3rd International Driving Symposium on Human Factors in Driver Assessment, Training, and Vehicle Design
June 27-30, 2005

Monday June 27, 2005

1:00 PM – 6:00 PM	**Early Registration** Knox County Hallway, Samoset Resort on the Ocean
3:00 PM – 5:00 PM	**Simulator Users Group Meeting** Camden Room, Samoset Resort on the Ocean
6:00 PM – 8:30 PM	**WELCOME RECEPTION** Owls Head Transportation Museum
7:15 PM	**OPENING REMARKS** General Chairs, Driving Assessment 2005 University of Iowa

Tuesday June 28, 2005

7:30 AM – 4:30 PM	**Registration Open** Knox County Hallway, Samoset Resort on the Ocean
7:30 AM – 8:45 AM	**Continental Breakfast** State of Maine Hall, Samoset Resort on the Ocean
9:00 AM – 10:00 AM	**NISSAN DISTINGUISHED KEYNOTE LECTURE** Knox County Ballroom, Samoset Resort on the Ocean **Sex and the Single-Vehicle Crash (01)** Leonard Evans (President, Science Serving Society)
10:00 AM – 10:15 AM	**BREAK-Refreshments** State of Maine Hall, Samoset Resort on the Ocean

Tuesday June 28, 2005

SESSION 1 – Lectures
Quantification of Driver Performance
10:15 AM – 12:00 PM
Knox County Ballroom, Samoset Resort on the Ocean

Session Chair: Nicholas Ward (University of Minnesota)

10:20 AM **Evidence and Dimensions of Commercial Driver Differential Crash Risk (02)**
Ronald R. Knipling (Virginia Tech Transportation Institute)

10:45 AM **Quantifying Driver Response Times Based upon Research and Real Life Data (03)**
Jeffrey W. Muttart (Eastern Connecticut State University)

11:10 AM **Variability of Driving Performance During Microsleeps (04)**
Amit Paul, Linda Ng Boyle, Jon Tippin, Matthew Rizzo (University of Iowa)

11:35 AM **Steering Entropy Revisited (05)**
Erwin R. Boer (LUEBEC)
Michael E. Rakauskas, Nicholas J. Ward (University of Minnesota)
Michael A. Goodrich (Brigham Young University)

12:00 PM – 1:30 PM **HONDA LUNCHEON & OUTSTANDING STUDENT PAPER AWARD CEREMONY**

Sponsored by Honda R&D Americas, Inc.
Pen Bay Gardens, Samoset Resort by the Ocean

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

Honda Outstanding Student Paper Award Winners:

Tuesday June 28, 2005

SESSION 2 – Lectures
Visual Performance
1:45 PM – 3:25 PM
Knox County Ballroom, Samoset Resort on the Ocean

Session Chair: John Lenneman (General Motors Corporation)

1:45 PM **Assessing Driving Performance with Moderate Visual Field Loss (06)**
Alex R. Bowers, Eli Peli (Harvard Medical School)
Jennifer Elgin, Gerald McGwin, Jr., Cynthia Owsley
(University of Alabama at Birmingham)

2:10 PM **Peripheral Motion Contrast Sensitivity and Older Drivers' Detection Failure Accident Risk (07)**
Steven Henderson (Transportation Safety Board of Canada — *Canada*)
Don C. Donderi (McGill University — *Canada*)

2:35 PM **Predicting Driving Performance in Older Adults with the Useful Field of View Test: A Meta-Analysis (08)**
Karlene K. Ball, Olivio J. Clay, Virginia G. Wadley, David L. Roth
(University of Alabama at Birmingham)
Jerri D. Edwards (University of Alabama in Huntsville)
Daniel L. Roenker (Western Kentucky University)

3:00 PM **Distance Perception with a Camera-Based Rear Vision System in Actual Driving (09)**
Michael J. Flannagan, Mary Lynn Mefford
(University of Michigan Transportation Research Institute)

3:30 PM **BREAK-Refreshments**
State of Maine Hall, Samoset Resort on the Ocean

SESSION 3 – Poster Session A
3:30 PM – 5:00 PM
State of Maine Hall, Samoset Resort on the Ocean

The Perceptions of Emergency Vehicle Drivers Using Simulation in Driver Training (10)
Jeffrey T. Lindsey, Ann E. Barron (University of Southern Florida)

The Effects of Speech Production and Speech Comprehension on Simulated Driving Performance (11) Tate T. Kubose, Kathryn Bock, Gary S. Dell, Susan M. Garnsey, Arthur F. Kramer, Jeff Mayhugh (University of Illinois, Urbana-Champaign)

The Effects of PC-Based Training on Novice Drivers' Risk Awareness in a Driving Simulator (12) Anuj K. Pradhan, Donald L. Fisher, Alexander Pollatsek (University of Massachusetts, Amherst)

Effects of Lane Departure Warning on Drowsy Drivers' Performance and State in a Simulator (13) Maria Rimini-Doering, Tobias Altmueller, Ulrich Ladstaetter, Markus Rossmeier (Robert Bosch GmbH — *Germany*)

