5th International Driving Symposium on Human Factors in Driver Assessment, Training, and Vehicle Design
June 22-25, 2009

Monday June 22, 2009

1:30 PM – 6:30 PM	**Early Registration** Lower Atrium, Yellowstone Convention Center
3:30 PM – 5:00 PM	**Workshop** Madison & Gallatin, Yellowstone Convention Center **Say, When Is That Driving Simulation Handbook EVER Going to be Finished? Highlights from an Important Ordeal** Jeff Caird (University of Calgary – *Canada*), Don Fisher (University of Massachusetts at Amherst), John Lee, Matthew Rizzo (University of Iowa)
6:00 PM – 8:30 PM	**WELCOME RECEPTION** Huntley Dining Room, Huntley Lodge

Tuesday June 23, 2009

7:00 AM – 4:00 PM	**Registration Open** Lower Atrium, Yellowstone Convention Center
7:00 AM – 8:30 AM	**Breakfast Buffet** Lower Atrium, Yellowstone Convention Center
8:30 AM – 9:30 AM	**NISSAN DISTINGUISHED KEYNOTE LECTURE** Madison & Gallatin, Yellowstone Convention Center **Traffic: Why We Drive the Way We Do (and What It Says About Us)** Tom Vanderbilt, Author
9:30 AM – 10:00 AM	**BREAK – Refreshments** Jefferson, Yellowstone Convention Center

Tuesday June 23, 2009

Session 1 – Lectures
Driver Distraction & Fatigue
10:00 AM – 11:30 AM
Madison & Gallatin, Yellowstone Convention Center

Session Chair: Natasha Merat, (University of Leeds — *United Kingdom*)

10:00 AM **The Blind Date: The Effects of Passenger Conversation and Gender on Looked-but-Failed-to-See (LBFTS) Errors (01)**
Cale White (AECOM), Jeff Caird (University of Calgary — *Canada*)

10:20 AM **A Measure of Strong Driver Fatigue (02)**
David Sommer (University of Applied Sciences Schmalkalden — *Germany*), Martin Golz (University of Applied Sciences Schmalkalden; Institute for System Analysis and Applied Numerics — *Germany*), Thomas Schnupp (University of Applied Sciences Schmalkalden — *Germany*), Jarek Krajewski (University of Wuppertal — *Germany*), Udo Trutschel (Circadian Technologies Inc.; Institute for System Analysis and Applied Numerics — *Germany*), Dave Edwards (Caterpillar Inc.)

10:40 AM **Comparison of Two Eye-Gaze Based Real-Time Driver Distraction Detection Algorithms in a Small-Scale Field Operational Test (03)**
Katja Kircher (Swedish National Road and Transport Research Institute [VTI]; Chalmers University — *Sweden*), Christer Ahlstrom, Albert Kircher (Swedish National Road and Transport Research Institute [VTI] — *Sweden*)

11:00 AM **Three Navigation Systems With Three Tasks: Using the Lane-Change Test (LCT) to Assess Distraction Demand (04)**
Joanne L. Harbluk, Julia S. Mitroi, Peter C. Burns (Transport Canada — *Canada*)

11:30 AM – 1:00 PM **HONDA LUNCHEON & OUTSTANDING STUDENT PAPER AWARDS CEREMONY**

Sponsored by Honda R&D Americas, Inc.
Huntley Dining Room, Huntley Lodge

Awards presented by
Mr. Charles Allen
Senior Vice President and General Manager
Honda R&D Americas, Inc.

The Honda Outstanding Student Paper Award winners will be announced at the luncheon.

Tuesday June 23, 2009

Session 2 – Lectures
Commercial Vehicle Operations
1:00 PM – 2:30 PM
Madison & Gallatin, Yellowstone Convention Center

Session Chair: Martin Walker (US DOT Federal Motor Carrier Safety Administration)

1:00 PM **Three Large Truck Crash Categories: What They Tell Us About Crash Causation (05)**
Ronald R. Knipling (Human Factors & Traffice Safety Consultant)

1:20 PM **Evaluation of an Onboard Safety Monitoring Device in Commercial Vehicle Operations (06)**
Jeffrey S. Hickman, Richard J. Hanowski (Virginia Tech Transportation Institute), Olu Ajayi (US DOT Federal Motor Carrier Safety Administration)

1:40 PM **Ecodrive Training Delivers Substantial Fuel Savings for Heavy Vehicle Drivers (07)**
Mark A. Symmons, Geoff Rose (Monash University — *Australia*)

2:00 PM **Object Detection and Identification Using Enhanced Camera/Video Imaging Systems (E-C/VISs) on Heavy Trucks (08)**
William A. Schaudt, Walter W. Wierwille, Richard J. Hanowski (Virginia Tech Transportation Institute)

Session 3 – Poster Session A
2:30 PM – 4:00 PM
Jefferson, Yellowstone Convention Center

Effects of Cognitive and Physical Decline on Older Drivers' Side-to-Side Scanning for Hazards While Executing Turns (09) Matthew Romoser, Donald L. Fisher (University of Massachusetts Amherst)

Aging and the Detection of Collision Events in Fog (10) Zheng Bian (University of California, Riverside), Rui Ni (Wichita State University), Amy Guindon, George J. Andersen (University of California, Riverside)

Differences in Simulated Car Following Behavior of Younger and Older Drivers (11) Elizabeth Dastrup, Monica N. Lees, Jeffrey D. Dawson, John D. Lee, Matthew Rizzo (University of Iowa)

A Simulator-Based Street-Crossing Training for Older Pedestrians: Short and Long Term Effects (12) Aurélie Dommes, Viola Cavallo (French National Institute for Transport and Safety Research [INRETS] — *France*)

Gender Effects on Lane Change Test (LCT) Performance (13) Tibor Petzoldt, Nina Bär, Josef F. Krems (Chemnitz University of Technology — *Germany*)

The Effect of Age on Decision Making During Unprotected Turns Across Oncoming Traffic (14) Nicholas D. Cassavaugh, Joshua E. Domeyer, Richard W. Backs (Central Michigan University)

Changing Driver Behavior Through Unconscious Stereotype Activation (15) Rob Gray, Russ Branaghan (Arizona State University)

Operator Fatigue Estimation Using Heart Rate Measures (16) Robert Hefner, David Edwards (Caterpillar Inc.), Christian Heinze, David Sommer, Martin Golz (University of Applied Science Schmalkalden — *Germany*), William Sirois, Udo Trutschel (Circadian Technologies Inc.)

Steering Wheel Behavior Based Estimation of Fatigue (17) Jarek Krajewski (University of Wuppertal — *Germany*), David Sommer (University of Applied Sciences Schmalkalden — *Germany*), Udo Trutschel (Circadian Technologies Inc.), Dave Edwards (Caterpillar Inc.), Martin Golz (University of Applied Sciences Schmalkalden — *Germany*)

Identifying Influences of Driving Behaviour: Could the Australian Work Driving Setting Be Unique? (18) Darren Wishart, Jeremy Davey, James Freeman, Bevan Rowland (Queensland University of Technology — *Australia*)

Considerations When Calculating Percent Road Centre From Eye Movement Data in Driver Distraction Monitoring (19) Christer Ahlstrom, Katja Kircher, Albert Kircher (Swedish National Road and Transport Research Institute [VTI] — *Sweden*)

Effects of Cell Phone Conversations on Driver Performance While Driving Under Highway Monotony (20) Mark Chan, Paul Atchley (University of Kansas)

Driving With Cardiovascular Disease: The Impact of Implantable Cardioverter Defibrillators on Driver Safety (21) Jessica R. Williams, Stephen J. Tregear (MANILA Consulting Group, Inc.)

Collision Avoidance Training Using a Driving Simulator in Drivers with Parkinson's Disease: A Pilot Study (22) Jeffrey D. Dawson, Matthew Rizzo, Steven W. Anderson, Elizabeth Dastrup (University of Iowa), Ergun Y. Uc (University of Iowa; Veterans Affairs Medical Center of Iowa City)

Normative Values for Driving Simulation Parameters: A Pilot Study (23) Abiodun Emmanuel Akinwuntan, Rebecca Tank, Lori Vaughn, Alexis Wilburn, Seth Easton (Medical College of Georgia)

Multiple Exposition to a Driving Simulator Reduces Simulator Symptoms for Elderly Drivers (24) Normand Teasdale, Martin Lavallière, Mathieu Tremblay (Centre de recherche FRSQ du CHA de Québec — *Canada*), Denis Laurendeau (Université Laval — *Canada*), Martin Simoneau (Centre de recherche FRSQ du CHA de Québec — *Canada*)

The Perception of Optical Flow in Driving Simulators (25) Zhishuai Yin, Ronald R. Mourant (Northeastern University)

Assessment in Driving Simulators: Where We Are and Where We Go (26) Bart Kappé, Leo de Penning (TNO — *The Netherlands*), Maarten Marsman (RCEC — *The Netherlands*), Erik Roelofs (CITO — *The Netherlands*)

Effects of Display Location Within Simulated Driving Environments (27) Matthew C. Crisler, Johnell O. Brooks, Kelly Riggins, Brandon Garris, Jessica Tyler, Sam Dahl (Clemson University)

Evaluating Design Options for a Dynamic Traffic Sign (28) Janet Creaser, Michael Rakauskas, Michael Manser (University of Minnesota), Nicholas Ward (Montana State University-Western Transportation Institute)

4:30 PM – 10:00 PM WESTERN TRANSPORTATION INSTITUTE (WTI) TOUR & HOMESTEAD DINNER

4:30 PM	**Depart Big Sky Resort** by bus shuttle Huntley Lodge Lobby **Maps will be provided if you prefer to drive*
5:30 PM	**Arrive at WTI**
5:45 PM	**Overview and Welcome**
6:00 - 8:00 PM	**Homestead dinner served**
6:15 - 8:30 PM	**Tours of facility** Leaving in 15-minute intervals (12 persons per group)
8:30 PM	**Last tour of facility group leaves**
8:00 - 9:00 PM	**Depart WTI** by bus shuttle
9:00 - 10:00 PM	**Return to Big Sky Resort**

Wednesday June 24, 2009

7:00 AM – 4:00 PM **Registration Open**
Lower Atrium, Yellowstone Convention Center

7:00 AM – 8:30 AM **Breakfast Buffet**
Lower Atrium, Yellowstone Convention Center

Session 4 – Hybrids
Intro Lecture/Poster
8:30 AM – 10:00 AM
Madison & Gallatin, Yellowstone Convention Center

Session Chair: Susan Chrysler (Texas Transportation Institute)

A Cross-Cultural Comparison of Younger and Older Adults' Simulated Highway Driving Performance Under Single and Dual Task Conditions (29) Bryan Reimer, Bruce Mehler (Massachusetts Institute of Technology [MIT] AgeLab & New England University Transportation Center), Joonwoo Son (Daegu Gyeongbuk Institute of Science and Technology [DGIST] — *South Korea*), Anna Pohlmeyer (Massachusetts Institute of Technology [MIT] AgeLab and New England University Transportation Center; Center of Human-Machine-Systems, Berlin University of Technology – *Germany*), Jarrod Orszulak, Jonathon Long, Joseph Coughlin (Massachusetts Institute of Technology [MIT] AgeLab and New England University Transportation Center)

Predicting Older Drivers' Difficulties Using the Roadwise Review (30) Charles Scialfa, Jennifer Ference, Jessica Boone, Richard Tay, Carl Hudson (University of Calgary — *Canada*)

Multiple-Session Simulator Training for Older Drivers and On-Road Transfer of Learning (31) Martin Lavallière (Centre de recherche FRSQ du CHA de Québec — *Canada*), Denis Laurendeau (Université Laval — *Canada*), Mathieu Tremblay, Martin Simoneau, Normand Teasdale (Centre de recherche FRSQ du CHA de Québec — *Canada*)

Comparing the Gap Acceptance and Turn Time Patterns of Novice With Experienced Drivers for Turns Across Traffic (32) Eve Mitsopoulos-Rubens, Thomas Triggs, Michael Regan (Monash University Accident Research Centre — *Australia*)

Hard Braking Events Among Novice Teenage Drivers By Passenger Characteristics (33) Bruce G. Simons-Morton, Marie Claude Ouimet, Jing Wang (National Institute of Child Health and Human Development; National Institute of Health), Sheila G. Klauer, Suzanne E. Lee, Thomas A. Dingus (Virginia Tech Transportation Institute)

Enhanced Seat Belt Reminder Systems for Teenage Drivers and Passengers (34) Neil Lerner, Jeremiah Singer, Mark Freedman (Westat)

Can Low Cost Road Engineering Measures Combat Driver Fatigue? A Driving Simulator Investigation (35) A. Hamish Jamson, Natasha Merat (University of Leeds — *United Kingdom*)

The Effects of Dual-Task Interference and Response Strategy on Stop or Go Decisions to Yellow Light Changes (36) David G. Kidd, Christopher A. Monk (George Mason University)

Validation of the Static Load Test for Event Detection During Hands-Free Conversation (37) Richard A. Young, Linda S. Angell (Wayne State University School of Medicine), John M. Sullivan (University of Michigan Transportation Research Institute), Sean Seaman, Li Hsieh (Wayne State University)

