UMTRI

RESEARCH REVIEW

• UNIVERSITY OF MICHIGAN TRANSPORTATION RESEARCH INSTITUTE • JANUARY–MARCH 2008 • VOLUME 39, NUMBER 1 •

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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

Teen Drivers Would Benefit from Greater Restrictions

An UMTRI study finds that graduated driver licensing programs for teen drivers throughout the United States should be even more restrictive.

"Motor vehicle crashes are the greatest single health threat to teens," says Ray Bingham, research associate professor in UMTRI's Social and behavioral Analysis Division. "Little or no positive change has occurred in teen crash numbers in the past 10 to 15 years. Clearly, current measures aimed at curbing teen drivers' involvement in crashes are not sufficient."

Bingham and colleagues Jean Shope (UMTRI research professor), Julie Parow (UMTRI research assistant), and Trivellore Raghunathan (biostatistics professor in the University of Michigan School of Public Health) studied data from nearly 7,000 teen drivers, Michigan State Police crash records, and Michigan Secretary of State driver history records. They found teens are at excess risk for all crash types.

By calculating crash rates using miles driven by an individual driver instead of the more common vehicle miles driven or by using per population methods, the researchers were able to provide a greater degree of specificity with regard to individual travel behavior and exposure to crash risk for men and women in different age groups. In addition, they examined multiple characteristics of crashes to create more realistic crash types and to measure their effects on crash risk.

Teens are at excess risk, they found, for all crash types, which include a combination of various elements: characteristics of the teen driver, time of day, day of week, driver behavior and the context within the vehicle.

"Inexperience, underdeveloped driving skills, and immaturity together contribute to poor performance of driving tasks," Bingham says. "Teens are about two-and-a-half times more likely to be in a crash than adults, but certain factors result in large increases in risk. One of these is having passengers. From other research, we know it is actually other teen passengers that pose the greatest risk, and we know that each additional passenger results in additional increase in crash risk."

Driving on weekends and at night are the next most common characteristics of teen driving that increase their crash risk. And when these things happen simultaneously—driving on a weekend night with passengers—they collectively contribute to substantial increases in teen crash risk.

While most states have passenger and nighttime driving restrictions for teens, none limits driving on weekends. The researchers say graduated driver licensing (GDL) programs should place restrictions on all of these interacting factors. In addition, GDL programs should move toward policies and restrictions that take more than one driving condition or characteristic into account at a time.

"Because restrictions target elements of high-risk crash types, reductions in restrictions should not just target one driving situation at a time, but should decrease in concert with each other so that crash types, and not just the individual elements contributing to crash risk, are addressed," Bingham says. "This would also result in restrictions being lifted more slowly and a more gradual increase in the exposure of teens to high-risk driving conditions, allowing them time to acquire the experience and skill needed to successfully handle those risks."

The researchers found that 56 percent of teen drivers in their study

continued...

had been in at least one crash, but crash rates improved significantly as the teens gained more driving experience. Women, both teen and adult, have higher crash rates than men for all crash types, except those involving alcohol.

The difference between teenage and adult women's crash rates, however, is smaller than between teen and adult men for all crash types. Females at age 16 are 3.7 times more likely to be in a crash than adult women drivers ages 45–65, but at age 19 are only 1.2 times more likely. For male drivers, 16-year-olds are 5.1 times more likely to be in a crash than adult men 45–65, but the rate drops to 1.6 times more likely at age 19.

GREGORY KOSTYNIUK

The study also looked at predictors of crash involvement for teen drivers. The best predictor for males was alcohol misuse in the past year. Measures most commonly predictive for females included peer alcohol use, parental permissiveness toward teen alcohol use, susceptibility to peer pressure and alcohol misuse in the past year.

"Some of the measures used may be indicators of the individuals' risk level and their susceptibility to crash involvement," Bingham says. "Other variables, such as alcohol misuse, may contribute directly to increased risk of being involved in a motor vehicle crash, as well. These characteristics might be used to identify teens who are at excess risk of being in a motor vehicle crash, or to tailor interventions to reduce their crash risk."

