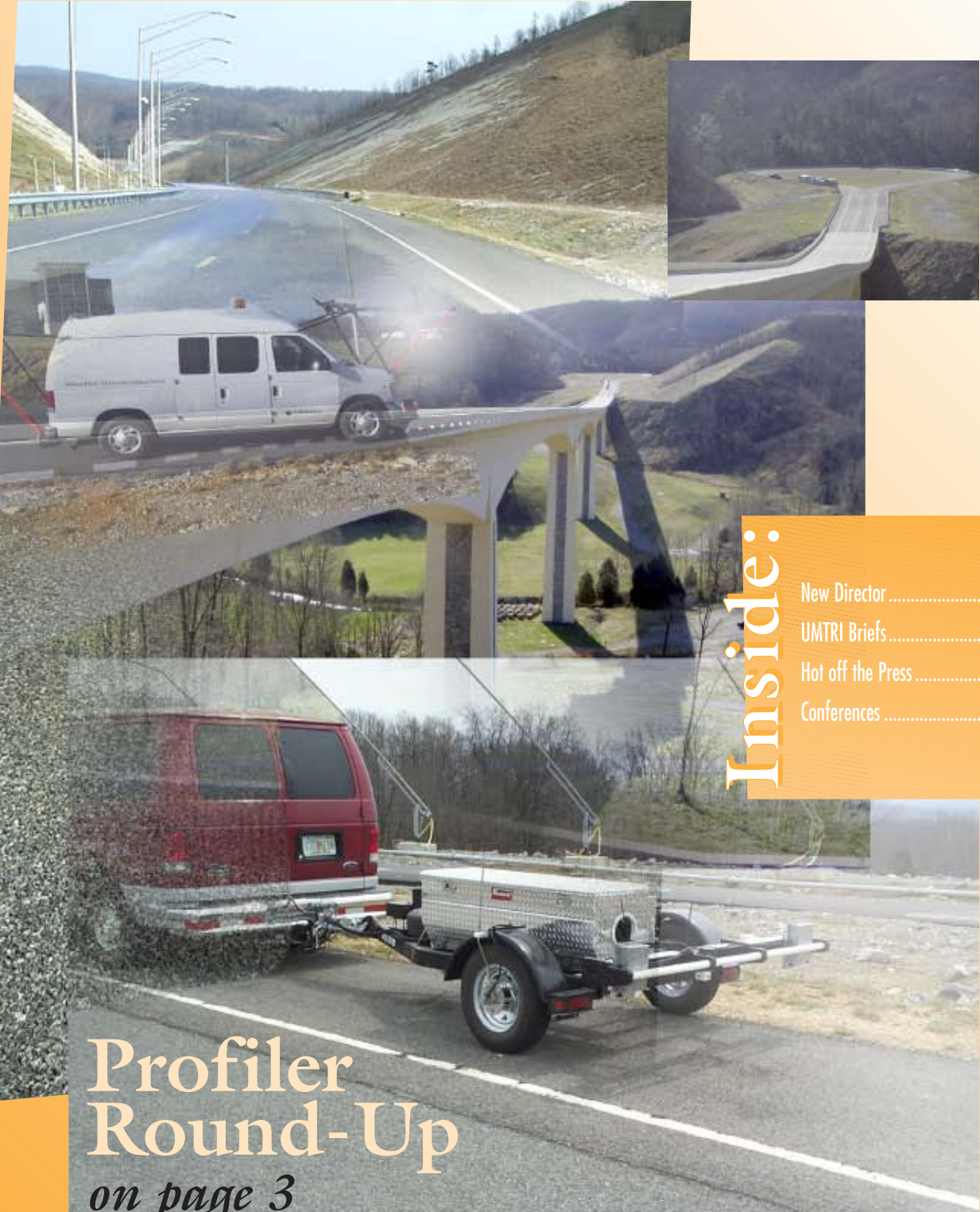


UMTRI

RESEARCH REVIEW

• UNIVERSITY OF MICHIGAN TRANSPORTATION RESEARCH INSTITUTE • JULY-SEPTEMBER 2004 • VOLUME 35, NUMBER 3 •



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UMTRI Welcomes a New Director

Dr. Peter Sweatman Joins UMTRI

Dr. Peter Sweatman assumed the UMTRI directorship on September 1, 2004. He is an international leader in the study of heavy vehicle dynamics, and his research has been widely recognized in the fields of vehicle design and engineering, vehicle safety, road safety, driver performance, highway condition monitoring, heavy vehicle standards, regulations, transport economics, and transport policy. He is internationally recognized as one of the pioneers in the scientific evaluation of the impacts of commercial vehicle operation on highway systems.