Comparing Techniques to Reduce Simulator Adaptation Syndrome and Improve Naturalistic Behaviour During Simulated Driving (38) James G. Reed-Jones, Rebecca J. Reed-Jones, Lana M. Trick, Ryan Toxopeus, Lori A. Vallis (University of Guelph — *Canada*)

Acquisition, Response, and Error Rates With Three Suites of Collision Warning Sounds (39) John M. Sullivan, Mary Lynn Buonarosa (University of Michigan Transportation Research Institute)

Driver Comprehension of Integrated Collision Avoidance System Alerts Presented Through a Haptic Driver Seat (40) Gregory M. Fitch, Jonathan M. Hankey (Virginia Tech Transportation Institute), Brian M. Kleiner (Virginia Tech)

The Adaption Test: The Development of a Method to Measure Speed Adaption to Traffic Complexity (41) Saskia de Craen, Divera A.M. Twisk (SWOV, Institute for Road Safety Research — *The Netherlands*), Marjan P. Hagenzieker (SWOV, Institute for Road Safety Research; Delft University of Technology — *The Netherlands*), Henk Elffers (NSCR, Institute for the Study of Crime and Law Enforcement — *The Netherlands*), Karel A. Brookhuis (Delft University of Technology — *The Netherlands*)

Differential Effects of Focal and Ambient Visual Processing Demands on Driving Performance (42) John K. Lenneman, Joseph Lenneman, Nicholas Cassavaugh, Richard Backs (Central Michigan University)

An Invariant May Drive the Decision to Encroach at Unsignalized Intersections (43) Kip Smith (Linköping University — *Sweden*), Aurélie Thome (Insa de Lyon — *France*), Christian Blåberg (Linköping University — *Sweden*), Jonas Bärgman (Autoliv Research — *Sweden*)

10:00 AM – 10:30 AM **BREAK – Refreshments**
Jefferson, Yellowstone Convention Center

Session 5 – Panel Discussion
Research Needs in Driver Assessment: The Future
10:30 AM – 12:00 PM
Madison & Gallatin, Yellowstone Convention Center

Session Moderator: Michael Griffith (Federal Highway Administration/Office of Safety)

Stephanie Binder (US DOT National Highway Traffic Safety Administration)
Martin Walker (US DOT Federal Motor Carrier Safety Administration)
Bruce Simon-Morton (National Institute of Child Health and Human Development; National Institute of Health)
Peter Burns (Transport Canada — *Canada*)

Wednesday June 24, 2009

12:00 PM – 1:30 PM **LUNCH**
Huntley Dining Room, Huntley Lodge

12:30 PM – 1:15 PM **Luncheon Lecture**
Huntley Dining Room, Huntley Lodge

Mechanisms Involved in the Recent Large Reductions in the U.S Road Fatalities
Michael Sivak (Head of Human Factors Division, Transportation Research Institute, University of Michigan)

Session 6 – Lectures
Medical Factors: Fitness to Drive
1:30 PM – 3:00 PM
Madison & Gallatin, Yellowstone Convention Center

Session Chair: Eli Peli (Schepens Eye Research Institute, Harvard Medical School)

1:30 PM **The Impact of Macular Disease on Pedestrian Detection: A Driving Simulator Evaluation (44)**
P. Matt Bronstad, Alex R. Bowers, Robert B. Goldstein, Amanda Albu, Eli Peli (Schepens Eye Research Institute, Harvard Medical School)

1:50 PM **Seizure and the Risk for Seizure Recurrence Among Individuals Who Have Undergone Surgery for Epilepsy (45)**
Stephen J. Tregear, Jessica R. Williams (MANILA Consulting Group, Inc.)

2:10 PM **Near Peripheral Motion Contrast Threshold Predicts Older Drivers' Driving Simulator Performance (46)**
Steven Henderson (Transportation Safety Board of Canada — *Canada*), Sylvain Gagnon, Charles Collin, Ricardo Tabone, Arne Stinchcombe (University of Ottawa — *Canada*)

2:30 PM **Prediction of Driving Ability in People With Dementia- and Non-Dementia-Related Brain Disorders (47)**
Carrie Innes (Van der Veer Institute for Parkinson's & Brain Research; Christchurch Hospital — *New Zealand),* Richard Jones (Van der Veer Institute for Parkinson's & Brain Research; Christchurch Hospital; University of Otago — *New Zealand*), John Dalrymple-Alford (Van der Veer Institute for Parkinson's & Brain Research; University of Canterbury — *New Zealand*), Julie Severinsen, Jane Gray (Burwood Hospital — *New Zealand*)

3:00 PM – 3:30 PM **BREAK – Refreshments**
Jefferson, Yellowstone Convention Center

Wednesday June 24, 2009

Session 7 – Poster Session B
3:30 PM – 5:00 PM
Jefferson, Yellowstone Convention Center

Attention Maintenance in Novice Drivers: Assessment and Training (48) Anuj Pradhan, Kathleen M. Masserang, Gautam Divekar, Ian Reagan, F. Dennis Thomas, Richard Blomberg, Alexander Pollatsek, Donald Fisher (University of Massachusetts at Amherst)

Crash Risk: Eye Movement as Indices for Dual Task Driving Workload (49)
Julie J. Kang, Zheng Bian, George J. Andersen (University of California, Riverside)

Manipulating Drive Characteristics to Study the Effects of Mental Load on Older and Younger Drivers (50) Lana M. Trick, Martin Lochner, Ryan Toxopeus, David Wilson (University of Guelph — *Canada*)

Comparison of the Effects of Two Push-to-Talk Button Implementations on Driver Hand Position and Visual Attention (51) Oskar Palinko, Andrew L. Kun (University of New Hampshire)

Quantifying the Subjective Brightness of Retroreflective Material Using Magnitude Estimations (52) Justin S. Graving (University of Minnesota), Richard A. Tyrrell, Stacy A. Balk (Clemson University)

How Well Do Drivers Understand Their Own Headlights? (53) Johnell O. Brooks, Richard R. Goodenough, Richard A. Tyrrell, Chris Guirl, Kristin Moore, Nathan Klein, Laura Davis, Tina Kubala (Clemson University)

Curve Negotiation: Identifying Driver Behavior Around Curves with the Driver Performance Database (54) Anna Mikolajetz (Human-Factors-Consult — *Germany*), Matthias J. Henning (Chemnitz University of Technology — *Germany*), Axel Tenzer (Ingenieurbüro Lange + Tenzer — *Germany*), Robert Zobel (Volkswagen AG — *Germany*), Josef F. Krems, Tibor Petzoldt (Chemnitz University of Technology — *Germany*)

Do Redundant Head-Up and Head-Down Display Configurations Cause Distractions? (55) Carl Jörgen Normarck, Phillip Tretten, Anita Gärling (Luleå University of Technology — *Sweden*)

Verbal-Spatial Cue Conflict: Implications for the Design of Collision-Avoidance Warning Systems (56) Jane H. Barrow, Carryl L. Baldwin (George Mason University)

Development of a System to Study the Impact of Headlight Glare in a Driving Simulator (57) Matthew Fullerton (Schepens Eye Research Institute, Harvard Medical School; University of York — *United Kingdom;* Technische Universität München — *Germany*), Eli Peli (Schepens Eye Research Institute, Harvard Medical School)

Ascertainment of On-Road Safety Errors Based on Video Review (58)
Jeffrey D. Dawson, Ergun Y. Uc, Steven W. Anderson, Elizabeth Dastrup, Amy M. Johnson, Matthew Rizzo (University of Iowa)

Age and Attentional Capacity (59) Dong-Yuan Debbie Wang, Scott Entsminger (University of North Florida)

Driving Assessment and Subsequent Driving Outcome: A Prospective Study of Safe and Unsafe Healthy Driver Groups (60) Petra Hoggarth (Van der Veer Institute for Parkinson's & Brain Research; University of Canterbury — *New Zealand*), Richard Jones (Van der Veer Institute for Parkinson's & Brain Research; Christchurch Hospital; University of Otago — *New Zealand*), Carrie Innes (Van der Veer Institute for Parkinson's & Brain Research; Christchurch Hospital — *New Zealand*), John Dalrymple-Alford (Van der Veer Institute for Parkinson's & Brain Research; University of Canterbury — *New Zealand*)

Estimating Workload Demands of Turning Left at Intersections of Varying Complexity (61) Arne Stinchcombe (University of Ottawa — *Canada*), Sylvain Gagnon (University of Ottawa; CanDRIVE, Ottawa Health Research Institute — *Canada*)

Implementation of a Driving Diary Intervention to Reduce Aberrant Driving Behaviours (62) Bevan Rowland, Jeremy Davey, James Freeman, Darren Wishart (Queensland University of Technology — *Australia*)

Useful Field of View Impairments in Drivers with Obstructive Sleep Apnea (63) Jon Tippin, (University of Iowa; Veterans Affairs Medical Center), JonDavid Sparks, Matthew Rizzo (University of Iowa)

A Recording and Analysis System of Bioptic Driving Behaviors (64) Gang Luo (Schepens Eye Research Institute, Harvard Medical School), Xianping Fu (Schepens Eye Research Institute, Harvard Medical School; Dalian Maritime University — *China*), Eli Peli (Schepens Eye Research Institute, Harvard Medical School)

Estimating Fatigue from Predetermined Speech Samples Transmitted by Operator Communication Systems (65) Jarek Krajewski (University of Wuppertal — *Germany*), Udo Trutschel (Circadian Technologies Inc.), Martin Golz (University of Applied Sciences Schmalkalden — *Germany*), David Sommer (Circadian Technologies Inc.), Dave Edwards (Caterpillar Inc.)

Withdrawn (66)

Nighttime Speed Negotiation on Rural Road S-Shaped Curves: Discussion of an Experimental Case-Study (67) Marco Pasetto, Andrea Manganaro (University of Padua — *Italy*)

5:30 PM – 9:30 PM **320 GUEST RANCH BARBEQUE**

5:30 PM	**Depart Big Sky Resort** by bus Huntley Lodge Lobby **Maps provided if you prefer to drive*
6:00 - 7:30 PM	**Social Hour** (cash bar)
7:30 PM	**Dinner**
9:00 PM	**Depart 320 Guest Ranch** by bus
9:30 PM	**Return to Big Sky Resort**

Thursday June 25, 2009

7:00 AM – 12:00 PM **Registration Open**
Lower Atrium, Yellowstone Convention Center

7:00 AM – 8:30 AM **Breakfast Buffet**
Jefferson, Yellowstone Convention Center

Session 8 – Lectures
Novice & Elderly Drivers
8:30 AM – 9:50 AM
Madison & Gallatin, Yellowstone Convention Center

Session Chair: Jeff Caird (University of Calgary — *Canada)*

8:30 AM **Validity of an On-Road Driver Performance Assessment Within an Initial Driver Training Context (68)**
Erik Roelofs (Cito, National Institute for Educational Measurement — *The Netherlands*), Jan Vissers (DHV Environment and Transportation — *The Netherlands*), Marieke van Onna (Cito, National Institute for Educational Measurement — *The Netherlands*), Reinoud Nägele (DHV Environment and Transportation — *The Netherlands*)

8:50 AM **Modeling the Behavior of Novice Young Drivers Using Data from In-Vehicle Data Recorders (69)**
Tsippy Lotan (Or Yarok — *Israel*), Tomer Toledo, Carlo G. Prato (Technion - Israel Institute of Technology — *Israel*)

9:10 AM **Elderly Pedestrians' Visual Timing Strategies in a Simulated Street-Crossing Situation (70)**
Viola Cavallo, Régis Lobjois, Aurélie Dommes, Fabrice Vienne (French National Institute for Transportation and Safety Research [INRETS] — *France*)

9:30 AM **Attention Function Structure of Older and Younger Adult Drivers (71)**
Stephanie Tuttle, Nicholas Cassavaugh, Richard W. Backs (Central Michigan University)

9:50 AM – 10:00 AM **BREAK – Refreshments**
Jefferson, Yellowstone Convention Center

Thursday June 25, 2009

Session 9 – Lectures
Design
10:00 AM – 11:20 AM
Madison & Gallatin, Yellowstone Convention Center

Session Chair: Nicholas Ward (Montana State University - Western Transportation Institute)

10:00 AM **How Do Drivers Behave in a Highly Automated Car? (72)**
Natasha Merat, A. Hamish Jamson (University of Leeds — *United Kingdom*)

10:20 AM **Design and Evaluation of Serial-Hybrid Vehicle Energy Gauges (73)**
Janet Creaser (University of Minnesota), John Lenneman (Central Michigan University), Joseph Szczerba (General Motors R&D and Planning)

10:40 AM **The Design and Assessment of Attention-Getting Rear Brake Light Signals (74)**
M. Lucas Neurauter, Robert E. Llaneras, Walter W. Wierwille (Virginia Tech Transportation Institute)

11:00 AM **Capturing Driver Response to In-Vehicle Human-Machine Interface Technologies Using Facial Thermography (75)**
Michelle L. Reyes, John D. Lee, Yulan Liang, Joshua D. Hoffman (University of Iowa), Ritchie W. Huang (Honda R&D Americas, Inc.)