In all, Bingham and colleagues say their study provides strong evidence that graduated driver licensing programs nationwide should include greater restrictions on teen driving, especially with passengers, at night and on weekends. In addition, GDL programs should require stiff penalties for underage drinking drivers by increasing driving restrictions or by extending the time of the restriction period.

The full report, "Crash Risk among Teen Drivers: Identification and Prediction of Excess Risk," is available at **http://hdl.handle.net/2027.42/57284**. RR

Seasonal Variations in Conspicuity of High-Visibility Garments

In 2005, 64,000 pedestrians were injured and 4,881 pedestrians were killed in traffic crashes in the United States.[1] The potential for harm is even greater for road workers who, like pedestrians, face danger from passing motorists, and who are additionally subject to harm within the work site from construction vehicles and equipment. Increasing the conspicuity of pedestrians and road workers through the use of high-visibility garments has long been advocated to address this problem.

In a recent study, UMTRI researchers Mary Lynn Buonorosa and Jim Sayer conducted a naturalistic, daytime field study to investigate the effects of garment color (fluorescent red-orange or fluorescent yellow-green), the amount of background material (jacket or vest), driver age (young or old), and season (summer or fall) on the conspicuity of high-visibility safety garments.

[1] United States Department of Transportation (2005). *Traffic Safety Facts 2005: A Compilation of Motor Vehicle Crash Data from the Fatality Analysis Reporting System and the General Estimates System* (Report DOT HS 810 631). Washington, D.C.: National Highway Traffic Safety Administration.

Method

Subjects drove an instrumented vehicle along a 29-km route in daytime, once in summer and again in fall. Their task was to detect pedestrians wearing high-visibility garments. All of the challenges normally encountered when driving on public roadways were present, thus providing a more ecologically valid level of workload than could be provided by test-track or static evaluations.

Twenty-four drivers, twelve older (mean age of 72.3) and twelve younger (mean age of 25.2), participated in the study. Distances at which pedestrians were first detected were recorded. Drivers had no prior knowledge about the number or location of pedestrians along the route.

Four new ANSI/ISEA 107-2004-compliant garments were used, two with fluorescent yellow-green background material (a Class 2 vest and a Class 2 jacket) and two with fluorescent red-orange background material (a Class 2 vest and a Class 2 jacket). The vests consisted of approximately 0.9 m^2 of fluorescent background material while the jackets used approximately 1.1 m2 of fluorescent background material. All retroreflective trim was white, 50 mm wide, and made of a vinyl-backed, microprismatic material. Each garment contained 0.17 m^2 of retroreflective trim.

Experimenters wearing high-visibility garments were positioned along the route at eight possible locations. They stood stationary on the right side of the road approximately 1.8 meters outside the edge line. In each trial, an experimenter was wearing one of the four high-visibility garments and was always facing oncoming traffic. The unobstructed site distance for each of the eight locations was at least 0.5 km.