A major theme of Sweatman's research has been the dynamic performance of heavy vehicles. For over ten years, he has been a strong advocate for performance-based standards (PBS) as an improved method for regulating heavy vehicles. Under PBS, heavy trucks are regulated by performance measures, instead of prescriptive measures of lengths, weights, etc. Many of the sixteen PBS, such as rollover threshold and low-speed offtracking standards, originated from work performed by UMTRI's Engineering Research Division. His work has been influential in developing FHWA truck size-and-weight evaluation tools and the world's first comprehensive PBS regulatory regime for Australia.

Before joining UMTRI, Sweatman was the founder and owner of Roaduser Systems Pty Ltd in Melbourne. The consulting firm, which he sold due to his move to the United States, conducts research and development on the productivity and safety of heavy vehi-

cles, both for the government and the transportation industry. Major work included developing performance-based standards for Australia's National Transport Commission and research and development work on innovative transportation systems (such as regenerative braking systems, which are used by the U.S. Army).

Prior to Roaduser Systems, Sweatman worked at the Australian Road Research Board (ARRB)¹ He served as chief scientist from 1984 to 1989, and founded and developed ARRB's heavy vehicle research program during the period of 1976 to 1989. From 1990 to

1997, he led a major international scientific investigation of the economic benefits of "road-friendly" and "bridge-friendly" trucks. This international cooperative research program was carried out under the Organisation for Economic Co-operation and Development

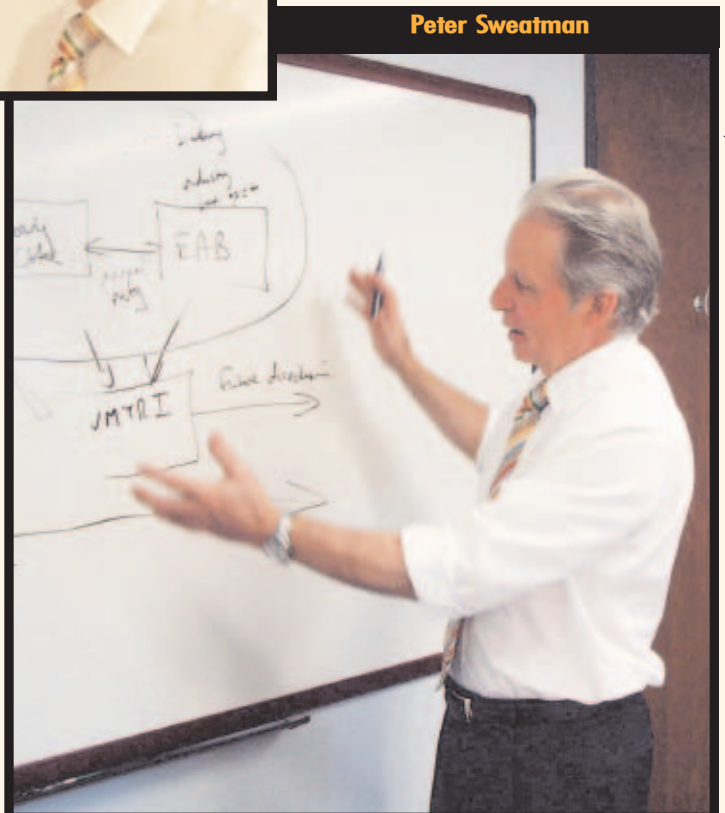
(OECD)² Road Transport Research Program and involved a multidisciplinary team from seventeen OECD member countries. He says of the experience, "I was fortunate to learn about all aspects of transportation systems—the vehicle, driver, and infrastructure—and I'm a great believer in interdisciplinary research."

He served for six years as the chairman of the Australian Road Transport Suppliers Association, whose goal is to increase the technical capabilities of the transportation industry and improve understanding between industry and regulators. His achievements were recognized by his election as a Fellow of the Academy of Technological

continued...



Peter Sweatman



PHOTOS: UMTRI / SHEKHAR ERINGTON

Sciences and Engineering in 1997 and by the award of a Centenary Medal in 2002 by the Prime Minister of Australia, "For Service to Australian Society in Transportation Engineering." In September 2004, he was named "Freight Industry Personality of the Year" at the annual Australian Freight Industry Awards. He quips, "I had to leave the country to get this kind of recognition."

Sweatman first visited UMTRI in 1975 to meet with staff from the Engineering Research Division, and has been associated with several UMTRI researchers ever since. He also knew John Woodrooffe, head of UMTRI's Transportation Safety Analysis Division, through his work with OECD.

Sweatman feels UMTRI's strengths are its people, knowledge bases, and databases. He feels UMTRI effectively delivers contract research, with a staff focused on carrying out their responsibilities to their sponsors. He says, "It's fantastic to have the opportunity to work directly with great people. I have a long-term interest in vehicle dynamics, but also feel that research should focus on the driver, so I'm excited about UMTRI's forward-thinking research, like the science of driving program."