11:20 AM **CONFERENCE WRAP-UP**

11:30 AM – 1:00 PM **LUNCH**
Jefferson, Yellowstone Convention Center

12:30 PM – 10:00 PM **GUIDED TOUR OF YELLOWSTONE NATIONAL PARK**
(optional)

12:30 PM **Begin loading bus for tour**
Huntley Lodge Lobby
1:00 PM **Depart for Yellowstone National Park**
10:00 PM **Return to Big Sky Resort**
(approximate)

5th International Driving Symposium on Human Factors in Driver Assessment, Training, and Vehicle Design
June 22-25, 2009

Summaries

Please note: Summaries have been edited for space and clarity. The conference proceedings will contain final papers.

Nissan Distinguished Keynote Lecture
Tuesday, June 23, 2009
8:30 AM – 9:30 AM
Traffic: Why We Drive the Way We Do (And What It Says About Us)
Tom Vanderbilt , Author

Session 1 – Lectures
Driver Distraction & Fatigue
Tuesday, June 23, 2009
10:00 AM – 11:30 AM

(01) The Blind Date: The Effects of Passenger Conversation and Gender on Looked-but-Failed-to-See (LBFTS) Errors Cale White (AECOM – *Canada*) and Jeff Caird (University of Calgary – *Canada*)

This study examined situations where drivers looked but failed to see hazards (LBFTS), and whether passenger conversation and gender affected hazard detection rates. To reliably produce LBFTS errors, 40 young drivers (M = 20.3) encountered motorcycles and pedestrians while making left turns in the University of Calgary Driving Simulator (UCDS). Prior to turn initiation, the UCDS screens flickered using an extension of change blindness methods. In addition, drivers either drove alone or conversed with an attractive confederate passenger. Measures of LBFTS errors, hazard detection and social factors were analyzed. Higher rates of LBFTS errors and hazard detection occurred while conversing than while driving alone. A discriminant function analysis (DFA) using conversation and gender as predictors accurately classified LBFTS errors. Higher passenger attraction and higher extroversion were related to missing more critical events. The basis of LBFTS errors in divided and selective attention and classification implications are discussed.

(02) A Measure of Strong Driver Fatigue David Sommer (University of Applied Sciences Schmalkalden – *Germany*), Martin Golz (University of Applied Sciences Schmalkalden; ISAAN – *Germany*), Thomas Schnupp (University of Applied Sciences Schmalkalden – *Germany*), Jarek Krajewski (University of Wuppertal – *Germany*), Udo Trutschel (Circadian Technologies Inc.; ISAAN – *Germany*), and Dave Edwards (Caterpillar Inc.)

Strong fatigue during sustained operations is difficult to quantify because of its complex nature and large inter-individual differences. The most evident and unambiguous sign is the occurrence of microsleep (MS) events. Our study detected MS using computational intelligence methods. We analyzed biosignal and video recordings of 10 healthy young adults completing 14 sessions over two nights in a driving simulation lab. Visual scoring led to 2,290 examples of MS. Only evident events accompanied by prolonged eyelid closures, roving eye movements, head noddings, major driving incidents, and drift-out-of-lane accidents were regarded as MS. The same number of counterexamples (Non-MS), where continued driving was still possible, were picked out from the recordings. Non-MS and MS examples covered only 15% of driving time. Support-Vector Machines were utilized as classifiers and adapted to these two classes of examples; applied consecutively, they accounted for 100% of time. Validation analysis demonstrated that the classifier gained high selectivity and specificity. Based on this complete coverage, the percentage of MS in a predefined time span can be calculated. This measure was highly correlated to deteriorations in driving performance and to subjective self-ratings of sleepiness. We conclude that reliable detection of MS is possible and that the percentage of detected MS gives an objective measure of strong driver fatigue.

(03) Comparison of Two Eye-Gaze Based Real-Time Driver Distraction Detection Algorithms in a Small-Scale Field Operational Test Katja Kircher (Swedish National Road and Transport Research Institute [VTI]; Chalmers University – *Sweden*), Christer Ahlstrom, and Albert Kircher (Swedish National Road and Transport Research Institute [VTI] – *Sweden*)

Driver distraction is a field that has received increasing attention in the last years, especially after it became evident that distraction is a major factor contributing to road casualties. Monitoring, detecting and limiting driver distraction could contribute significantly to improve road traffic safety. With the introduction of novel unobtrusive gaze-tracking systems real-time algorithms based on the driver's gaze direction can be developed for driver distraction warning systems. The study describes and compares two different algorithms for gaze-based driver distraction detection based on the eye tracking data obtained in a field study. One algorithm relies on the metric "percent road centre" of gaze direction, the other on gaze zones in the vehicle. Results show that both algorithms have potential for detecting driver distraction, but that no effect of the distraction warnings on attention as defined by the algorithms could be observed.

(04) Three Navigation Systems With Three Tasks: Using the Lane-Change Test (LCT) To Assess Distraction Demand Joanne L. Harbluk, Julia S. Mitroi, and Peter C. Burns (Transport Canada – *Canada*)

The Lane Change Test (ISO, 2008; Mattes, 2003) was used to assess distraction demand when drivers completed three typical navigation tasks (an easy navigation task, a point of interest task and a difficult navigation task) using three different navigation systems. In order for the LCT headed for be a useful procedure, it must distinguish good from poor navigation systems and acceptable from unacceptable tasks performed using those systems. The results provide some general support for the LCT as a sensitive measure of distraction. Some aspects of the results, however, called into question the adequacy of the LCT as a sufficient measure of distraction. In particular, the LCT was found to be insensitive to task demands arising from excessive task duration. Since risk exposure is a function of secondary task duration (as well as other factors such as intensity, frequency and timing), it is recommended that a measure of task duration be incorporated in the LCT procedure. When the MDEV was modified to incorporate task duration, the resulting measure (mean deviation per average task) reflected more adequately the interaction demands of the various navigation tasks.

Session 2 – Lectures
Commercial Vehicle Operations
Tuesday, June 23, 2009
1:00 PM – 2:30 PM

(05) Three Large Truck Crash Categories: What They Tell Us About Crash Causation Ronald R. Knipling (Human Factors & Traffic Safety Consultant)

Large Truck Crash Causation Study (LTCCS) data is used to compare three categories of crash involvements: truck single-vehicle (SV) involvements, multi-vehicle (MV) involvements in which the truck has been assigned the critical reason (CR), and MV involvements in which the other vehicle (OV) has been assigned the CR. These three categories represent distinctly different causal contributions by truck drivers to the crash, with SV involvements having the greatest truck driver impairment and misbehavior. Surprisingly, paired comparisons of the three categories indicate that truck SV and truck-CR MV crash involvements were the most *dissimilar* in their causal profiles. Factors associated with truck SV crash involvements include non-use of safety belts, driver unfamiliarity with roadways, vehicle failures, lack of prior sleep, 16+ hours awake, and early morning driving. Dense traffic situations (e.g., rush hours) make trucks more likely to be at-fault in MV crashes. Many other factors were not associated with differences among the categories, suggesting no *differential* effect on truck driver safety performance, even though they might affect risk generally. Among fatigue-related factors, those related to sleep and alertness physiology were linked to SV crashes, while those related only to Hours-of-Service (HOS) work rules were not.

(06) Evaluation of an Onboard Safety Monitoring Device in Commercial Vehicle Operations Jeffrey S. Hickman, Richard J. Hanowski (Virginia Tech Transportation Institute), and Olu Ajayi (US DOT Federal Motor Carrier Safety Administration)

The Federal Motor Carrier Safety Administration (FMCSA) funded this project to provide an independent evaluation of DriveCam's low-cost Driving Behavior Management System (DBMS). Participating drivers drove an instrumented vehicle for 17 consecutive weeks while they made their normal, revenue-producing deliveries. During the 4-week Baseline phase, the event recorder recorded safety-related events. However, the feedback light on the event recorder was disabled and safety managers did not have access to the recorded critical incidents to provide feedback to drivers. During the 13-week Intervention phase, the feedback light on the event recorder was activated and safety managers had access to the recorded safety-related events (following the coaching protocol with drivers). Carrier A significantly reduced the mean frequency of recorded events/miles traveled from Baseline to Intervention by 37 percent (p = 0.049), while Carrier B significantly reduced the mean frequency of recorded events/miles traveled from Baseline to Intervention by 52.2 percent (p = 0.03). The results suggest the combination of onboard safety monitoring and behavioral coaching were responsible for the reduction in mean frequency of events/miles traveled at Carriers A and B.

(07) Ecodrive Training Delivers Substantial Fuel Savings for Heavy Vehicle Drivers Mark A. Symmons and Geoff Rose (Monash University – *Australia*)

A small group of heavy vehicle drivers underwent an ecodrive training course. Their driving was assessed for various ecodrive variables as they completed an 18-mile circuit in normal traffic immediately after the course and again 6 and 12 weeks later. Compared to pre-course measures, these drivers reduced their fuel consumption by an average of 27%, the number of gear changes by 29%, and the number of brake applications by 41%, though not all differences were statistically significant due to the size of this pilot and large driver variability. Importantly, the improvements were not offset by increases in the time taken to complete the circuit. At the 6-week point a control group was also assessed, and they used more fuel and more gear changes, and applied their brakes more often than the control group. Safety variables were inconclusive. A larger, in-service trial is warranted.

(08) Object Detection and Identification Using Enhanced Camera/Video Imaging Systems (E-C/VISs) on Heavy Trucks William A. Schaudt, Walter W. Wierwille, and Richard J. Hanowski (Virginia Tech Transportation Institute)

Tests were performed to determine the feasibility of developing an Enhanced Camera/Video Imaging System (E-C/VIS) to provide heavy vehicle drivers with better situation awareness to the sides and rear of their vehicles. It is well known that large blind spots currently exist in these areas and that sideswipe crashes can occur as a result. An additional goal was to extend the operating envelope of conventional video to nighttime and to inclement weather. A three-channel system was envisioned in which there would be a camera at each (front) fender of the tractor looking backward along the sides of the tractor trailer. The third channel would be aimed rearward from the back of the trailer. Indoor tests involved selection of components having the best capabilities, while early outdoor tests used the selected components in a single-channel side mounted system. Once developed, the heavy vehicle three-channel system was tested in a static object detection and identification experiment, as well as a dynamic on-road experiment. The current document describes the static object detection and identification experiment methodology and results. In regard to object detection and identification, objects were correctly detected and identified significantly more often with the E-C/VIS than with mirrors alone. Objects directly behind the heavy vehicle could be detected with the rear wide-angle look-down camera of the E-C/VIS whereas such objects could not be detected with conventional side mirrors.

Session 3 – Poster Session A
Tuesday, June 23, 2009
2:30 PM – 4:00 PM

(09) Effects of Cognitive and Physical Decline on Older Drivers' Side-to-Side Scanning for Hazards While Executing Turns Matthew Romoser and Donald L. Fisher (University of Massachusetts Amherst)

Age related declines in cognitive and physical ability significantly impair an older adult's ability to safely drive. As we age it gradually becomes more difficult to scan for, detect, process, and ultimately react to critical elements in our driving environment. Older drivers are over-represented in angled impacts in intersections. Research has shown that older drivers tend to execute fewer side-to-side glances while in the process of turning than middle-aged drivers. This decrease in scanning can directly lead to an increase in angled impacts. The present research investigates the correlation between cognitive and physical decline and the likelihood that an older driver will execute side-to-side glances at the beginning and during a turn. Results of both simulator and field drive sessions with fifty-four older drivers 70-89 years of age demonstrated that cognitive, but not physical, decline was significantly correlated with a decrease in side-to-side scanning while turning.

(10) Aging and the Detection of Collision Events in Fog Zheng Bian (University of California, Riverside), Rui Ni (Wichita State University), Amy Guindon, and George J. Andersen (University of California, Riverside)

The current study investigated age-related differences in the detection of collision events in fog. Observers were presented with displays simulating an object moving towards a driver at a constant speed and linear trajectory. The observers' task was to detect whether the object would collide with them. Fog and display duration of the object were manipulated. We found that performance decreased when fog was simulated for older but not for younger observers. An age-related decrement was also found with shorter display durations. These results suggest that under poor weather conditions with reduced visibility, such as fog, older drivers may have increased accident risk due to decreased ability to detect impending collision events.

(11) Differences in Simulated Car Following Behavior of Younger and Older Drivers Elizabeth Dastrup, Monica N. Lees, Jeffrey D. Dawson, John D. Lee, and Matthew Rizzo (University of Iowa)

Older drivers are at risk for vehicle crashes due to impairments of visual processing and attention, placing these drivers at greater risk in driving tasks that require continuous attention to neighboring traffic, especially lead vehicles (LVs). We investigated car following behavior in 42 younger drivers (ages 18 to 44 years) and 58 older drivers (ages 65 to 86 years) in a driving simulator. The drivers were instructed to maintain two car lengths from a virtual LV. The LV varied its velocity according to a sum of three sine waves, making the velocity changes unpredictable to the drivers. A Fourier analysis was performed using the vehicle trajectory data to derive measures of coherence, gain, and delay as indices of car following behavior. These measures, as well as headway distance, were compared between the two groups. Older drivers were less able to match changes in the LV velocity indicated by lower coherence (0.76 v. 0.84, p=0.019) and larger gain (2.24 v. 1.74, p=0.031). However, these drivers followed further behind the LV than younger drivers, a potential compensatory strategy that may reduce collision risk for older drivers.