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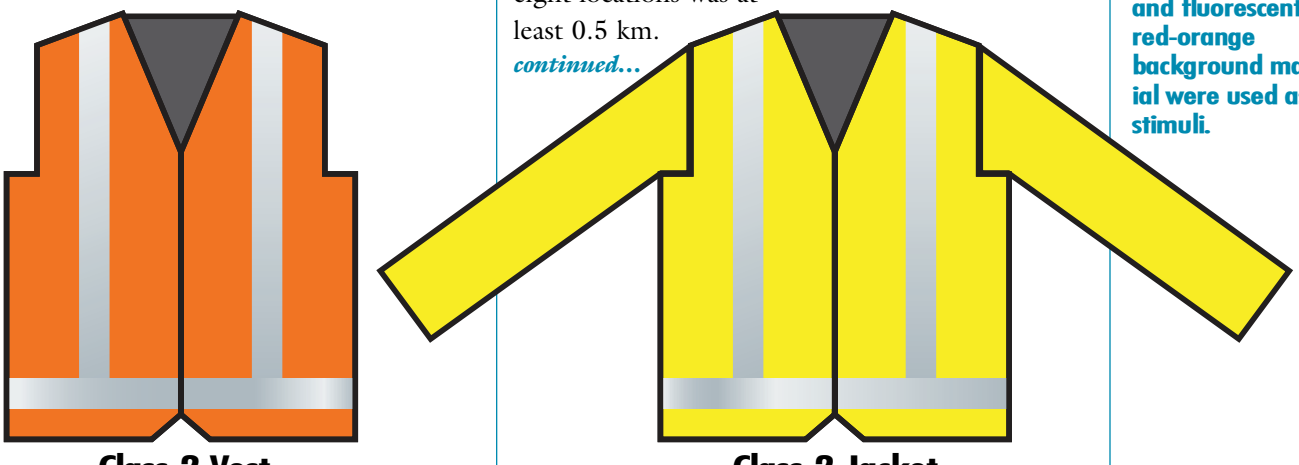
UMTRI BRIEFS



Below-Left: **Class 2 vests and jackets with fluorescent yellow-green and fluorescent red-orange background material were used as stimuli.**

Results

Researchers analyzed data using a mixed linear model. The within-subject variables were garment type (Class 2 vest or Class 2 jacket), garment color (fluorescent yellow-green or fluorescent red-orange), and season (summer or fall). The between-subjects variable was driver age (older or younger). Location of the pedestrians was included in the model as a covariate. The dependent measure was the distance at which a pedestrian was detected.

The effect of garment type was statistically significant, with drivers on average detecting pedestrians 71 meters farther when they were wearing jackets as compared with vests (at 436 versus 365 meters). It makes sense that additional fluorescent material in the form of sleeves would increase the conspicuity of pedestrians, resulting in longer detection distances.

The effect of season was also statistically significant, with drivers detecting pedestrians at farther distances in fall than in summer (at 423 versus 377 meters). However, it is possible that this was the result of a learning effect. Even though there was a three-month separation between the subjects' two drives, the route was not complicated and, in order to keep the foliage backgrounds comparable, the locations of the pedestrians varied little between the seasons.

Detection distances for fluorescent yellow-green and fluorescent red-orange garments were not significantly different. Additionally, there was no main effect of age. However, the interaction of age group and garment type was statistically significant, $F(1, 9.84) = 5.63$, $p = 0.039$. While age did not play a role in subjects identifying pedestrians wearing jackets, younger participants detected the vests at longer distances than did the older participants.

Analyses of color and luminance contrasts suggest that color contrast with natural back