Because UMTRI already functions well internally, Sweatman would like to focus on external opportunities, including providing staff with the greater opportunity to interact with professionals outside of UMTRI. He says, "I would like to see UMTRI grow and widen its influence, with its

achievements recognized on a broader scale. I'd like to see UMTRI actively engaged with other major transportation research institutes, both in the U.S. and internationally."

Sweatman says coming to the U.S. is "a big move that I'm very excited about. The U.S. has a highly developed transportation system, and this is an opportunity for me to learn and

behind in Melbourne to wrap up the details of their move, and joined him in Ann Arbor in mid-November. Their 28-year-old daughter Sarah is looking forward to visiting.

UMTRI's previous director, Barry Kantowitz, is currently on sabbatical, writing a book. He will return to UMTRI as a researcher professor. **RR**



UMTRI / SHERIDAN EMMINGTON

"I'd like to see UMTRI actively engaged with other major transportation research institutes, both in the U.S. and internationally."

make some contribution. The U.S. is a diverse and wonderful country whose academic and scientific pursuits I hold in high esteem. I'm pleased to be part of it."

Sweatman holds a bachelor's degree in mechanical engineering and a doctorate in vehicle dynamics from the University of Melbourne. Outside of work, he enjoys bluegrass music. He sang and played guitar semi-professionally for twenty years in the band Hardrive. His wife Patricia stayed

¹ ARRB is similar to the Transportation Research Board, except that it develops more of its own research.

² OECD is an international organization, headquartered in France, with thirty member countries sharing a commitment to democratic government and the market economy. The group provides publications and statistics on economic and social issues including macroeconomics, trade, education, science, transportation, and innovation.

The Great Pavement Profiler Round-Up

This article, written by Lisa Pope, was originally published in the June, 2004 edition of FHWA's FOCUS. It is reprinted here with permission.

Sixty-eight road profilers. Two test tracks. Five days. The largest road profiler comparison and verification study to date was held April 4–8, 2004, at the Virginia Department of Transportation's Smart Road Facility in Blacksburg, Virginia, and the Pennsylvania Department of Transportation's road profiler testing facility in Newville, Pennsylvania. Sponsored by the Federal Highway Administration (FHWA), the profiler "round-up" study was performed by UMTRI.

"An experiment of this size and variety was needed to improve the way people verify profilers. We also wanted to compare different types of profilers and see how reproducible profiler results are," says study director Steve Karamihas of UMTRI. "The project was also designed to increase the comfort level of states in using profiler devices," adds Mark Swanlund of FHWA. "We want to increase awareness so that using profilers becomes the standard." About 48 states are using profilers to evaluate the pavement quality of their road networks, with approximately 10 using them for construction quality control for individual projects. An additional 25 states

are considering the use of profilers for construction quality control.

Road profilers use lasers and other technology to measure pavement smoothness, as calculated using indexes such as the International Roughness Index (IRI). With more highway agencies emphasizing the importance of enhancing pavement smoothness, "the payoff in using profilers is that the quality of the data is much better," says Karamihas. "You can measure what you've produced quickly on a job site, and if you see a problem with the pavement you can correct the problem before additional paving is done.

Profilers provide a clearer picture of the shape of the road, while older devices, such as the California profilograph, would result in a more distorted profile that didn't exactly match the pavement. Profilers also provide a more accurate rating of how the road's smoothness would be perceived by the average driver.

In addition to comparing different types of profilers and improving methods for verifying their results, goals of the study include:

- establishing criteria for selecting profiler verification sites
- studying the interaction of various profiler types with pavement surface texture
- setting performance requirements for reference profilers

The round-up featured a range of profilers, with high-speed, lightweight, low-speed, walking-speed, and reference devices tested. The measurements taken by the various profilers will be compared to reference profiles of the test roads, to check profiler accuracy,

continued...

Sixty-eight road profilers were tested at the smart road in Blacksburg, Virginia (shown here) and at the Pennsylvania Department of Transportation road profiles testing facility in Newville, Pennsylvania.



THE TRANSIST GROUP, INC. / GEORGE K. CHANG





and to the results obtained by the other participating devices. Participants represented state highway agencies, FHWA, universities, manufacturers, and industry. Auburn University, for example, brought its high-speed profiler, which it has been using since 2001 for research studies. High-speed profilers mounted on trucks or vans can travel at highway speeds, with no need for traffic control. “The profiler is infinitely faster than previous methods and gives you more consistent data,” says Mary Stroup-Gardiner of Auburn University.