(12) A Simulator-Based Street-Crossing Training for Older Pedestrians: Short and Long Term Effects Aurélie Dommes and Viola Cavallo (French National Institute for Transport and Safety Research [INRETS] – *France*)

The study aimed at developing and assessing a training method to improve the safety of elderly pedestrians with a simulator-based street-crossing technique specially designed for their needs and difficulties. Twenty seniors were enrolled in a street-crossing training program, and twenty other seniors were assigned to the control group (internet-use training). Before the training, immediately after it, and 6 months later, street-crossing decisions and behaviors were assessed using a simulated street-crossing task. The results showed that the simulator-based training enhanced the safety of the elderly pedestrians. However, the way in which they took into account the speed of the approaching car in their decisions and behaviors had not improved. The lack of effectiveness of training in the use of speed may reveal age-related sensory and cognitive impairments that our simulator-based method could not alleviate. The results of this study stressed the importance of greater attention to senior street-crossing retraining.

(13) Gender Effects on Lane Change Test (LCT) Performance Tibor Petzoldt, Nina Bär, and Josef F. Krems (Chemnitz University of Technology – *Germany*)

There are various easy-to-implement, low-cost methodologies for evaluating driver performance under distraction caused by in-vehicle tasks. One of them is the Lane Change Test (LCT), which is currently under consideration for becoming an ISO-standardized procedure. This paper investigates the effect of gender on LCT performance. Although a common procedure in psychological research, balancing for gender is not a requirement made by the ISO draft. However, using data from three LCT experiments, we found gender differences in LCT, as well as secondary task performance. We conclude that subject samples balanced for gender are necessary to assure comparability of LCT results.

(14) The Effect of Age on Decision Making During Unprotected Turns Across Oncoming Traffic Nicholas D. Cassavaugh, Joshua E. Domeyer, and Richard W. Backs (Central Michigan University)

The present study examined whether age-related differences in quantitative measures of left-turn performance could explain older drivers' increased susceptibility to crashing while making unprotected left turns across traffic. Older and younger adults made left turns across traffic in a driving simulator. Time to decide to turn, time to negotiate the turn, the size of the accepted gap, gap clearance, and time to collision with an oncoming vehicle were measured. Significant effects of age were found in decision time, turn time and gap size. A significant interaction between age group and the speed of oncoming traffic was obtained for decision time. Implications for older adults' safety and future directions are discussed.

(15) Changing Driver Behavior Through Unconscious Stereotype Activation Rob Gray and Russ Branaghan (Arizona State University)

Under the guise of evaluating a head-up display in a driving simulator, participants completed scrambled sentence tasks (while waiting at stop signs) designed to prime either an elderly or teenage stereotype. Driving speeds between stop signs in the *Stereotype* conditions were compared to *Control* conditions in which non-age-specific words were substituted for stereotyped words. Participants had a lower maximum speed in the *Elderly Stereotype* condition and a higher maximum speed in the *Teenage* condition (as compared to controls). These effects were obtained even though the participants were completely unaware of the themes in the experimental conditions. For both stereotypes, the change in behavior occurred relatively quickly: a significant effect on driving speed was observed after only five stops. These findings indicate that it may be possible to reduce the incidence of dangerous driving behavior through the use of unconscious priming.

(16) Operator Fatigue Estimation Using Heart Rate Measures Robert Hefner, David Edwards (Caterpillar Inc.), Christian Heinze, David Sommer, Martin Golz (University of Applied Sciences Schmalkalden – *Germany*), William Sirois, and Udo Trutschel (Circadian Technologies Inc.)

This study evaluated the viabililty of using Tachograms for estimating fatigue in industrial and transportation applications. Tachograms were recorded continuously and several heart rate measures were calculated and correlated with other well-established fatigue measures. It was anticipated that changes in operator fatigue during a night time study could be depicted during three different conditions. In the first, a 40-minute monotonous driving task, the Karolinska Sleepiness Scale, Variation of Lane Deviation, number of Micro-Sleep Events, numbers of accidents, and the PERCLOS score were the subjective and objective fatigue measures. In the second, a 10-minute Compensatory Tracking Task, the Mean Distance of a moving disk to a given target, the Standard Deviation of the Distance, the Mean Velocity of the disk and the Standard Deviation of the Velocity over the test were used as fatigue measures. In the third, a 5-minute Psychomotoric Vigilance Test, Mean Response Times, the Standard Deviation of Response Times, the Mean of the inverse of the Slowest 10% of Response Times, and the number of lapses were the fatigue measures. Correlations between heart rate and fatigue measures were calculated and classified for one volunteer, who completed two night time episodes in a real-car lab following a partial sleep deprivation design. Results show strong correlations between heart rate variability (HRV) measures and multiple fatigue measures.

(17) Steering Wheel Behavior Based Estimation of Fatigue Jarek Krajewski (University of Wuppertal – *Germany*), David Sommer (University of Applied Sciences Schmalkalden – *Germany*), Udo Trutschel (Circadian Technologies Inc.), Dave Edwards (Caterpillar Inc.), and Martin Golz (University of Applied Sciences Schmalkalden – *Germany*)

This paper examined a steering behavior based fatigue monitoring system. The advantages of using steering behavior for detecting fatigue are that these systems measure continuously, cheaply, non-intrusively, and robustly even under extremely demanding environmental conditions. The expected fatigue-induced changes in steering behavior are a pattern of slow drifting and fast corrective counter steering. Using advanced signal processing procedures for feature extraction, we computed 3 feature sets in the time, frequency and state space domain (a total number of 1251 features) to capture fatigue impaired steering patterns. Each feature set was separately fed into 5 machine learning methods (e.g. Support Vector Machine, K-Nearest Neighbor). The outputs of each single classifier were combined to an ensemble classification value. Finally we combined the ensemble values of 3 feature subsets to a meta-ensemble classification value. To validate the steering behavior analysis, driving samples are taken from a driving simulator during a sleep deprivation study (N=12). We yielded a recognition rate of 86.1% in classifying slight from strong fatigue

(18) Identifying Influences of Driving Behaviour: Could the Australian Work Driving Setting Be Unique? Darren Wishart, Jeremy Davey, James Freeman, and Bevan Rowland (Queensland University of Technology – *Australia*)

Work-related driving safety is an emerging concern for Australian and overseas organisations. An in-depth investigation was undertaken into a group of fleet drivers' attitudes regarding what personal and environment factors have the greatest impact upon driving behaviours. A number of new and unique factors not previously identified were found including: vehicle features, vehicle ownership, road conditions, weather, etc. The major findings of the study are discussed in regards to practical solutions to improve fleet safety.

(19) Considerations When Calculating Percent Road Centre From Eye Movement Data in Driver Distraction Monitoring Christer Ahlstrom, Katja Kircher, and Albert Kircher (Swedish National Road and Transport Research Institute [VTI] – *Sweden*)

Percent road centre (PRC) is a performance indicator that is sensitive to driver distraction. The original definition of PRC is based on fixation data extracted from eye movement recordings, but it has also been suggested that PRC can be determined directly from the gaze data without segmenting it into saccades and fixations. The primary aim of this paper is to investigate if this is the case. Naturalistic driving data from a small-scale field operational test comprising seven vehicles was used in the evaluation. It was found that PRC time traces based on gaze data and fixation data, respectively, were highly similar (correlation coefficient=0.95, average wavelet semblance=0.84) except for an absolute amplitude difference of about 8%. This indicates that the two approaches can be used interchangeably and that the processing step of segmenting gaze data into saccades and fixations can be left out. In addition to this finding, design issues related to the calculation of PRC are investigated. Especially, the impact of gaze cases pointing towards the intersection of the road centre area and the centre rear mirror were investigated. Results lead to conclude that gazes and fixations on the centre rear mirror should be removed from the PRC calculations, as they may negatively influence the correctness of the performance indicator.

(20) Effects of Cell Phone Conversations on Driver Performance While Driving Under Highway Monotony Mark Chan and Paul Atchley (University of Kansas)

It has often been suggested by individuals that engaging in a cell phone conversation would help keep them awake under monotonous conditions where task underload might lead to a decrease in arousal. To further extend laboratory findings of performance in vigilance type tasks while distracted, a monotonous highway driving scenario was designed to test the anecdotal hypothesis of improved performance. Driver performance related to lane keeping and recall memory were studied under distracted and non-distracted conditions. Results of the simulator study were consistent with laboratory findings of performance decrement when dual tasking indicating that the perceived benefits from the secondary conversational task does not outweigh its costs.

(21) Driving With Cardiovascular Disease: The Impact of Implantable Cardioverter Defibrillators on Drivers Safety Jessica R. Williams and Stephen J. Tregear (MANILA Consulting Group, Inc.)

Cardiovascular disease (CVD) is the leading cause of death in the United States. More attention is being placed on treatment of CVD among employees in safety sensitive occupations, such as transportation. Implantable cardioverter defibrillators (ICDs) are increasingly being used to treat CVCs, but although effective in preventing sudden death from cardiac arrhythmia, there is concern about allowing individuals with an ICD to drive. A systematic review and meta-analysis was conducted to examine the health and safety impacts of ICDs on driving. We considered data pertaining to four outcomes for those with an ICD: crash rate, sudden death while driving, the occurrence of syncope while driving, and the occurrence of at least one shock from their ICD while driving. Currently, the impact of an ICD on driver safety cannot be determined. Our assessments of the evidence pertaining to crash rates and sudden incapacitation were inconclusive. Our results do indicate, however, that some individuals with an ICD will experience an inappropriate ICD discharge while driving. This is a potential hazard to driver safety. Quantitative assessment of the available data suggests that approximately 6.3% of all individuals with an ICD who drive will experience a discharge while driving. These findings have potential implications for regulatory agencies with responsibility for road safety; particularly those agencies that regulate safety sensitive industries.

(22) Collision Avoidance Training Using a Driving Simulator in Drivers With Parkinson's Disease: A Pilot Study Jeffrey D. Dawson, Matthew Rizzo, Steven W. Anderson, Elizabeth Dastrup (University of Iowa), and Ergun Y. Uc (University of Iowa; Veterans Affairs Medical Center of Iowa City)

Parkinson's disease (PD) impairs driving performance, and simulator studies have shown increased crashes compared to controls. In this pilot study, eight drivers with PD participated in three drive sessions with multiple simulator intersections of varying visibility and traffic load, where an incurring vehicle posed a crash risk. Over the course of the three sessions (once every 1-2 weeks), we observed reduction in crashes ($p=0.059$) and reaction times ($p=0.006$) to the vehicle incursion. These findings suggest that our simulator training program is feasible and potentially useful in drivers with PD. Future research questions include transfer of training to different driving tasks, duration of benefit, and the effect on long-term real-life outcomes in comparison to a standard intervention (e.g., driver education class) in a randomized trial.

(23) Normative Values for Driving Simulation Parameters: A Pilot Study Abiodun Emmanuel Akinwuntan, Rebecca Tank, Lori Vaughn, Alexis Wilburn, and Seth Easton (Medical College of Georgia)

In this pilot study, data obtained from a population of healthy younger (18-24 yrs), middle aged (25-64 yrs) and older drivers (65+ yrs) were used to establish normative values of parameters commonly documented during simulated driving. The older drivers' performances in most of the driving skills assessed were significantly worse than those of the other 2 classes of drivers. In line with previous studies, our data showed deterioration of driving skills with increasing age. The test-retest reliability of the driving simulation parameters were moderate to very high.

(24) Multiple Exposition to a Driving Simulator Reduces Simulator Symptoms for Elderly Drivers Normand Teasdale, Martin Lavallière, Mathieu Tremblay (Centre de recherche FRSQ du CHA de Québec – *Canada*), Denis Laurendeau (Université Laval – *Canada*), and Martin Simoneau (Centre de recherche FRSQ du CHA de Québec – *Canada*)

This study examines how older drivers responded to repeated exposures to a driver simulator. Older active and fit drivers participated in 5 simulator sessions within a 14-day period. For each session, simulator sickness symptoms were measured with the Simulator Sickness Questionnaire at baseline and post-session. In addition, participants completed a 10-cm visual analog scale (0= no symptom, 10= mild nausea) at baseline and after a familiarization scenario and post-session. Overall, older adults adapted to the driving simulator and by the fourth session, they showed no difference in sickness scores between the baseline and the post-session measurements. Increasing the exposure duration at session 5 yielded an increase in the sickness symptoms. These results suggest that shorter-duration multiple exposures could reduce simulator sickness symptoms in elderly drivers and allow a more effective use of simulators for training by preventing early withdrawal of participants.