Cognitive and Psychomotor Correlates of Self-Reported Driving Skills and Behavior (14) Nebi Sümer, H. Belgin Ayvasik (Middle East Technical University — *Turkey*), Nurhan Er (Ankara University — *Turkey*)

An Evaluation of Driving Ability in a Simulator: A Good Predictor of Driving Ability After Stroke (15) Ann-Helen Patomella, Anders Kottorp (Karolinska Institutet — *Sweden*)

Withdrawn (16)

Enhancing the Message Displayed on Dynamic Message Signs (17) Chun-Ming Yang, Dusty Waters, Carmeris C. Cabrera, Jyh-Hone Wang, Charles E. Collyer (University of Rhode Island)

Visual Field Defects and the Risk of Motor Vehicle Collisions Among Patients with Glaucoma (18) Gerald McGwin, Jr., Aiyuan Xie, Andrew Mays, Wade Joiner (University of Alabama at Birmingham), Dawn K. DeCarlo (Nova Southeastern University), Tyler Andrew Hall, Cynthia Owsley (University of Alabama at Birmingham)

Verbal Collision Avoidance Messages of Varying Perceived Urgency Reduce Crashes in High Risk Scenarios (19) Carryl L. Baldwin, Jennifer F. May (Old Dominion University)

Withdrawn (20)

Tracking Driver Eye Movements at Permissive Left-Turns (21) Michael A. Knodler, Jr. (University of Massachusetts, Amherst), David A. Noyce (University of Wisconsin, Madison)

Age Related Decrements in Steering Control: The Effects of Landmark and Optical Flow Information (22) Rui Ni, George J. Andersen (University of California, Riverside), Sean McEvoy, Matthew Rizzo (University of Iowa)

Psychophysiological Measures of Driver Distraction and Workload While Intoxicated (23) Michael E. Rakauskas, Nicholas J. Ward, Edward Bernat, Meredith Cadwellader, Christopher Patrick, (University of Minnesota), Dick de Waard (University of Gröningen — *The Netherlands*)

Workload Changes in Teenaged Drivers Driving with Distractions (24) Renee F. Slick, Elizabeth T. Cady, Tuan Q. Tran (Kansas State University)

Driver Assessment with Measures of Continuous Control Behavior (25) R. Wade Allen (Systems Technology, Inc.), Thomas D. Marcotte (University of California at San Diego), Theodore J. Rosenthal, Bimal L. Aponso (Systems Technology, Inc.)

Matching In-Car Voice with Driver State: Impact on Attitude and Driving Performance (26) Ing-Marie Jonsson (Toyota Information Technology Center), Clifford Nass (Stanford University), Helen Harris (Toyota Information Technology Center), Leila Takayama (Stanford University)

Assessing Driver Fitness to Participate in FHWA Field Experimentation at Night (27) John A. Molino (Science Applications International Corporation), Kenneth S. Opiela (Federal Highway Administration), Bryan J. Katz (Science Applications International Corporation), M. Joseph Moyer (Federal Highway Administration)

The Impact of Cognitive Deficits and Spasticity on Driving Simulator Performance in Multiple Sclerosis (28) Thomas D. Marcotte (University of California), Theodore J. Rosenthal (Systems Technology, Inc.), Jody Corey-Bloom, Erica Roberts, Sara Lampinen (University of California), R. Wade Allen (Systems Technology, Inc.)

Change Detection Performance Under Divided Attention with Dynamic Driving Scenarios (29) Yi-Ching Lee, John D. Lee, Linda Ng Boyle (University of Iowa)

Driver Workload Management During Cell Phone Conversations (30) Chip Wood, Joshua Hurwitz (Motorola Labs)

Simulator Performance vs. Neurophysiologic Monitoring: Which is More Relevant to Assess Driving Impairment? (31) Henry J. Moller, Leonid Kayumov, Eric L. Bulmash, Colin M. Shapiro, Sidney H. Kennedy (Toronto Western Hospital, University of Toronto — *Canada*)

Assessment of a Driver Interface for a Lateral Drift and Curve Speed Warning Systems: Mixed Results for Auditory and Haptic Warnings (32) Tina Brunetti Sayer (Visteon Corporation), James R. Sayer, Joel M. Devonshire (The University of Michigan Transportation Research Institute)

Withdrawn (33)

Wednesday June 29, 2005

7:30 AM – 4:30 PM **Registration Open**
Knox County Hallway, Samoset Resort on the Ocean

7:30 AM – 8:15 AM **Continental Breakfast**
State of Maine Hall, Samoset Resort on the Ocean

SESSION 4 – Lectures
Driver Assistance Systems
8:15 AM – 10:00 AM
Knox County Ballroom, Samoset Resort on the Ocean

Session Chair: Hiroshi Tsuda (Nissan Technical Center North America, Inc.)