In Virginia, profilers were tested on the Smart Road’s 2.57-km (1.6-mi) track. The track features five different 161-m long (528-ft) test sections: two with smooth asphalt and one each with rough asphalt, continuously reinforced concrete,

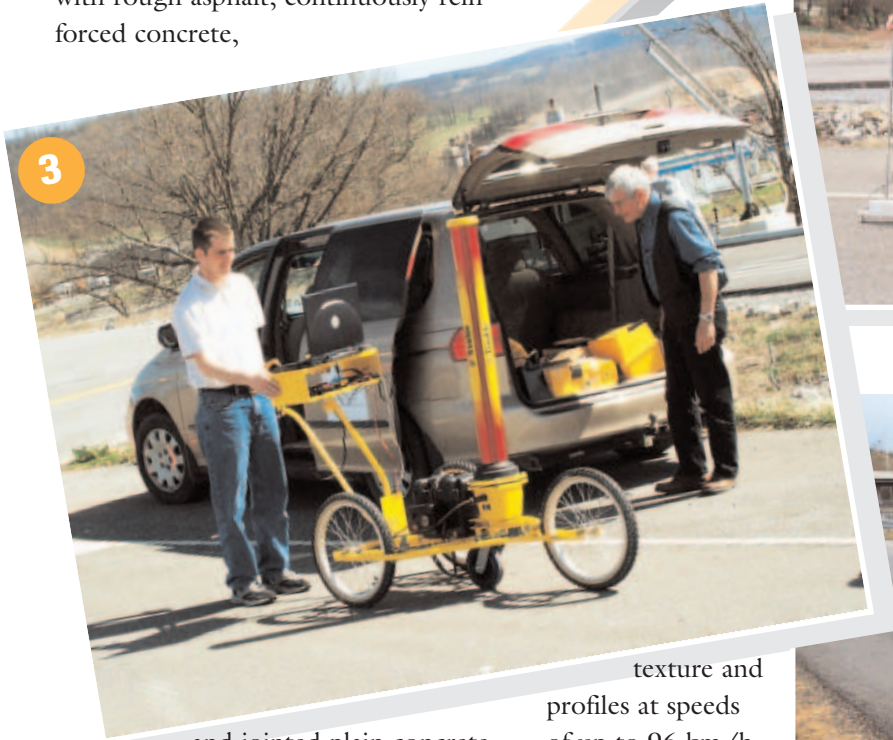
measurements on three nearby road sections with live traffic.

Laurin Lineman of FHWA’s Federal Lands Highway Office tested the high-speed MGPS surface profiler. The MGPS surface profiler was developed from the FHWA Turner-Fairbank Highway Research Center’s ROSAN texture measurement system and is now commercially available. The Federal Lands Highway Office has owned three of the profilers for five years and is currently in the process of implementing the MGPS as a quality assurance tool. The laser-based profiler can measure pavement

can obtain the data a lot faster.” At a cost of approximately \$80,000, the profiler is more expensive than older devices such as the California profilo-

graph, but the additional cost is offset by savings realized from not having to close traffic lanes to collect data.

Mike Upp, an engineer for the Harley-Davidson Motor Co., brought a high-speed laser profiler to the testing. The profiler is mounted on a trailer system and can be towed behind a truck or van. “We just started using the profiler this year,” says Upp. “Road roughness correlates to damage, which affects our riders. We use the profiler at our own testing facilities in Alabama, Arizona, and



and jointed plain concrete. The sections had downward slopes ranging from 3 percent to 6 percent. The Pennsylvania test track featured four 161-m long (528-ft) test sections: smooth concrete, rough concrete, smooth asphalt, and rough asphalt. High-speed profilers also had the option in Pennsylvania of taking

texture and profiles at speeds of up to 96 km/h (60 mi/h). “We are collecting much better data with it than we did previously using the California profilograph,” says Lineman. “Another advantage is that we



Some of the equipment tested at the roundup event included (top to bottom): (1) a custom-built profiler owned by the Federal Aviation Administration; (2) the ROMDAS Z-250 roughness calibration profiler, operated by Jerry James; (3) the Auto Rod and Level, built by APR Consultants, Inc. and operated by Mike Freeman (left) and Tony Gerardi; and (4) the ICC lightweight profiler, owned by New Enterprise Stone & Lime Co., Inc. and operated by Ed Wilson.

PHOTOS THIS PAGE: UMTRI / STEVE KARAHANAS

Florida, to see what various road surfaces are like. Then we figure out how they will affect our customers. We like the trailer system because it's flexible and it's easy to ship around the country."

The Maryland State Highway Administration has two high-speed profilers that it has used for the past four years for quality assurance testing on new projects and for some network-wide assessments. Maryland combines the IRI data collected from the network-wide assessments with rutting and cracking data to create a Pavement Condition Index. This