(25) The Perception of Optical Flow in Driving Simulators Zhishuai Yin and Ronald R. Mourant (Northeastern University)

Optical flow is generated when a driver's vehicle traverses a 3-D virtual environment in a driving simulator. Understanding the generated optical flow may help in lessening simulator sickness. Two experiments were designed to investigate the perceived optical flow in different driving environments using two driving simulators: 1) a fixed base simulator and 2) a turning cabin simulator whose turning cabin rotates around the y-axis. In the first experiment, the perception of optical flow when making left/right turns was studied using both simulators. Results revealed that subjects experienced a higher amount of optical flow when making right turns then left turns. In addition, the optical flow perceived by drivers in the fixed base simulator was greater than that in the turning cabin simulator. We designed the second experiment to investigate the optical flow perceived when driving straight ahead, driving on circular curves, and driving on curves with transitions (clothoids). Again, two simulators were used. The amount of optical flow was highest when driving on circular curves, and was lowest when driving straight ahead. While using the turning cabin simulator, the degree of optical flow decreased greatly on circular curves, and curves with clothoids as compared to that in the fixed base simulator. We conclude that optical flow in driving simulators can be lessened by using a turning cabin simulator.

(26) Assessment in Driving Simulators: Where We Are and Where We Go Bart Kappé, Leo de Penning (TNO – *The Netherlands*), Maarten Marsman (RCEC – *The Netherlands*), and Erik Roelofs (CITO – *The Netherlands*)

This paper describes the mindset at the start of a three-year project to develop a test on a driving simulator. It reviews the literature, presents background information on driver training simulators and their relation with assessment. It then introduces some of the ideas behind this project, the adaptive cognitive model that will be used, as well as the interoperable assessment module we will develop.

(27) Effects of Display Location Within Simulated Driving Environments Matthew C. Crisler, Johnell O. Brooks, Kelly Riggins, Brandon Garris, Jessica Tyler, and Sam Dahl (Clemson University)

Driving simulators offer researchers experimental control while minimizing safety issues and reducing costs relative to on-road and test track experimental procedures. However, with the control of the visual environment that simulators allow, it can be tempting to develop experimental protocols that utilize displays within the visual environment of the simulator. Such displays have the potential to differentially affect driving performance based on their location within the driving environment. A simulator experiment was conducted in order to assess the effects of having drivers fixate a display at nine different locations on the center channel of a DriveSafety driving simulator. In general, driving performance was best when the display was in the middle of the screen. Both horizontal and vertical deviations from the center of the screen resulted in increased lane position variability, and drivers tended to drive closer to the opposite lane boundary toward which they were fixating when a display was located to the left or right of the center. In addition, response times to a task presented in the display were faster when the display was located toward the center of the screen.

(28) Evaluating Design Options for a Dynamic Traffic Sign Janet Creaser, Michael Rakauskas, Michael Manser (University of Minnesota), and Nicholas Ward (Montana State University-Western Transportation Institute)

This study describes two usability methods that were used to determine the final design of a prototype dynamic traffic sign. The Cooperative Intersection Collision Avoidance System-Stop Sign Assist (CICAS-SSA) is an infrastructure-based driver support system to improve gap acceptance at rural stop-controlled intersections. This study evaluated drivers' comprehension of recommended design changes made to the SSA message set using paper-and-pencil and computerized testing. The goal was to choose the final interface design that would later be tested using driving simulation. Overall, comprehension was highest for sign messages that showed prohibitive information and was lowest for signs indicating no traffic was detected near the intersection. The results for the design options were similar between studies, allowing for the selection of a final set of design features for the interface. Results also suggest that the two methodologies provided a low-cost alternative to simulation for down-selecting the design options.

Session 4 – Hybrids
Intro Lecture/Poster
Wednesday, June 24, 2009
8:30 AM – 10:00 AM

(29) A Cross-Cultural Comparison of Younger and Older Adults' Simulated Highway Driving Performance Under Single and Dual Task Conditions Bryan Reimer, Bruce Mehler (Massachusetts Institute of Technology [MIT] AgeLab and New England University Transportation Center), Joonwoo Son (Daegu Gyeongbuk Institute of Science and Technology [DGIST] – *South Korea*), Anna Pohlmeyer (Massachusetts Institute of Technology [MIT] AgeLab and New England University Transportation Center; Center of Human-Machine-Systems, Berlin University of Technology – *Germany*), Jarrod Orszulak, Jonathon Long, and Joseph Coughlin (Massachusetts Institute of Technology [MIT] AgeLab and New England University Transportation Center)

Driving is a complex psychomotor task that is often interrupted by secondary activities that divert attention away from the roadway. The risk of inattentive driving is known to vary with age. The degree to which culture impacts these changes is less established. To study the impact of age and culture on drivers' capacity to manage dual task demands, we developed a parallel driving simulation in the US and Korea. We assessed the performance of 135 drivers divided into two age groups, younger (20–29) and older (60-69). Both age and cultural group differences in basic highway driving performance measures were observed. However, the relative impact of the dual task demands on driving performance was largely consistent across cultures.

(30) Predicting Older Drivers' Difficulties Using the Roadwise Review Charles Scialfa, Jennifer Ference, Jessica Boone, Richard Tay, and Carl Hudson (University of Calgary – *Canada*)

There has been a substantial growth in research attempting to predict accidents and performance in older drivers. The Roadwise Review and the substantively identical Driver Health Inventory have been reported to provide a valid and cost-effective means of assessing crash risk in older community-dwelling adults. We administered the DHI to a community-dwelling sample of older (45 - 85 years) drivers. We also asked them to report on the difficulties they experienced while driving and on the frequency and type of crashes and moving violations the experienced in the previous two years. Results indicated on several of the tests there are substantial floor or ceiling effects, as well as barriers to usability and acceptance. Low inter-test correlations are consistent with the notion that different capacities are being indexed with the DHI. However, generally there were only low correlations between DHI performance and self-reported difficulties in driving, accidents or moving violations. While the DHI and Roadwise Review may well be valuable in providing older drivers with information on skills related to driving performance, in its current form it does not appear to be a useful tool in licensure or the prediction of driver risk.

(31) Multiple-Session Simulator Training for Older Drivers and On-Road Transfer of Learning Martin Lavallière (Centre de recherche FRSQ du CHA de Québec – *Canada*), Denis Laurendeau (Université Laval – *Canada*), Mathieu Tremblay, Martin Simoneau, and Normand Teasdale (Centre de recherche FRSQ du CHA de Québec – *Canada*)

Driving retraining classes may offer an opportunity to attenuate some of the aging manifestation that may alter driving skills. Unfortunately, there are suggestions that classroom programs do not improve the driving performance of elderly drivers. The aim of this study was to evaluate if specific simulator training sessions with video-based feedback can modify on-road behaviors of elderly drivers. In order to evaluate the effectiveness of the training, 10 elderly drivers who received feedback were tested before and after the training program with an on-road standardized evaluation. A control group (12 older drivers) also participated. Participants in this group received a classroom training program and similar exposure to driving in a simulator but without driving-specific feedback. After attending the training program, the control group showed no modification of their driving performance (on-road score, frequency of successful turning maneuvers and frequency blind spot verification before lane change maneuvers). On the other hand, participants in the feedback group improved their driving skills for all maneuvers that were evaluated. These results suggest that simulator training transferred effectively to on-road performance. In order to be effective, driving programs should include active practice sessions with driving specific feedback.

(32) Comparing the Gap Acceptance and Turn Time Patterns of Novice With Experienced Drivers for Turns Across Traffic Eve Mitsopoulos-Rubens, Thomas Triggs, and Michael Regan (Monash University Accident Research Centre – *Australia*)

Novice drivers are over-represented in crashes involving turns across traffic at intersections and yet little is understood about the contributing factors. The current study proposed to explore the gap acceptance and turn time patterns of novice relative to experienced drivers when turning across traffic. Thirty novice and 30 experienced drivers each carried out a series of trials in a driving simulator that varied in their level of task demand – operationalised in terms of the gap between two successive oncoming vehicles. The novices accepted more gaps than the experienced drivers, although this effect was restricted to gaps falling within the decision "dilemma zone" (higher task demand). Examination of the turn time components for the accepted and, where appropriate, the rejected gaps, revealed that the performance of the novice drivers, in contrast with that of the experienced drivers, was not consistent with the changing task demands. These findings are interpreted in the context of differences between novice and experienced drivers' calibration skill – that is, the ability to match task demands to one's driving capabilities.

(33) Hard Braking Events Among Novice Teenage Drivers By Passenger Characteristics Bruce G. Simons-Morton, Marie Claude Ouimet, Jing Wang (National Institute of Child Health and Human Development; National Institute of Health), Sheila G. Klauer, Suzanne E. Lee, and Thomas A. Dingus (Virginia Tech Transportation Institute)

In a naturalistic study of teenage drivers (N = 42) hard braking events of $\leq$-0.45 *g* were assessed over the first 6 months of licensure. A total of 1,721 hard braking events were recorded. The video footage of a sample (816) of these events was examined to evaluate validity and reasons for hard braking. Of these, 788 (96.6%) were estimated valid, of which 79.1% were due to driver misjudgment, 10.8% to risky driving behavior, 5.3% to legitimate evasive maneuvers, and 4.8% to distraction. Hard braking events per 10 trips and per 100 miles were compared across passenger characteristics. Hard braking rates per 10 trips among newly licensed teenagers during the first 6 months of licensure were significantly higher when driving with teen passengers and lower with adult passengers than driving alone; rates per 100 miles were lower with adult passengers than with no passengers. Further examination of the results indicates that rates of hard braking with teenage passengers were significantly higher compared with no passengers: 1) for male drivers; 2) during the first month of licensure. The data suggest that novice teenage driving performance may not be as good or safe when driving alone or with teenage passengers as with adult passengers and provide support for the hypothesis that teenage passengers increase driving risks, particularly during the first month of licensure.

(34) Enhanced Seat Belt Reminder Systems for Teenage Drivers and Passengers Neil Lerner, Jeremiah Singer, and Mark Freedman (Westat)

Failure to use a seat belt is a significant highway safety concern for teenagers. The current Federally-required seat belt reminder system is limited in its effectiveness, and many automobile manufacturers are now providing enhanced seat belt reminder (ESBR) systems. Current systems are designed for the general driving public and their design must represent a trade-off between effectiveness in promoting belt use and consumer acceptance. Teens may respond differently to system features and trade-off considerations may be different for risk-prone teens. This study conducted research to evaluate teen driver and passenger reactions to a variety of ESBR systems and features. The study was conducted in an operational, but stationary vehicle, with simulated drives. Systems and features were evaluated regarding their likelihood of increasing belt use, annoyance, signal appropriateness, desirability, and other aspects. Discussion groups were also held with the parents of teen drivers. Based on findings of the experiment and discussions, a set of recommendations was developed for the design of optimal ESBR systems oriented toward teen drivers and their passengers.

(35) Can Low Cost Road Engineering Measures Combat Driver Fatigue? A Driving Simulator Investigation A. Hamish Jamson and Natasha Merat (University of Leeds – *United Kingdom*)

Driver fatigue is a major cause of road accidents, accounting for over 20% of serious accidents on motorways and monotonous roads in the U.K. This study investigated the potential for low-cost, road-based, engineering measures to act as alerting features in an otherwise monotonous driving environment and hence combat fatigue. Thirty-three drivers took part in the driving simulator study. There was some evidence of an alerting effect provided to drivers by all three of the treatments tested: chevron road-surface markings, transverse-carriageway rumble strips and variable message signs. However, the alerting effect did appear to be relatively weak and potentially quite short-lived. Nevertheless, there may well be potential for any of the novel alerts to be deployed in the field in a known fatigue-related accident area.

(36) The Effects of Dual-Task Interference and Response Strategy on Stop or Go Decisions to Yellow Light Changes David G. Kidd and Christopher A. Monk (George Mason University)

Distractions can interfere with driving by causing central processing bottlenecks. In addition to performance decrements, central processing delays may also impair decision-making during critical driving maneuvers such as stop or go decisions at intersections. It was hypothesized that distractions would delay the stop or go decision leading to more go responses. Participants drove 4 simulated drives and made stop or go decisions at intersections with and without a distracting task. Distractions did not result in more go responses at intersections. Additionally, dual-task interference in braking responses was found to be dependent upon participants' response strategies. Theoretical implications of response strategy on processing bottlenecks were discussed.

(37) Validation of the Static Load Test for Event Detection During Hands-Free Conversation Richard A. Young, Linda S. Angell (Wayne State University School of Medicine), John M. Sullivan (University of Michigan Transportation Research Institute), Sean Seaman, and Li Hsieh (Wayne State University)

Objective. To see if visual event reaction times (RTs) during hands-free conversation conditions in the Enhanced Static Load Test (ESLT) can predict RTs in similar conditions in on-road driving. *Methods*. Brake reaction times to random center and side light events were measured while watching a driving video, attempting to keep a marker in the center of the lane with a steering wheel, answering the phone by pressing a button, and carrying on neutral or angry hands-free conversations in covert (silent) or overt mode on a hands-free phone device. Open-road tests were conducted in traffic for subjects with similar side and front light events, with foot reaction times measured while engaged in the same secondary tasks and conditions. *Results*. Mean RTs for the task segments in the lab were predictive of the mean RTs for the corresponding task segments in the on-road test ($r = 0.90$, df = 16, $p < 0.000001$). *Conclusion*. This study validates the Enhanced Static Load Test as predictive of visual event RTs during open-road driving for the range of experimental conditions and tasks considered.