CHART 1

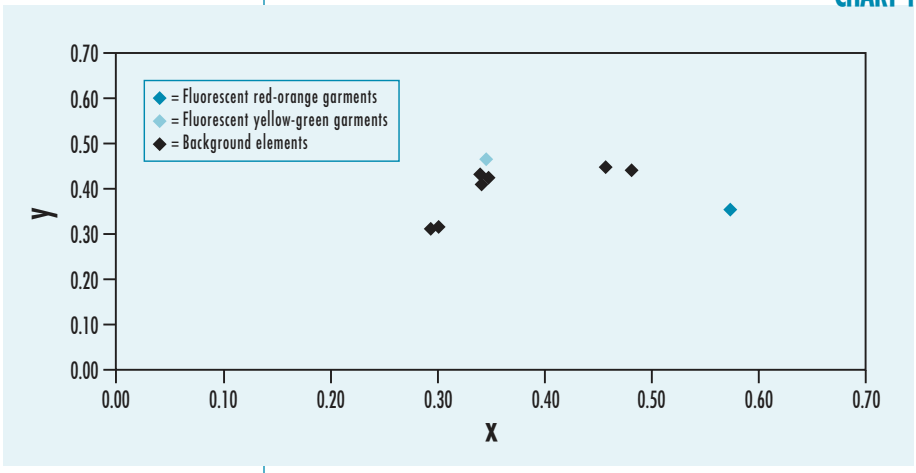


CHART 2

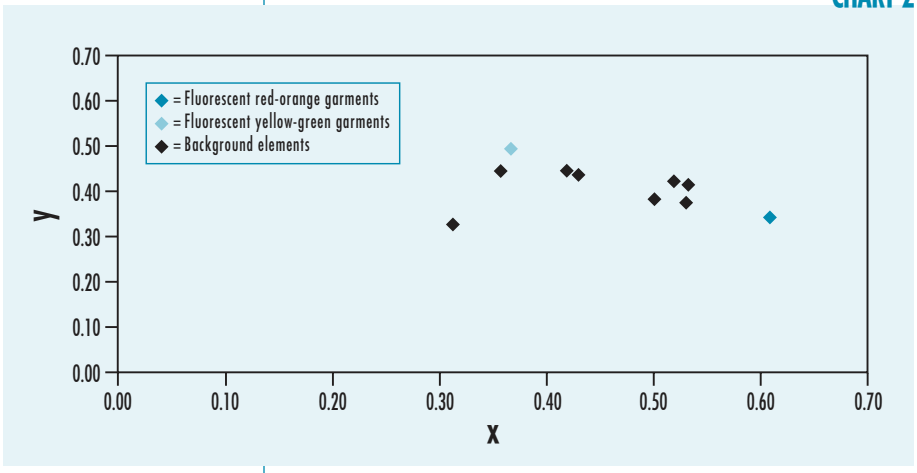
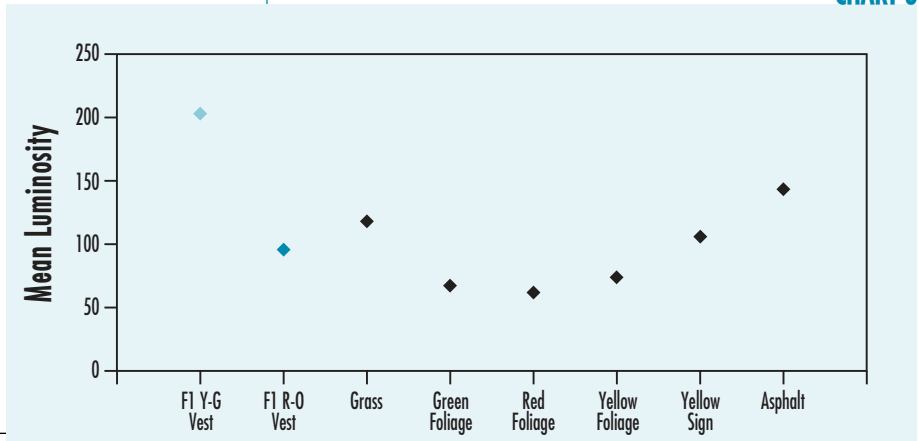


CHART 3



***At Right*— Chromaticity coordinates for the fluorescent-colored vests and jackets in the summer (chart 1) and fall (chart 2). The mean luminosity data for each of the vests and the background elements indicate that the luminance contrast between the vest and the background is substantially greater for the fluorescent yellow-green material than for the fluorescent red-orange material (chart 3).**

CHARTS BY UMTRI / MARY LYNN BUONOROSA; GRAPHICS BY UMTRI / SHEKINAH ERRINGTON

grounds might contribute more to the conspicuity of fluorescent red-orange garments than the corresponding luminance contrast. Regardless of season, the fluorescent red-orange vest was conspicuous because its color is very different from the natural background. While the fluorescent yellow-green vest also differs from the natural setting in this study, its contrast was not as great as that of the fluorescent red-orange vest.