PHOTOS: THE TRANSTEC GROUP, INC. / GEORGE K. GAHNS

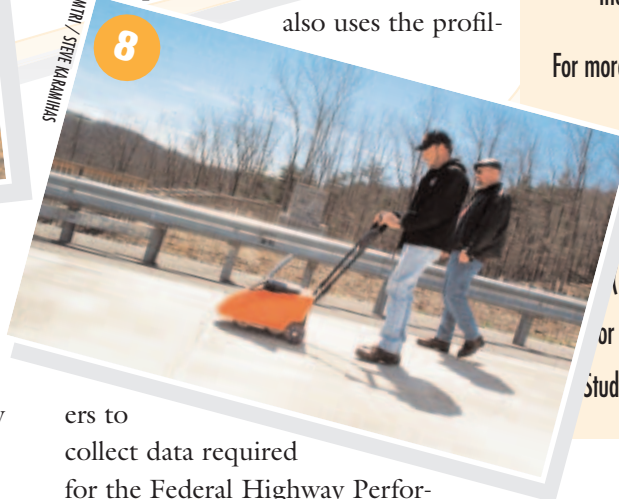


Also on hand at the profiler roundup were (top to bottom): (5) the ULIP (ultra-light inertial profiler), owned by the Federal Highway Administration, built by Starodub using the Segway Human Transporter, and operated by Mark Swanlund; (6) the SurPro 1000 walking speed profiler, owned by the Florida Department of Transportation and operated by Marc Morin; (7) the D-Meter Model 0308 floor profiler, built and owned by Allen Face & Company; and (8) the ARRB (Australian Road Research Board) walking profiler, owned by the New Jersey Department of Transportation and operated by Nicholas Gephart with Robert Sauber in the background.

incentives are awarded for meeting smoothness targets.

The Virginia Department of Transportation (VDOT), meanwhile, has three high-speed profilers. It uses them to measure the ride quality of new overlays and set targets for contract incentives and disincentives for pavement smoothness. VDOT also uses the profil-

UMTRI / STEVE KARMIHAS



ers to collect data required for the Federal Highway Performance Monitoring System. "Virginia is also starting to use them to collect data

Eighteen states and FHWA are participating in a \$1.5-million pooled-fund study, "Improving the

Quality of Pavement Profiler Measurement," which kicked off in May 2003. The four-year study's top priority is to build a transportable reference device that states and their contractors can test profilers against. "We need a tool that states can use to calibrate their devices, as there's no broad agreement currently as to what the reference is," says Brian Schlepfi of the Ohio Department of Transportation and chair of the pooled-fund study. The study will also:

- Deliver sample profiler procurement specifications and maintenance guidelines.
- Establish criteria for verification centers and assist with their development. (Tom Gillespie of UMTRI's Engineering Research Division is working on establishing the criteria.)
- Provide software that can locate surface imperfections that require repair during pavement construction. (UMTRI's Steve Karamihas has developed the algorithm and source code for this project, which The Transtec Group, Inc. is integrating into the software.)

For more information on the pavement profiler pooled-fund study or to join the study, contact Bob Orthmeyer at FHWA, /08-283-3533 (email: robert.orthmeyer@fhwa.dot.gov), or visit pooledfund.org and search for study No. TPF-5(063).



continued...



UMTRI / DAN HUDOLSON

Index helps Maryland decide which road projects to work on.

For new projects, contractors are required to report on the road's pavement smoothness. Sample quality assurance testing is then done by Maryland to check on the accuracy of the contractor's data. Contract



The Gomaco Smoothness Indicator is a slow-speed, non-contact profiler. It uses sonic technology, and its sensors trace the wheel tracks for reading smoothness data on up to eight traces on four lanes in one process.



on bridges and is looking at the profiler's ability to measure pavement texture," says Kevin McGhee of the Virginia Transportation Research Council.

FHWA tested its ultra-light, slow-speed profiler, which was built using the Segway(tm) Human Transporter. The device operates at about 16 km/h (10 mi/h) and performs laser measurements of the pavement. An attached computer collects the data. Another slow-speed device tested was GOMACO's new GSI(r) profiler, which uses sonic technology to measure the pavement. The device, which provides real-time measurements, can straddle a pavement slab to profile it and does not have to be driven on the pavement. The GSI provides smoothness readings for both wet or cured concrete and asphalt slabs. Any irregularities in the slab are identified, and their locations are recorded through the use of a distance

tracking encoder. Contractors can then repair the concrete surface while it's still in the plastic state. Smoothness readings can also be seen before saw cuts are made for joints and tining or the texturing of the slab.

The data collected at the round-up will be used to test the American Association of State Highway and Transportation Officials' provisional standards, which were adopted in 2002 and published the following year. These provisional standards cover profiler use, including how to certify a profiler and how to use it on a job site. The standards also address how to incorporate pavement smoothness requirements into a paving contract. Improving the quality of pavement profile data is the goal of a new state

pooled-fund study as well (*see sidebar*). "We want to generate a golden profiler standard against which other profilers can be measured," says Bob Orthmeyer of FHWA.

Karamihas is now evaluating the data collected at the two test tracks in April to see how repeatable the data collected from each profiler device was and how reproducible, in terms of two different devices obtaining the same result. This data evaluation will aid in determining a reference standard for profilers. All participants will receive a report about their profiler results. An overall report on the study results will also be issued later this year.