(38) Comparing Techniques to Reduce Simulator Adaptation Syndrome and Improve Naturalistic Behaviour During Simulated Driving James G. Reed-Jones, Rebecca J. Reed-Jones, Lana M. Trick, Ryan Toxopeus, and Lori A. Vallis (University of Guelph – *Canada*)

Electrical stimulation of the vestibular sensory system during virtual environment simulations reduces the incidence of simulator adaptation syndrome (SAS). However, interactions between vestibular stimulation and complex visual scenery can increase oculomotor symptoms. This study examined a technique to reduce symptoms of SAS using the application of galvanic cutaneous stimulation of the neck. The effect of both vestibular and cutaneous stimulation was also evaluated on the naturalistic driving behaviour of curves. Thirty participants drove a rural virtual environment with high visual cues. Three groups of 10 were used to compare the effect of galvanic vestibular and galvanic cutaneous stimulation versus a control group on post drive scores of the SSQ (Simulator Sickness Questionnaire) and 3 driving variables (steering variability, lane position, and vehicular speed). Galvanic cutaneous stimulation while driving decreased SSQ scores, but did not affect driving behaviour. Conversely, galvanic vestibular stimulation while driving curves resulted in vehicular speeds that were reflective of natural real world driving behaviour and similar SSQ scores to control. These results support the theory that cutaneous stimulation of the neck is a worthy alternative to vestibular stimulation for reducing SAS, especially for complex visual scenes; however, if naturalistic driving behaviour (of curves) is important, vestibular stimulation remains the better choice.

(39) Acquisition, Response, and Error Rates With Three Suites of Collision Warning Sounds John M. Sullivan and Mary Lynn Buonarosa (University of Michigan Transportation Research Institute)

The acquisition, response speed, and error rates of three suites of collision warning sounds were investigated to evaluate the effect of sound alteration on responding. In each suite, four sounds were pictorially associated with four collision scenarios. Suite A included two natural sounds, and two artificial sounds semantically associated with one of four crash scenarios; Suite B was a variant of A, altered to reduce perceived urgency; Suite C was a set of abstract sounds constructed to vary in urgency and matched to the subjective urgency of each scenario. For each suite, subjects first learned to associate the suite's warning sounds with an assigned crash scenario to an established criterion. This was followed by reaction time trials in which a sound was played and subjects quickly identified the scenario associated with the sound. For both young and old subjects, Suite A produced the shortest reaction times and fewest trials to criterion, suggestive of the response efficiencies reported for auditory icons. In contrast, the sounds used in Suite B, while variants of Suite A, were most difficult to learn and were not different from Suite C with respect to error rates and reaction time. It is suggested that even relatively minor alterations of a warning sound can result in marked differences in acquisition and performance.

(40) Driver Comprehension of Integrated Collision Avoidance System Alerts Presented Through a Haptic Driver Seat Gregory M. Fitch, Jonathan M. Hankey (Virginia Tech Transportation Institute), and Brian M. Kleiner (Virginia Tech)

The purpose of this study was to quantify the effects of increasing the number of collision avoidance system alerts presented through a haptic driver seat on drivers' response performance. Twenty-four participants performed specific driving maneuvers in response to one, three, or seven haptic seat alerts while they drove an instrumented vehicle. Participants verbally identified the alerts after executing a maneuver. Results show that drivers made the correct driving maneuver in response to the alerts. This was likely because of the strong stimulus-response compatibility designed into the haptic seat. As predicted by Information Theory, drivers' mean manual response time to the alerts significantly increased, and their verbal response accuracy significantly degraded, as the number of alerts increased. A three-alert haptic seat approach is recommended providing specific design requirements are met.

(41) The Adaption Test: The Development of a Method to Measure Speed Adaption to Traffic Complexity Saskia de Craen, Divera A.M. Twisk (SWOV, Institute for Road Safety Research – *The Netherlands*), Marjan P. Hagenzieker (SWOV, Institute for Road Safety Research; Delft University of Technology – *The Netherlands*), Henk Elffers (NSCR, Institute for the Study of Crime and Law Enforcement – *The Netherlands*), and Karel A. Brookhuis (Delft University of Technology – *The Netherlands*)

To monitor novice driver performance in the first years of solo driving, a test aimed at assessing speed adaptation to the traffic situation was developed and evaluated. The Adaptation Test consisted of 18 traffic scenes presented in two (almost) identical photographs, which differed in one single detail, increasing the situation's complexity. The difference in reported speed between the two pictures was used as an indication of drivers' adaptation of speed to the complexity of the traffic situation. A previous study showed that novice, unsafe and overconfident drivers, as identified in an on-road driving assessment, performed worse on the Adaptation Test (i.e., less often reported a lower speed in the more complex situation). The analysis of new data in this paper shows no correlation between performance on the Adaptation Test and self-reported crashes, and that after two years, experienced drivers had improved their performance on the Adaptation Test just as much as novice drivers.

(42) Differential Effects of Focal and Ambient Visual Processing Demands on Driving Performance John K. Lenneman, Joseph Lenneman, Nicholas Cassavaugh, and Richard Backs (Central Michigan University)

In this study, the differential effects of focal and ambient visual demand on driving were investigated. Subjects participated in a dual-task experiment in which they performed a driving simulation task and a focal or ambient side-task. It was predicted that the focal side-task would cause a significant deterioration in the maintenance of longitudinal control but not lateral control, while there should be no effects of the ambient side-task on driving performance. In general, the results suggest a differentiation in the processing demands of focal and ambient vision.

(43) An Invariant May Drive the Decision to Encroach at Unsignalized Intersections Kip Smith (Linköping University – *Sweden*), Aurélie Thome (Insa de Lyon – *France*), Christian Blåberg (Linköping University – *Sweden*), and Jonas Bärgman (Autoliv Research – *Sweden*)

This paper introduces a novel approach to understanding when and where drivers make the Go / No Go decision (not) to turn left and encroach upon an approaching car that has the right-of-way in an unsignalized intersection. Approximately 2,400 hours of video recordings at two intersections near Göteborg, Sweden were used as data. Automated image processing software extracted the trajectories of the pairs of cars involved in more than 14,000 left turns at the first intersection and 2,400 at the second. We subdivided the data into four different left-turn scenarios - where the approaching car arrives from the opposite direction, from the lateral direction, from the intended direction (merging), and while making its own left turn. For each scenario, we found the distances between the 2 cars at the time when we can assume the decision (not) to turn is made and conducted logistic regressions to identify the distances associated with the 50/50 acceptance probabilities for the decision (not) to turn. We also calculated the resulting encroachment distances ('trailing buffers') for every decision to turn. We found that separations were virtually the same across scenarios at each intersection but differed across intersections. Tacit, intersection-dependent knowledge of this invariant may drive the decision of whether or not to turn and encroach. We discuss the implications of this finding for the design of in-vehicle active safety systems.

Session 5 – Panel Discussion
Research Needs in Driver Assessment: The Future
Wednesday, June 24, 2009
10:30 AM – 12:00 PM

Luncheon Lecture
Wednesday, June 24, 2009
12:30 PM – 1:15 PM

Mechanisms Involved in the Recent Large Reductions in the U.S Road Fatalities
Michael Sivak (Head of Human Factors Division, Transportation Research Institute, University of Michigan)

Road fatalities in the U.S. have decreased, on a year-to-year basis, every month from May 2007 through December 2008 (with the 2008 fatalities being the lowest since 1961). Importantly, the reductions in road fatalities were greater than the corresponding reductions in gasoline sales and distance driven. Consequently, it appears that a major shift in driver behavior might be occurring. This presentation will discuss evidence concerning the changes in driver behavior that are likely to be responsible for the larger-than-expected drop in road fatalities.

Session 6 – Lectures
Medical Factors: Fitness to Drive
Wednesday, June 24, 2009
1:30 PM – 3:00 PM

(44) The Impact of Macular Disease on Pedestrian Detection: A Driving Simulator Evaluation P. Matt Bronstad, Alex R. Bowers, Robert B. Goldstein, Amanda Albu, and Eli Peli (Schepens Eye Research Institute, Harvard Medical School)

We describe the design of a driving simulator study to determine the effect of central visual field loss (due to macular disease) on pedestrian detection when driving. Pilot data suggest that a scotoma (blind area) in the central visual field can impair driving by increasing response time to hazardous circumstances.

(45) Seizure and the Risk for Seizure Recurrence Among Individuals Who Have Undergone Surgery for Epilepsy Stephen J. Tregear and Jessica R. Williams (MANILA Consulting Group, Inc.)

Epilepsy is a central nervous system disorder for which recurrent seizures are the main symptom. Seizures resulting from epilepsy may culminate in unpredictable and sudden incapacitation, and thus are of significant concern to those interested in driver safety. Surgical therapy is one of the main treatment options for patients who do not respond to pharmacotherapy. Although approximately two thirds of individuals who undergo the most common types of surgery for epilepsy become seizure free, a significant proportion of these individuals will experience seizure recurrence. A systematic review and meta-analysis was conducted to examine the likelihood of seizure recurrence among individuals who have undergone surgery for epilepsy. Specifically, we were interested in quantifying the relationship between time since last seizure and the likelihood that a seizure will occur within the following year. Our results indicate that the longer the time that has elapsed since the occurrence of the last seizure, the lower the risk for seizure recurrence in the following year. The average annual risk for experiencing seizure recurrence among individuals who have remained seizure free for ≥8 years is less than 2% and less than 1% for those who have remained seizure free for ≥10 years. These findings have important implications for regulatory agencies with responsibility for road safety; particularly those agencies that regulate safety sensitive industries.

(46) Near Peripheral Motion Contrast Threshold Predicts Older Drivers' Driving Simulator Performance Steven Henderson (Transportation Safety Board of Canada – *Canada*), Sylvain Gagnon, Charles Collin, Ricardo Tabone, and Arne Stinchcombe (University of Ottawa – *Canada*)

The method of descending limits assessed motion contrast thresholds of 11 young participants (17–28), and 21 older drivers (63–86) for 0.4 cycle/degree drifting Gabor stimuli at 15 degrees eccentricity. Peripheral motion contrast thresholds (PMCT) of younger participants (M = –45.5 dB, SD = 1.66 dB) and older participants (M = –43.3 dB, SD = 3.79 dB) differed ($t(29) = 2.295$, $p < .05$ (all p-values one-tailed)). Older drivers performed UFOV® tests and a high-fidelity driving simulation. Between independent variables, significant correlations were PMCT with UFOV2 ($r = .74$, $p < .001$), PMCT with UFOV3 ($r = .50$, $p < .01$), PMCT with age ($r = .73$, $p < .001$), UFOV2 with age ($r = .48$, $p < .05$), and UFOV3 with age ($r = .44$, $p < .05$). Between vision and simulator measures, PMCT and UFOV2 significantly predicted rater's simulator score ($r = .66$, $p < .001$; $r = .58$, $p < .01$ respectively), and simulator crashes ($r = .63$, $p < .001$; $r = .72$, $p < .001$ respectively). Thus, PMCT and UFOV2 strongly predicted simulator performance. Partial correlations showed that: association between PMCT and UFOV2 was not age–related; PMCT and UFOV2 tapped a common visual function; and PMCT assessed a component not captured by UFOV2. The descending limits procedure is as reliable and faster than forced-choice. A PMCT test that informs at-risk drivers about visual deficits may help them compensate with voluntary scanning techniques and other driving modifications.

(47) Prediction of Driving Ability in People With Dementia- and Non-Dementia-Related Brain Disorders Carrie Innes (Van der Veer Institute for Parkinson's & Brain Research; Christchurch Hospital – *New Zealand),* Richard Jones (Van der Veer Institute; Christchurch Hospital; University of Otago – *New Zealand*), John Dalrymple-Alford (Van der Veer Institute; University of Canterbury – *New Zealand*), Julie Severinsen, and Jane Gray (Burwood Hospital – *New Zealand*)

Two hundred people with brain disorders referred for a driving assessment were recruited and tested on a computerized battery of sensory-motor and cognitive tests (*SMCTests*) and a blinded on-road assessment. Based on *SMCTests* performance, binary logistic regression (BLR) and nonlinear causal resource analysis (NCRA) models classified on-road pass or fail with 70% accuracy. Greater accuracy could be achieved by splitting referrals into two groups: (1) Dementia and (2) Non-dementia-related brain disorders. BLR models classified on-road driving outcome as pass or fail with accuracies of 76% (Dementia) and 75% (Non-dementia), while NCRA models had accuracies of 77% and 80%, respectively. Measures of attention were most critical for predicting driving ability in the dementia group. In the other group, prediction of driving ability improved with assessment of a broader range of sensory-motor and cognitive functions. Compared to BLR, NCRA was able to identify and use additional measures to improve accuracy; it was also better able to accommodate outliers as it is a non-linear modelling method based upon individual impairments. We propose 3 main factors underlying sub-optimal prediction of driving ability based on *SMCTests*: (1) there are 1 or more functions important for driving ability which are not currently assessed with *SMCTests*; (2) suboptimal classification/prediction techniques or models; or (3) inaccuracies in the on-road driving assessments.