On the other hand, the luminance contrast between the vest and the background was substantially greater for the fluorescent yellow-green material than for the fluorescent red-orange material. Consequently, the luminance contrast might be the primary variable affecting the conspicuity of the fluorescent yellow-green vests in both seasons.

UMTRI Research Basis for Child Restraint Law

On March 27, 2008, Governor Granholm signed Michigan's new child restraint law. Effective July 1, the law will require the use of approved booster seats for children between the ages of four and eight and less than four feet nine inches tall. For details on the law, see **www.umtri.umich.edu/content/MIChildRestraintLaw.pdf**.

Several UMTRI researchers have provided technical data over the past few years to support passing this law:

- Ray Bingham, research associate professor in the Social and Behavioral Analysis Division
- Charlie Compton, head of UMTRI's Transportation Data Center
- David Eby, head of the Social and Behavioral Analysis Division
- Kathy Klinich, assistant research scientist in the Biosciences Division
- Miriam Manary, senior research associate in the Biosciences Division
- Mark Sochor, assistant research scientist in the Biosciences Division
- Renée St. Louis, research assistant in the Social and Behavioral Analysis Division
- Jonathan Vivoda, research associate in the Social and Behavioral Analysis Division

To find out more about UMTRI's work in child passenger protection, see the following articles in previous editions of *UMTRI Research Review*:

- "Studies Find Low Use of Booster Seats" in volume 36, number 3
- "Child Passenger Safety" in volume 32, number 2
- "Crash Protection for Child Passengers" in volume 31, number 3

The following related UMTRI reports are also available online:

- "Factors Influencing the Use of Booster Seats: A Statewide Survey of Parents" is available at **http://hdl.handle.net/2027.42/8519**.
- "Community-Based Booster Seat Promotion Programs: Baseline Results of a Direct Observation Survey" is available at **http://hdl.handle.net/2027.42/13899**.

CENTERS FOR DISEASE CONTROL AND PREVENTION (CDC), NATIONAL CENTER FOR INJURY PREVENTINO AND CONTROL (NCIPC)

UMTRI BRIEFS

UMTRI at TRB

UMTRI director Peter Sweatman, researchers, and staff members welcomed friends, colleagues, and sponsors at a reception during the 87th Transportation Research Board Annual Meeting. The theme for the reception, held Sunday, January 13 at the Omni Shoreham Hotel in Washington, D.C., was "The Power of Naturalistic Driving Studies."

The following UMTRI researchers authored several papers that were presented at the meeting and presided over sessions covering a range of topics representing the diversity of UMTRI's research disciplines.

Andrea Barretto, research associate in the Social and Behavioral Analysis Division, presented "Results of Web-Based Survey to Prevent Injury—Including Traffic Injury—Relative to Alcohol Use among College Freshman," which was coauthored by Ray Bingham.

Ray Bingham, research associate professor in the Social and Behavioral Analysis Division, presented "Parents' Attitudes Toward Booster Seat Use: Changes from 2004 to 2007" and "Factors Contributing to Excess Crash Risk among Teen Drivers," which was coauthored by Jean Shope, associate director of UMTRI and research professor in the Social and Behavioral Analysis Division.

David W. Eby, head of UMTRI's Social and Behavioral Analysis Division, and Dave LeBlanc, assistant research scientist in the Engineering Research Division, presented "Fitness-to-Drive in Early-Stage Dementia: Two Instrumented Vehicle Studies," which was coauthored by Lisa Molnar.

Tim Gordon, head of UMTRI's Engineering Research Division, presented "Research Needs on VII Applications," "System Requirements for Site-Based Video Systems," and "Benefits and Costs of Four Approaches to Improving the Rollover Stability of Cargo Tank Motor Vehicles," whose UMTRI coauthors include Christopher Winkler, Daniel Blower, and Michelle Barnes. He presided over the sessions "Recent Progress in Integrated Vehicle-Highway Systems" and "Vehicle-Highway Automation Committee," as well as over the poster session "Safety, Mobility, and Liability Impacts of Driver Assistance Systems."