To learn more about the profiler round-up study, contact Mark Swanlund at FHWA, (202) 366-1323 or mark.swanlund@fhwa.dot.gov, or Steve Karamihas at UMTRI, (734) 936-1057 or stevemk@umich.edu. **RR**



STAPP Car Crash Conference

This year's Stapp Car Crash Conference was held November 1–3 at the Gaylord Opryland Resort in Nashville, Tennessee.

This is the premier forum for presentation of the latest research in impact biomechanics, human injury tolerance, and related fields that advance the knowledge of land-vehicle crash injury protection. The conference provides an opportunity to participate in open discussion regarding the causes and mechanisms of injury and the development of new tools and concepts for assessing the effectiveness of occupant protection technologies relative to reducing injuries and fatalities in automobile crashes. Papers presented at the Stapp conference are published in the annual *Stapp Car Crash Journal* following an intensive peer-review process by members of the Stapp Conference Advisory Committee.

Leda Ricci of UMTRI's Biosciences Division serves as the executive director of the Stapp Advisory Committee and executive editor of the *Stapp Car Crash Journal*. She is responsible for the overall administration and management of the paper-review process, the Stapp journal, and the Stapp conference. Larry Schneider, research professor and head of UMTRI's Biosciences Division, and Donald Huelke, UMTRI professor emeritus, are members of the Stapp Conference Advisory Committee. Schneider is also one of three rotating conference general chairmen and also serves as an editor-in-chief of the *Stapp Car Crash Journal*.

This year's conference was hosted by Wayne State University (WSU), and professor Albert I. King of WSU is the conference general chairman.

See www.stapp.org for details on the annual event.