Session 7 – Poster Session B
Wednesday, June 24, 2009
3:30 PM – 5:00 PM

(48) Attention Maintenance in Novice Drivers: Assessment and Training
Anuj Pradhan, Kathleen M. Masserang, Gautam Divekar, Ian Reagan, F. Dennis Thomas, Richard Blomberg, Alexander Pollatsek, and Donald Fisher (University of Massachusetts at Amherst)

All programs assessing attention maintenance inside the vehicle have required eye trackers and either a driving simulator or a specially equipped field vehicle. Ideally, one would like a way to assess attention maintenance that could be implemented on a desktop PC. Additionally, one would like to have a program that could be used to train novice drivers to maintain their attention more safely on the forward roadway. An experiment was run (a) to determine whether a program FOCAL (Focused Concentration and Attention Learning) using a desktop PC could differentiate between the attention maintenance skills of novice and experienced drivers and (b) to determine whether a program that improved the hazard anticipation skills of novice drivers might also improve their attention maintenance skills. FOCAL was able to differentiate between the attention maintenance skills of novice and experienced drivers. However, hazard anticipation training did not improve the attention maintenance skills of the novice drivers.

(49) Crash Risk: Eye Movement as Indices for Dual Task Driving Workload Julie J. Kang, Zheng Bian, and George J. Andersen (University of California, Riverside)

The goal of the present study was to examine eye movements as a function of dual task difficulty while driving. Two tasks were examined: maintaining a predetermined distance while car following and detecting a light change. Task demands were manipulated by varying the amplitude of lead vehicle's (LV) speed change and increasing the average LV speed. As task demands increased, the number of saccades decreased. There was no significant difference in number of fixations, fixation duration, number of eye blinks, or pupil size. While car following performance did not change, drivers were more accurate at the light detection task at the 100% amplitude condition verses the 120%.

(50) Manipulating Drive Characteristics to Study the Effects of Mental Load on Older and Younger Drivers Lana M. Trick, Martin Lochner, Ryan Toxopeus, and David Wilson (University of Guelph – *Canada*)

A driving simulator was used to assess performance in younger and older drivers (M ages 18 and 71 years). The impacts of three challenges were assessed: visibility (clear day, fog), traffic density (low, high) and wayfinding (no challenge, drivers challenged to use signs and landmarks to find their destination). Performance was measured in terms of hazard RT, collisions, wayfinding errors (missed or extra turns), and driving speed. The challenge manipulations produced interactive effects and age was a factor in some of these interactions. Older drivers missed more turns in wayfinding but overall they performed as well or better than younger drivers and reduced their speed more to driving challenges.

(51) Comparison of the Effects of Two Push-to-Talk Button Implementations on Driver Hand Position and Visual Attention Oskar Palinko and Andrew L. Kun (University of New Hampshire)

Buttons built into the steering wheel are used in many vehicles as push-to-talk (PTT) buttons for in-car speech user interfaces. We explore the influence of such a fixed PTT button on driver hand position on the steering wheel and on visual attention while driving. We also explore these variables for a wireless PTT glove, which allows drivers to use the entire surface of the steering wheel to operate the PTT button. Participants in our driving simulator-based study were willing to take advantage of the flexibility in hand position afforded by the glove PTT button. We also found that participants cast glances toward the steering wheel significantly less often when using the PTT glove than they did when operating the fixed PTT button.

(52) Quantifying the Subjective Brightness of Retroreflective Material Using Magnitude Estimations Justin S. Graving (University of Minnesota), Richard A. Tyrrell, and Stacy A. Balk (Clemson University)

Ten small patches of retroreflective material were evaluated using a method of magnitude estimation to quantify the effect of changing the coefficient of retroreflection (R_A) on brightness perception. Seventeen undergraduates participated. The results show that brightness is tightly linked with R_A. Brightness was influenced more by changes in lower R_A than changes in higher R_A and follows Steven's power law for brightness. Practical and theoretical implications are discussed.

(53) How Well Do Drivers Understand Their Own Headlights? Johnell O. Brooks, Richard R. Goodenough, Richard A. Tyrrell, Chris Guirl, Kristin Moore, Nathan Klein, Laura Davis, and Tina Kubala (Clemson University)

The current research represents an initial investigation of drivers' understanding of high beam and low beam headlight patterns in a nighttime driving environment. Fifty-four university students used a highlighter to indicate on a paper diagram of a roadway scene the portion of the scene that they felt their headlights would illuminate. Although the headlight patterns produced by participants varied more than expected, several consistent patterns emerged. Classification and evaluation of these drivers' responses revealed that many drivers misunderstand the area of the roadway that is illuminated by their headlights. These misunderstandings fall into fairly distinct patterns. The results indicate many drivers possess an incomplete understanding of the pattern of illumination provided by their headlights. These results are consistent with earlier evidence that many road users fail to appreciate the visibility challenges that exist at night.

(54) Curve Negotiation: Identifying Driver Behavior Around Curves with the Driver Performance Database Anna Mikolajetz (Human-Factors-Consult – *Germany*), Matthias J. Henning (Chemnitz University of Technology – *Germany*), Axel Tenzer (Ingenieurbüro Lange + Tenzer – *Germany*), Robert Zobel (Volkswagen AG – *Germany*), Josef F. Krems and Tibor Petzoldt (Chemnitz University of Technology – *Germany*)

Approximately one quarter of all accidents outside city limits occur while driving around curves, where assistance systems could prevent the driver from negotiating curves with excessive speed. This study argues that the parameterizing of a Driving Assistant System could be realized with data from realistic, noncritical driving behavior offered by Naturalistic Driving Studies. The Driver Performance Database presented in this study provides a tool for observing normal, noncritical driving behavior. The Database contains results from road tests with an instrumented vehicle that were carried out on public road traffic on a predetermined route, which was precisely measured in advance. In addition to vehicle state parameters, we also collected data concerning the driving environment and physiological information. With the Driver Performance Database it is possible to generate different facets of human driving behavior in a descriptive and normative way, which is illustrated by driver behavior in curve negotiation.

(55) Do Redundant Head-Up and Head-Down Display Configurations Cause Distractions? Carl Jörgen Normarck, Phillip Tretten, and Anita Gärling (Luleå University of Technology – *Sweden*)

This study was designed to investigate effects of different display configuration designs. Nineteen drivers completed a driving simulator study designed to resemble normal driving. Driving performance, glance behaviour, physiological measures, and task completion times was measured for two display configuration designs both during driving only and during driving with a simple secondary task, which consisted of detection, and off-setting of presented warnings. The display configuration design with more centrally placed information, e.g. the HUD and HDD, had less detrimental effects on driving performance and glance behaviour. The physiological measures showed, however, no significant differences between display configuration designs.

(56) Verbal-Spatial Cue Conflict: Implications for the Design of Collision-Avoidance Warning Systems Jane H. Barrow and Carryl L. Baldwin (George Mason University)

A spatial auditory Stroop paradigm was used to examine the effects of verbal-spatial cue conflict on response accuracy, reaction time, and driving performance. Participants responded to either the semantic meaning or the spatial location of a directional word, which were either congruent (i.e. the word "right" being presented from the right) or incongruent (i.e. the word "right" being presented from the left), while following a lead car in a simulated driving scenario. Accuracy was worse when participants were responding to the spatial location of a word in an incongruent trial, indicating that participants experienced significant interference when trying to ignore the semantic meaning of the word when it conflicted with the presentation location. Implications for the design of collision-avoidance warning systems are discussed.

(57) Development of a System to Study the Impact of Headlight Glare in a Driving Simulator Matthew Fullerton (Schepens Eye Research Institute, Harvard Medical School; University of York – *United Kingdom*; Technische Universität Munchen – *Germany*), and Eli Peli (Schepens Eye Research Institute, Harvard Medical School)

We report on the development of a realistic dynamic simulation of oncoming headlamp glare in a driving simulator. To our knowledge, no such simulation had been attempted or achieved previously. The simulation is based on superposition of a bright LED display through a beam splitter on the simulator screen and synchronizing the illuminated LED position to the image of the simulated oncoming car. LED brightness is adjusted to result in the level of light that such headlights would cause in the driver's eyes, enabling the testing of glare effect on drivers of different ages and impact (reduction or increase) of various vision devices.

(58) Ascertainment of On-Road Safety Errors Based on Video Review Jeffrey D. Dawson, Ergun Y. Uc, Steven W. Anderson, Elizabeth Dastrup, Amy M. Johnson, and Matthew Rizzo (University of Iowa)

Using an instrumented vehicle, we have studied several aspects of the on-road performance of healthy and diseased elderly drivers. One goal from such studies is to ascertain the type and frequency of driving safety errors. Because the judgment of such errors is somewhat subjective, we applied a taxonomy system of 15 general safety error categories and 76 specific safety error types. We also employed and trained professional driving instructors to review the video data of the on-road drives. In this report, we illustrate our rating system on a group of 111 drivers, ages 65 to 89. These drivers made errors in 13 of the 15 error categories, comprising 42 of the 76 error types. A mean (SD) of 35.8 (12.8) safety errors per drive were noted, with 2.1 (1.7) of them being judged as serious. Our methodology may be useful in applications such as intervention studies, and in longitudinal studies of changes in driving abilities in patients with declining cognitive ability.

(59) Age and Attentional Capacity Dong-Yuan Debbie Wang and Scott Entsminger (University of North Florida)

Accident and fatality rates begin to increase after age 55. Previous research indicated only weak relationships between crash involvement and poor acuity. The other factor that may influence driving performance is impaired attentional function. In a study of young adults, Green and Bavelier (2003) showed that action-video-game players have greater attention capacity than non-video-game players and that non-video-game players can be trained to enhance visual attention and its spatial distribution. It is not clear whether the reduced driving capability of older adults is due to a decreased attention capacity. In this paper, attention capacity of young and older drivers was examined using a flanker task paradigm. Participants were asked to respond to two shapes (diamond/square) in one of six circles arranged in a ring. At the same time, a distractor (square/diamond) was displayed on the left or the right of the ring. Workload was manipulated by presenting different shapes in all the other circles or only one shape in the ring. The influence of the irrelevant shape on the performance (flanker effect) under different load conditions was compared between older and younger drivers. Reaction time under the high-load condition was longer than in the low-load condition and older drivers' reaction time was slower than younger drivers'. However, for both age groups, flanker effect only existed for the low-load condition and tends to disappear in the high-load condition.

(60) Driving Assessment and Subsequent Driving Outcome: A Prospective Study of Safe and Unsafe Healthy Driver Groups Petra Hoggarth (Van der Veer Institute for Parkinson's & Brain Research; University of Canterbury – *New Zealand*), Richard Jones (Van der Veer Institute for Parkinson's & Brain Research; Christchurch Hospital; University of Otago – *New Zealand*), Carrie Innes (Van der Veer Institute for Parkinson's & Brain Research; Christchurch Hospital – *New Zealand*), and John Dalrymple-Alford (Van der Veer Institute for Parkinson's & Brain Research ; University of Canterbury – *New Zealand*)

Older drivers are an increasingly numerous section of the population who are often targeted for driving assessment. Little is known as to whether on-road driving assessments result in an older driver population who have fewer negative driving events. Fifty-eight healthy older drivers (mean age 77, range 71-84, no diagnosis of neurological disorder), completed a non-enforced on-road driving assessment and detailed sensory-motor and cognitive testing. Self-reported and official data regarding crashes and traffic offences were collected for both the five years prior to the on-road assessment and the 12 months following in order to determine whether those who received a Fail score on the on-road assessment had higher rates of negative driving events than those who passed (43 passed, 15 failed). No increase in adverse outcomes was found either retrospectively or prospectively for those who failed the on-road assessment. Similarly there were no significant differences in cognitive, sensory-motor, and demographic variables between those who passed and failed. Healthy older drivers who failed the on-road assessment did not show evidence of poorer driving behaviour even at the level of descriptive statistics.

(61) Estimating Workload Demands of Turning Left at Intersections of Varying Complexity Arne Stinchcombe (University of Ottawa – *Canada*), and Sylvain Gagnon (University of Ottawa; CanDRIVE, Ottawa Health Research Institute – *Canada*)

The challenge posed by left-turns has been well-documented in literature. Left-turns are thought to be complex roadway sites resulting in a significant proportion of motor-vehicle collisions. The purpose of the present study was to determine whether subjective and objective workload is affected by left-turns of varying complexity (i.e., information processing and maneuvering) in a sample of young inexperienced drivers. A secondary goal was to determine the effect of administering a secondary task on subjective workload. To this end, 60 inexperienced drivers completed four simulated driving scenarios of varying visual and maneuvering complexity. Half of participants completed an objective measure of workload (i.e., a secondary task) while all participants completed a subjective measure of workload upon completion of each scenario. The results demonstrated the effect of complexity on subjective and objective workload. Specifically, information processing complexity was found to significantly affect both subjective and objective measures of participants' workload while the influence of maneuvering complexity was detected through subjective load only.