Steve Karamihas, senior research associate in the Engineering Research Division, presented various talks as part of the workshop ProVAL: Profile Viewing and Analysis Software: "Vehicle Ride and Ride Indices," "Cross-Correlation and Profiler Certification," "Hands-On Exercises," "Power Spectral Density," "Smoothness Assurance Module," and "More Hands-On Exercises." He also presented a separate paper, "Consistency in Measurement Practices."

Lidia Kostyniuk, research scientist in the Social and Behavioral Analysis Division, presented "Development of Analysis Methods Using Existing Data: Phase 1," which was coauthored by Paul Eric Green.

Lisa Molnar, lead research associate in the Social and Behavioral Analysis Division, presided over the session "Using Instrumented Vehicles to Study Driving and Dementia: The Next Frontier in Driving Behavior Research."

Jim Sayer, assistant research scientist in the Human Factors Division, presented "Toward Best Practices for Ethical and Privacy Issues in On-Road Driving Research."

Renée St. Louis, research assistant in the Social and Behavioral Analysis Division, presented "Use of Booster Seats When Not Required by Law: Trends in Michigan."

Jonathon Vivoda, research associate in the Social and Behavioral Analysis Division, presented "The Effect of a Daytime Click It or Ticket Program on Nighttime Safety Belt Use."

John Woodrooffe, head of UMTRI's Transportation Safety Analysis Division, presided over a meeting of the Motor Vehicle Size and Weight Committee and over the session "Safety and Productivity of Large Commercial Vehicles." RR

Kokkolaras Joins Biosciences Division

Michael Kokkolaras, an associate research scientist in the University of Michigan's Department of Mechanical Engineering, has accepted a 20 percent appointment in UMTRI's Biosciences Division. He is working with Matt Reed, UMTRI research associate professor, to address the challenge of optimizing restraint system performance for a wide range of occupant characteristics and crash types. This work is made more timely by the stepped-up pressure on manufacturers to increase fuel economy. Improving miles-per-gallon will almost certainly lead to lighter vehicles in many vehicle segments, and lighter vehicles are generally less safe for their occupants, all other factors being equal. Thus, their goal is to help to improve restraint systems so that occupant protection continues to improve even as some types of vehicles become lighter. Kokkolaras previously worked with Reed on a research project through the Automotive Research Center (ARC), a program funded by the U.S. Army Tank Automotive Research, Development and Engineering Command (TARDEC). The project involved applying optimization to truck cab layout, which combined Michael's optimization background with the posture-prediction models developed in Biosciences. That collaboration also resulted in a conference paper and journal article over the past few years, and spun off other research activities.

Kokkolaras joined the University in 2000. In addition to his work with ARC, he has been active in the Optimal Design Engineering Laboratory in the University of Michigan's Department of Mechanical Engineering, and has conducted research sponsored by a wide range of organizations, including the National Science Foundation and a number of automotive industry companies. He earned a Ph.D. in mechanical engineering from Rice University and a diploma in aerospace engineering from the Technical University of Munich. His research interests include multidisciplinary optimization, design under uncertainty, systems engineering, decomposition and coordination methods for optimal system design, and platform-based design of product families. RR

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Michael Kokkolaras

RECENT UMTRI PUBLICATIONS

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.