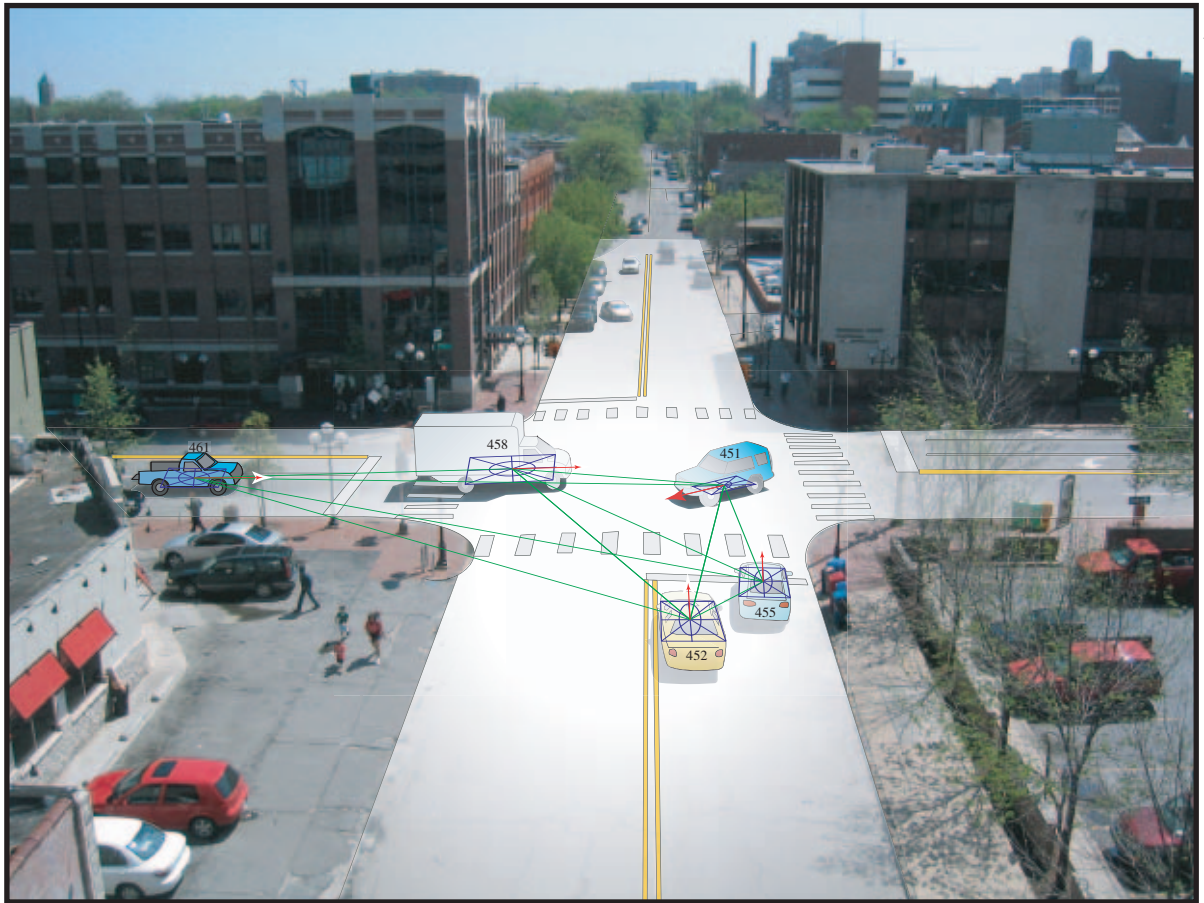


Quantifying Normal Driving Behavior from Site-Based Digital Video Cameras

The System for Assessment of the Vehicle Motion Environment (SAVME) is an example of a tool for quantifying natural driving behavior in statistically powerful datasets. It is an empirical measurement method for documenting how vehicles move and position themselves in proximity to others during normal driving conditions. The SAVME technique obtains an archival record of the control behavior of drivers on public roads by capturing and processing data from specialized road-side cameras.

Site-based capture of vehicle motion data bridges the technology gap between vehicle-based systems and infrastructure-based systems, with high data quality. Prior to SAVME, no technique has produced a general-purpose tool of this kind for studying the kinematics of precrash safety. It is an enabling technology with many potential applications for research, such as providing direct information for transportation operations, traffic flow management, crash risk analysis, etc.

continued...



UMTRI / JEFFREY WALKER

In this graphic from the validation tests, a search for range and range-rate revealed a near-collision. A driver turned right onto the main road and matched acceleration to the preceding vehicle, only to be confronted with a lane of stopped traffic. Luckily a crash was avoided because there was a gap in the left lane to move into.

The SAVME approach can be used to gather driver information such as reactions to being cut off, normal following distance, and typical lane change trajectories. Tim Gordon, head of UMTRI's Engineering Research Division, says "Analysis of this data can create a foundation for developing intelligent-transportation-systems countermeasures that identify the need for intervention. For example, SAVME technology can provide reference data to design systems to reduce crashes at intersections. The data might also be applied in real-time to vehicle-infrastructure cooperation (using communication between the roadside and vehicles to improve safety), such as by warning motorists of a potential incident at an intersection."

THE GROUNDWORK

The SAVME method was developed by researchers from UMTRI, Veridian, and Nonlinear Dynamics Inc. The project was sponsored by NHTSA.

In the original project, SAVME collected digital video images from roadside towers at a 10 Hz sampling rate. These images were processed into a one-track file, or 10 Hz trajectory, for each vehicle passing through the selected road site. This file quantifies the vehicle trajectories and intervehicular relationships involved in normal driving. A master clock establishes a time base for each track file as each vehicle operates over the surveyed piece of roadway. The time-stamped motions of each vehicle are expanded to determine the intervehicular variables of range, range-rate, and azimuth angles that situate it relative to all other vehicles that coexisted on the road at the same moment in time. Expanded further through

Kalman filtering, the dataset is augmented with additional variables that could not be derived directly from the video images, such as longitudinal acceleration, yaw rate, front wheel angle, lateral velocity, and heading angle. The track files are then compiled in a relational database, easily accessible for analysis with commercial software. The database allows analyzing the natural driving process and a host of “what if” questions involving driver-assistance functions in the normal driving environment.

The System for Assessment of the Vehicle Motion Environment (SAVME) method:

- collects detailed digital video image from roadside cameras
- uses image processing to produce a comprehensive track file—a kinematic time history for each vehicle seen by the cameras
- creates a comprehensive record of the control behavior of real drivers on real roads
- calculates intervehicle variables of range, range rate, and direction (azimuth) to quantify vehicle directions
- provides data to explore the potential impact of new technologies for safety and performance improvements

The resulting dataset then provides:

- refined estimates of vehicle location (x,y) on the road
- heading (yaw) angle
- vehicle forward and lateral speeds
- vehicle yaw rate and lateral acceleration
- estimates of steering wheel motions
- vehicle longitudinal acceleration, reflecting driver throttle and brake applications

In the pilot project, two video cameras were secured to 100-foot towers overlooking a five-lane arterial road. The cameras were synchronized to capture frames simultaneously, and the images were calibrated so that the overlapping images could be analyzed. Roadside measurements were gathered from nineteen hours of video, capturing some 30,500 vehicles. Track file data was validated against measurements from instrumented vehicles conducting maneuvers through the same test site. Validation results showed that spatial accuracies were within 2 ft (0.6m) and the accuracy of velocity components were typically within 2 ft/sec (0.6m/s). Greater levels of accuracy will be possible using higher resolution cameras and an increased number of camera positions.

Researchers queried the database to explore common driving scenarios such as “flying passes,” left turns across oncoming traffic, emerging from a signed intersection, queue formation and dispersal, and braking propagation along a vehicle string. Results produced histograms and computed-measure distributions for headway times, times-to-collision, driver reaction delays, queue startup delays, etc. Results included x,y trajectories and motion time histories for individual vehicles and vehicle clusters. Range, range-rate, and azimuth angle histories were also determined.