(62) Implementation of a Driving Diary Intervention to Reduce Aberrant Driving Behaviours Bevan Rowland, Jeremy Davey, James Freeman, and Darren Wishart (Queensland University of Technology – *Australia*)

Crash data involving taxis indicates that such drivers are over represented in crashes and are one to two times more likely to be involved in a fatality crash. This study reports on the pre intervention survey to provide a baseline measure of the self-reported attitudes and corresponding driving behaviours of a sample of taxi drivers. Results indicate that some taxi drivers willingly admit to engaging in unsafe driving practices. In addition, preliminary results of a post intervention survey revealed that taxi drivers' safety perceptions, attitude and behaviours improved after completing a Driving Diary intervention.

(63) Useful Field of View Impairments in Drivers with Obstructive Sleep Apnea Jon Tippin (University of Iowa; Veterans Affairs Medical Center), JonDavid Sparks, and Matthew Rizzo (University of Iowa)

As a group, drivers with obstructive sleep apnea (OSA) have an increased risk for motor vehicle crashes, but determining individual crash risk is difficult. We tested the hypothesis that drivers with OSA have impaired visual attention, as indexed by reduced useful field of view (UFOV), a predictor of high-risk driving. Forty-one drivers with untreated OSA and 50 comparison drivers were assessed by UFOV. OSA drivers performed significantly worse than controls on all UFOV subtests and had reduced UFOV as indicated by a higher mean total UFOV score ($p = 0.0017$). However, only 4 OSA and 2 control drivers had values indicative of high crash risk (UFOV reduction >23%). Drivers with OSA have reduced UFOV compared to drivers without neurological or sleep disorders. However, as UFOV identifies few high-risk drivers, its role in assessing crash risk in an unselected population of drivers with OSA appears to be limited.

(64) A Recording and Analysis System of Bioptic Driving Behaviors Gang Luo (Schepens Eye Research Institute, Harvard Medical School), Xianping Fu (Schepens Eye Research Institute, Harvard Medical School; Dalian Maritime University – *China*) and Eli Peli (Schepens Eye Research Institute, Harvard Medical School)

Millions of visually impaired people do not drive because they fail to meet the general vision requirements. There is a legal option in 38 US states where people with moderate central vision loss (e.g. visual acuity better than 20/200) may be permitted to drive while wearing spectacle-mounted bioptic telescopes. However, the safety of bioptic driving is still highly controversial, because bioptic use in driving is not well understood. Whether and how bioptic telescopes are actually used in driving, how they should be used appropriately, and whether their use results in better or worse driving performance has never been scientifically established. We are developing an in-car camera system that can be installed in bioptic drivers' own vehicles to record their daily driving activities over long periods of time. Videos of the driver and traffic, GPS coordinates, XYZ acceleration, and vehicle black box data are recorded. We are also developing computer-aided reviewing techniques to automatically identify the most informative driving segments from the vast amount of data and, reconstruct the selected driving maneuvers on an interactive interface, so that these representative segments can be assessed off-line by driver evaluation and training specialists.

(65) Estimating Fatigue from Predetermined Speech Samples Transmitted by Operator Communication Systems Jarek Krajewski (University of Wuppertal – *Germany*), Udo Trutschel (Circadian Technologies Inc.), Martin Golz (University of Applied Sciences Schmalkalden – *Germany),* David Sommer (Circadian Technologies Inc.), and Dave Edwards (Caterpillar Inc.)

We present an estimation of fatigue level within individual operators using voice analysis. One advantage of voice analysis is its utilization of already existing operator communications hardware (2-way radio). From the driver viewpoint it's an unobtrusive, non-interfering, secondary task. The expected fatigue induced speech changes refer to the voice categories of intensity, rhythm, pause patterns, intonation, speech rate, articulation, and speech quality. Due to inter-individual differences in speech pattern we recorded speaker dependent baselines under alert conditions. Furthermore, sophisticated classification tools (e.g. Support Vector Machine, Multi-Layer Perceptron) were applied to distinguish these different fatigue clusters. To validate the voice analysis predetermined speech samples gained from a driving simulator-based sleep deprivation study (N=12; 01.00-08.00 a.m.) are used. Using standard acoustic feature computation procedures we selected 1748 features and fed them into 8 machine learning methods. After each combining the output of each single classifier we yielded a recognition rate of 83.8% in classifying slight from strong fatigue.

(66) Withdrawn

(67) Nighttime Speed Negotiation on Rural Road S-Shaped Curves: Discussion of An Experimental Case-Study Marco Pasetto and Andrea Manganaro (University of Padua – *Italy*)

Road users' perception of risk while driving is the focal point discriminating prudent from imprudent behavior. One of the main factors that can influence a driver's level of risk perception is 'lighting,' given that the driving conditions on roads alter radically between daytime and nighttime hours. This paper describes the results of a study conducted along a section of rural road containing a sharp S-shaped curve linking two long rectilinear approach roads in the sequence 'tangent-curve-tangent.' The driving behavior of the road users was surveyed in both directions of travel by day and at night, demonstrating a notable discrepancy in driving style between the two conditions.

Session 8 – Lectures
Novice & Elderly Drivers
Thursday, June 25, 2009
8:30 AM – 9:50 AM

(68) Validity of an On-Road Driver Performance Assessment Within an Initial Driver Training Context Erik Roelofs (National Institute for Educational Measurement – *The Netherlands*), Jan Vissers (DHV Environment and Transportation – *The Netherlands*), Marieke van Onna (Cito, National Institute for Educational Measurement – *The Netherlands*), and Reinoud Nägele (DHV Environment and Transportation – *The Netherlands*)

Based on a competence-oriented view of driving, a driver performance assessment (DPA) has been developed to inform learner drivers about their progress in acquiring driving proficiency. An initial validation study was carried out to evaluate the adequacy of inferences based on DPA-scores assigned by driving instructors. The results of two pilots are presented. Implications for driving performance assessment within driver training programs are discussed.

(69) Modeling the Behavior of Novice Young Drivers Using Data From In-Vehicle Data Recorders Tsippy Lotan (Or Yarok – *Israel*), Tomer Toledo, and Carlo G. Prato (Technion - Israel Institute of Technology – *Israel*)

Novice young drivers suffer from increased crash risk that translates into over-representation in road injuries. A better understanding of the driving behavior of novice young drivers and of their determinants is needed to tackle this problem. To this extent, this study analyzes the behavior of novice young drivers within a Graduated Driver Licensing (GDL) program. Data on driving behavior of novice drivers and their parents is collected using in-vehicle data recorders, which calculate compound risk indices as measures of the risk taking behavior of the various drivers. Data is used to estimate a negative binomial model to identify the major factors that affect the driving behavior of the young drivers. Estimation results suggest that the risk taking behavior of young drivers is influenced by that of their parents and decreases with higher levels of supervised driving and stricter monitoring by the parents.

(70) Elderly Pedestrians' Visual Timing Strategies in a Simulated Street-Crossing Situation Viola Cavallo, Régis Lobjois, Aurélie Dommes, and Fabrice Vienne (French National Institute for Transportation and Safety Research [INRETS] – *France)*

The purpose of the present experiment was to investigate the effect of age and of the approaching vehicle's speed on crossing behavior in an interactive street-crossing simulation. Seventy-eight subjects aged from 20-30, 60-70 and 70-80, took part in the experiment. Half of them were female and half were male. The participants were asked to cross between two approaching cars if they judged crossing possible. Vehicle speed (40 and 60 km/h) and time gap between cars (from 1 to 7s) were varied. The results show that the accepted time gap increased with age, but that the adopted safety margins, as well as the rates of unsafe crossings and missed opportunities were globally comparable for all groups of participants. However, the speed of the approaching vehicles was identified as an important risk factor for elderly pedestrians. Unlike younger pedestrians, seniors exhibited more risky behaviors at higher speeds. Results are discussed in relation to the visual information used, and with respect to the validity of judgment and crossing tasks in the study of pedestrian behavior.

(71) Attention Function Structure of Older and Younger Adult Drivers
Stephanie Tuttle, Nicholas Cassavaugh, and Richard W. Backs (Central Michigan University)

Groups of younger (*n*=49, *M* age = 21.7 years) and older (*n*=52, *M* age = 73.0 years) adults performed computer-based cognitive tests and simulated driving. Results from the cognitive tests were submitted to Principal Components Analysis (PCA) and 6 components were extracted that explained more than 77% of the variance. The components were labeled speed, divided, sustained, executive, selective/inhibition, and visual search in descending order of amount of variance explained. The component scores were used to predict simulated driving performance. Hierarchical step-wise regressions were computed with driving performance as the criterion, and age group (forced) and the component scores (step-wise) as predictors. Results showed that the speed and divided components were more likely to explain additional driving performance variance beyond age group than the other components.

Session 9 – Lectures
Design
Thursday, June 25, 2009
10:00 AM – 11:20 AM

(72) How Do Drivers Behave in a Highly Automated Car? Natasha Merat and A. Hamish Jamson (University of Leeds – *United Kingdom*)

This paper outlines the results of a driving simulator study conducted for the European CityMobil project, designed to investigate the effect of a highly automated driving scenario on driver behaviour. Drivers' response to a number of 'critical' scenarios was compared in manual driving vs. in automated driving. Drivers were in full control of the vehicle and its manoeuvres in the manual driving condition; control of the vehicle was transferred to an 'automated system' in the automated driving condition. Automated driving involved the engagement of lateral and longitudinal controllers to keep the vehicle in the centre of the lane and at 40 mph, respectively. Drivers were required to regain control of the driving task if the automated system was unable to handle a critical situation. An auditory alarm warned drivers of an imminent collision in such critical situations. Drivers' response to all critical events was much later in the automated driving condition, compared to manual driving. This is thought to be because drivers' situation awareness was reduced during automated driving, with response only produced after hearing the alarm. Or, drivers may have relied too heavily on the system, waiting for the auditory alarm before responding in a critical situation. These results suggest that action must be taken when implementing fully automated driving to ensure that the driver is kept in the loop at all times and is able to respond in time and appropriately during critical situations.

(73) Design and Evaluation of Serial-Hybrid Vehicle Energy Gauges Janet Creaser (University of Minnesota), John Lenneman (Central Michigan University), and Joseph Szczerba (General Motors R&D and Planning)

This paper describes a usability study of serial-hybrid vehicle energy gauge designs. Eight gauges that were modified by design format (bars, dials), color (one color, two colors) and the type of information present (range information, no range information) were tested in a driving simulator under urban/suburban traffic conditions. Participants answered questions about the state of the battery and fuel tank separately and also answered questions that involved combining the information from both sources of energy. Comprehension was assessed based on accuracy and response times to the questions when a gauge was presented. Participants also completed subjective ratings of the gauges. Driving performance was assessed to determine if driving was affected by responding to gauge presentations. Overall, the results indicated that the bar design using two colors and including range information performed best when integration of the two energy sources was required. These attributes were also most preferred by participants in this study.

(74) The Design and Assessment of Attention-Getting Rear Brake Light Signals
M. Lucas Neurauter, Robert E. Llaneras, and Walter W. Wierwille (Virginia Tech Transportation Institute)

This paper summarizes work intended to further characterize and develop rear brake light signals likely to improve driver reaction to hard-braking lead-vehicle events, emphasizing unique and novel approaches not previously studied. The work developed optimized signal lighting configurations, including specifications for LED signal approaches (flash frequencies, brightness levels, patterns), and performed field evaluations to assess eye-drawing capability of candidate signals for drivers who were looking away from the forward view. Results indicate that newer rear signaling designs can be very effective at drawing drivers' eyes back to the forward roadway, and that flashing and brightness are two important signal properties moderating effectiveness (attention-getting). Remarkable performance gains can be achieved via use of LED signal approaches that both flash and increase signal intensity or lamp brightness.

(75) Capturing Driver Response to In-Vehicle Human-Machine Interface Technologies Using Facial Thermography Michelle L. Reyes, John D. Lee, Yulan Liang, Joshua D. Hoffman (University of Iowa), and Ritchie W. Huang (Honda R&D Americas, Inc.)

Measuring driver response to in-vehicle human-machine interface (HMI) systems is critical for automotive design and evaluation. Physiological measures provide a useful complement to performance-based and subjective measures because they can estimate the affective response of drivers in a way that requires no overt response. We explored how facial temperature might reflect the drivers' response to demands when interacting with in-vehicle systems. Sixteen drivers completed a series of tasks while driving in a simulator. Facial temperature was measured using an infrared camera. The analyses focus on how the thermal data, aggregated over four facial regions, correlated with measures of driving performance and subjective ratings of workload and frustration. Temperature measures correlated more with driving performance measures of longitudinal rather than lateral control, suggesting thermal measures are sensitive to different cognitive processes than are typically assessed by measures of steering and lane position. Thermal measures also correlated with subjective ratings. Aggregated over long time windows, thermal measures have temporal specificity and might be able to identify specific interactions that increase workload and frustration. No single facial area or summary measure emerged as the best indicator of driver response; rather, composite measures of facial temperature could be developed that offer a more complete profile of driver response.