Conference Papers

Green, P. 2007. "Why Driving Performance Measures are Sometimes not Accurate (and Methods to Check Accuracy)." *In Driving Assessment 2007: Proceedings of the 4th International Driving Symposium on Human Factors in Driver Assessment, Training, and Vehicle Design.* pp. 394–400.
http://ppc.uiowa.edu/driving-assessment/2007/proceedings/papers/066_Green.pdf

LeBlanc, D.; Sayer, J.; Winkler, C.; Bogard, S.; Devonshire, J. 2007. "Field Test Results of a Road Departure Crash Warning System: Driver Utilization and Safety Implications. In *Driving Assessment 2007: Proceedings of the 4th International Driving Symposium on Human Factors in Driver Assessment, Training, and Vehicle Design.* pp. 246–252.
http://ppc.uiowa.edu/driving-assessment/2007/proceedings/papers/042_LeBlancSayer.pdf

Sullivan, J.M.; Bärgman, J.; Adachi, G.; Schoettle, B. 2007. "Driver Performance and Workload Using a Night Vision System." In *Driving Assessment 2007: Proceedings of the 4th International Driving Symposium on Human Factors in Driver Assessment, Training, and Vehicle Design.* pp. 519–526.
http://ppc.uiowa.edu/driving-assessment/2007/proceedings/papers/084_SullivanBargman.pdf

Tsimhoni, O.; Flannagan, M.J.; Mefford, M.L.; Takenobu, N. 2007. "A Simple and Effective Display for Night Vision Systems." In *Driving Assessment 2007: Proceedings of the 4th International Driving Symposium on Human Factors in Driver Assessment, Training, and Vehicle Design.* pp. 271–277.
http://ppc.uiowa.edu/driving-assessment/2007/proceedings/papers/047_TsimhoniFlannigan.pdf

Journal Articles

Dickerson, A.E.; Molnar, L.J.; Eby, D.W.; et al. 2007. "Transportation and Aging: A Research Agenda for Advancing Safe Mobility." *Gerontologist*, vol. 37, no. 5, pp. 578–590.

Technical Reports

Buonarosa, M. L.; Sayer J.R. 2007. *Seasonal Variations in Conspicuity of High-Visibility Garments.* Report No. UMTRI-2007-42.
The research documented in this report was sponsored by UMTRI's Industry Affiliation Program for Human Factors in Transportation Safety.

Flannagan, M.J.; Schoettle, B. 2007. *Benefits of Headlamp Leveling and Cleaning for Current U.S. Low Beams.* Report No. UMTRI-2007-46.
The research documented in this report was sponsored by UMTRI's Industry Affiliation Program for Human Factors in Transportation Safety.

Green, P.E.; Matteson, A. 2007. *Evaluation of 2006 Idaho Crash Data Reported to Motor Carrier Management Information System Crash File.* Report No. UMTRI-2007-51.
http://hdl.handle.net/2027.42/58053
The research documented in this report was sponsored by the Federal Motor Carrier Safety Administration.

Jarossi, L.; Hershberger, D.; Green, P.E.; Woodrooffe, J. 2007. *Buses Involved in Fatal Accidents Codebook 2005 (Version Nov 6, 2007).* Report No. UMTRI-2008-5.
http://hdl.handle.net/2027.42/58055
The research documented in this report was sponsored by the Federal Motor Carrier Safety Administration.

Jarossi, L.; Matteson, A.; Woodrooffe, J. 2007. *Buses Involved in Fatal Accidents Factbook.* 2003 Report No. UMTRI-2008-2.
The research documented in this report was sponsored by the Federal Motor Carrier Safety Administration.
http://hdl.handle.net/2027.42/57994

Schoettle, B.; Sivak, M.; Takenobu, N. 2007. *Market-Weighted Trends in the Design Attributes of Headlamps in the U.S.* Report No. UMTRI-2007-20.
The research documented in this report was sponsored by UMTRI's Industry Affiliation Program for Human Factors in Transportation Safety.

Sivak, M.; Schoettle, B.; Tsimhoni, O. 2007. *Moon Phases and Nighttime Road Crashes Involving Pedestrians.* Report No. UMTRI-2007-41.
The research documented in this report was sponsored by UMTRI's Industry Affiliation Program for Human Factors in Transportation Safety.