FUTURE APPLICATIONS

There are significant opportunities to develop and deploy this technology under the Future Strategic Highway Research Program (F-SHRP).¹ For example, data from SAVME deployment can be used to motivate design improvements at high-risk intersections. Future development should lead to turnkey systems for wide applications in research and transport management. **RR**

¹ F-SHRP is a U.S. DOT program. One of its aims is to gain a more precise understanding of the contribution of multiple factors to vehicle collisions.

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Transportation Tidbits

- The United States' first automobile was successfully driven on September 22, 1893, in Springfield, Massachusetts. Its builders, Charles and Frank Duryea, were bicycle makers. Charles had spotted a gasoline engine at the 1886 Ohio State Fair and was convinced that an engine-driven carriage could be built. It took the brothers two years to design and build the car.
- The first American cross-country automobile trip was completed on August 1, 1903. The journey from New York City to San Francisco was driven in a Packard and took fifty-two days.
- On August 5, 1914, the first traffic light was installed at the intersection of Euclid Avenue and East 105th Street in Cleveland, Ohio. At the time, roads were shared by horses, cars, and streetcars, and it soon became apparent that traffic rules were needed. The traffic light was not the only improvement to debut during this era: The traffic island was introduced in 1907, dividing lines appeared in 1911, and the "no left turn" sign was introduced in 1916.
- On July 1, 1956, Congress enacted a highway revenue act to create a fund for the construction of over 42,500 miles of interstate highways over thirteen years. The push for a national highway system began many years earlier in 1919 with the privately-funded construction of the Lincoln Highway. To pay for the project a system of taxes, relying heavily on the taxation of gasoline, was implemented.
- The United States passed legislation requiring all newly manufactured cars to contain driver's-side air bags on September 1, 1989.
- On July 2, 1992, original Corvette engineer Zora Arkus Duntov drove the one-millionth Chevrolet Corvette off of the assembly line in Bowling Green, Kentucky. Duntov helped develop the small-block V-8 engine to increase the Corvette's power; he introduced the Duntov high-lift cam-shaft; and he introduced fuel injection. **RR**

Source: This Day in Automotive History,
www.historychannel.com/tdih

**American Traffic Safety Services Association
Mid-Year Meeting**

August 19–21, Chicago, Illinois
www.atssa.com/meetevents

Traffic Data Collection and Analysis

August 26–27 / September 30–October 1
Orlando, Florida / Las Vegas, Nevada
www.asce.org/conted/seminars

**International Conference
on Traffic Psychology**

September 5–9, Nottingham, England
www.icttp.com

Driving Simulation Conference Europe

September 8–10, Paris, France
<http://dsc-europe.inrets.fr>

AAAM Scientific Conference

September 12–15, Key Biscayne, Florida
www.carcrash.org

**North American Conference
on Elderly Mobility**

September 12–15, Detroit, Michigan
www.tiami.org/ElderlyMobb brochure7.2.pdf

**Transportation Association
of Canada Annual Conference**

September 19–22, Quebec City, Canada
www.tac-atc.ca/english

**Human Factors and Ergonomics Society
Annual Meeting**

September 20–24, New Orleans, Louisiana
hfes.org/meetings/2004menu.html

International Body Engineering Symposium

September 21–22, Troy, Michigan
www.sae.org/calendar/ibe

IRCOBI 2004: Biomechanics of Impact

September 22–24, Graz, Austria
www.ircobi.org/interface.html

Accelerated Pavement Testing Conference

September 26–29, Minneapolis, Minnesota
www.cce.umn.edu/engineering/accelerated_pavement

GHSA Annual Meeting: Highway Safety

September 25–29, Honolulu, Hawaii
www.statehighwaysafety.org

V.I.S.I.O.N. Second International Congress

September 27–28, Rouen, France
www.sia.fr

National Highway Utility Conference

September 29–October 1, St. Petersburg, Florida
www.natlconference.com/h_nhuc_home_nested.htm

**Seventh International IEEE Conference
on Intelligent Transportation Systems**

October 3–6, Washington, D.C.
www.itsc2004.org

ETC 2004: European Transport Conference

October 4–6, Strasbourg, France
www.aetransport.co.uk

IEEE 2004: Systems, Man, and Cybernetics

October 10–13, The Hague, Netherlands
www.ieeesmc2004.tudelft.nl

Accident Reconstruction for Traffic Engineers

October 11–15, Denver, Colorado
server.traffic.northwestern.edu/course/course_more.asp?id=437

**International Symposium on
High-Performance Concrete**

October 17–20, Atlanta, Georgia
www.pci.org/convention

Convergence 2004

October 18–20, Detroit, Michigan
www.convergence2004.org

Eleventh World Congress on ITS

October 18–22, Nagoya, Japan
www.itswc2004.jp

Forty-Eighth Stapp Car Crash Conference

November 1–3, Nashville, Tennessee
www.stapp.org 

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