Sullivan, J.M.; Bogard, S. 2007. *Warning Reliability and Driver Performance in Naturalistic Driving.* Report No. UMTRI-2007-44.
The research documented in this report was sponsored by UMTRI's Industry Affiliation Program for Human Factors in Transportation Safety. RR

Conferences & Events

ITE 2008 Technical Conference and Exhibit
March 30–April 2, Miami, Florida
www.ite.org/conference

Transportation and University Communities Conference
April 5–8, Reno, Nevada
www.apta.com/conferences_calendar/univ/

National Work Zone Awareness Week
April 7–11, Nationwide
http://ops.fhwa.dot.gov/wz/outreach/wz_awareness.htm

Public Meeting on IVBSS
April 10–11, Ypsilanti, MI
www.itsa.org/ivbss.html

Lifesavers: National Conference on Highway Safety Priorities
April 13–15, Portland, Oregon
www.lifesaversconference.org

SAE World Congress
April 14–17, Detroit, Michigan
www.sae.org/congress

Design-Build in Transportation Conference
April 16–18, Louisville, Kentucky
www.designbuildtransportation.com

TRA 2008: Transport Research Arena
April 21–25, Ljubljana, Slovenia
www.tra2008.si

International Symposium on Transportation and Development Innovative Best Practices
April 24, Beijing, China
http://jtzx.net.cn/tdibp

APA National Planning Conference
April 27–May 1, Las Vegas, Nevada
www.planning.org/2008conference

Annual Transportation Safety Conference
April 29–30, Topeka, Kansas
www.kuce.org/programs/ktsc

International Bus Roadeo / Bus and Paratransit Conference
May 4–7, Austin, Texas
www.apta.com/conferences_calendar/bus

Vehicle Dynamics Expo
May 6–8, Stuttgart, Germany
www.vehicledynamics-expo.com

National Transportation Week
May 11–17, Nationwide
www.ntweek.org

Western Regional Grade Crossing Safety Training Conference
May 12–14, Ventura, California
www.techtransfer.berkeley.edu/railroad

WTS Annual Conference
May 14–16, Atlanta, Georgia
www.wtsinternational.org

Thirtieth World Congress of the International Road Transport Union
May 15–16, Istanbul, Turkey
www.iru.org/index/en_2008_istanboul_index

International Conference on Heavy Vehicles
May 19–22, Paris, France
http://hvparis2008.free.fr

CTS Transportation Research Conference
May 20–21, Saint Paul, Minnesota
www.cts.umn.edu/Events/ResearchConf

Telematics Detroit Conference
May 20–22, Novi, Michigan
www.telematicsupdate.com/detroit2008 RR

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Transportation Tidbits

- The first car advertisement to appear in a national magazine was published on March 31, 1900, in the *Saturday Evening Post*. The W.E. Roach Company of Philadelphia advertised its cars with the tagline "Automobiles That Give Satisfaction."

- On February 4, 1913, Louis Henry Perlman of New York received a patent for the first demountable tire-carrying rim. Prior to this invention, changing a tire also involved changing the wheel.

- Edsel Ford succeeded his father, Henry Ford, as president of Ford Motor Company on January 1, 1919, at age twenty-five. The same day, the company announced a minimum wage increase to $6.00 per day, which was generous for the time. Edsel was Henry's only child.

- On February 29, 1908, a standardization test of three random Cadillacs took place at the Brooklands Track in Weybridge, England, in association with the Royal Automobile Club. This test was the first step toward a heightened reputation for American cars. Proving the validity of interchangeable parts paved the way for mass production and ease of car repair.

- The first U.S. nationwide highway numbering system was instituted on March 2, 1925. The system was a joint effort of state and federal highway officials who were appointed by the secretary of agriculture. The board also developed shield-shaped highway number markers. Over time, interstate highway numbering would be improved by colored signs and the odd-even demarcation between north-south and east-west routes.

- On January 2, 1994, Chrysler Corporation introduced the Neon. This plastic-bodied compact car was sporty and economical, and quickly became popular, especially with young drivers. RR

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

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