8:20 AM **Comparison Between Visual and Tactile Signal Detection Tasks Applied to the Safety Assessment of In-Vehicle Information Systems (34)**
Johan Engström, Nina Åberg, Emma Johansson
(Volvo Technology Corporation — *Sweden*)
Jakob Hammarbäck (Uppsala — *Sweden*)

8:45 AM **Road-to-Lab: Validation of the Static Load Test for Predicting On-Road Driving Performance While Using Advanced In-Vehicle Information and Communication Devices (35)**
Richard Young, Bijaya Aryal, Marius Muresan, Xuru Ding, Steve Oja, S. Noel Simpson
(General Motors Engineering)

9:10 AM **Driver Distraction and Reliance: Adaptive Cruise Control in the Context of Sensor Reliability and Algorithm Limits (36)**
Bobbie D. Seppelt, Monica N. Lees, John D. Lee (University of Iowa)

9:35 AM **Driver Distraction: A Naturalistic Observation of Secondary Behaviors With the Use of Driver Assistance Systems (37)**
James R. Sayer, Mary Lynn Mefford, Kezia Shirkey, Jessica Lantz
(The University of Michigan Transportation Research Institute)

10:00 AM – 10:15 AM **BREAK-Refreshments**
State of Maine Hall, Samoset Resort on the Ocean

Wednesday June 29, 2005

SESSION 5 – Lectures
Medical Factors
10:15 AM – 12:10 PM
Knox County Ballroom, Samoset Resort on the Ocean

Session Chair: Karlene Ball (University of Alabama at Birmingham)

10:15 AM **Driving Assesment in Maine — A Medical Perspective**
Bruce Sigsbee, MD (American Academy of Neurology, senior member)

10:30 AM **Unsafe Rear-End Collision Avoidance in Alzheimer's Disease (38)**
Ergun Y. Uc, Matthew Rizzo, Steven W. Anderson, Qian Shi, Jeffrey D. Dawson (University of Iowa)

10:55 AM **Innovative Fatigue Management Approach in the Trucking Industry (39)**
Anneke Heitmann, Rainer Guttkuhn (Circadian Technologies, Inc.)
Dean Croke (FleetRisk Advisors, LLC)
Martin Moore-Ede (Circadian Technologies, Inc.)

11:20 AM **Quantifying the Benefits of Enhancing Medications on Driving Performance: Comparing OROS® MPH vs. se-AMPH ER® in Driving Safety of ADHD Teenagers as Case Example (40)**
Frances P. Thorndike, Daniel J. Cox, R. Larry Merkel, Melissa Moore, Roger Burket, Carrie Muller, Boris Kovatchev (University of Virginia Health System)

11:45 AM **Cognitive Abilities Related to Driving Performance in a Simulator and Crashing on the Road (41)**
Steven W. Anderson, Matthew Rizzo, Qian Shi, Ergun Y. Uc, Jeffrey D. Dawson (University of Iowa)

12:15 PM – 1:30 PM **LUNCH**
Pen Bay Gardens, Samoset Resort on the Ocean

SESSION 6 – Presentation and Panel Discussion
Naturalistic Driving and the Virginia Tech 100 Car Study
1:45 PM – 3:25 PM
Knox County Ballroom, Samoset Resort on the Ocean

Moderator: John D. Lee (University Iowa)

Presenter: Tom Dingus (Virginia Tech Transportation Institute)

Panel Members: Leonard Evans (Science Serving Society)
Donald Fisher (University of Massachusetts)
Jane Stutts (University of North Carolina)
Richard Young (General Motors Engineering)

Wednesday June 29, 2005

3:30 PM **BREAK-Refreshments**
State of Maine Hall, Samoset Resort on the Ocean

SESSION 7 – Poster Session B
3:30 PM – 5:00 PM
State of Maine Hall, Samoset Resort on the Ocean

Examination of the Efficacy of Proximity Warning Devices for Young and Older Drivers (42) Arthur F. Kramer, Nicholas D. Cassavaugh, William J. Horrey, Ensar Becic, Jeffery Mayhugh (University of Illinois)

Effect of Simulator Training on Driving After Stroke: A Randomized Controlled Trial (43) Abiodun Emmanuel Akinwuntan, Willy De Weerdt, Hilde Feys, Jan Pauwels (Katholieke Universiteit Leuven — *Belgium*), Guido Baten, Patricia Arno (CARA, Belgian Road Safety Institute — *Belgium*), Carlotte Kiekens (University Hospital Pellenberg — *Belgium*)

Can Sea Bands® Be Used to Mitigate Simulator Sickness? (44) Amy D. Wesley (UGS Corporation), Tina Brunetti Sayer (Van Buren Township, Michigan), Steve Tengler (Nissan North America)

Gaze Behavior During Simulated Driving: Elements for a Visual Driving Aid (45) Daniel R. Mestre (UMR Mouvement et Perception, CNRS/Universite de la Mediterranee — *France*) Frank Mars (Institut de Recherche en Communications et Cybernetique de Nantes — *France*) Sylvian Durand (UMR Mouvement et Perception, CNRS/Universite de la Mediterranee — *France*) Fabrice Vienne, Stéphane Espié (Modelisations, Simulations et Simulateurs de Conduite — *France*)

Performing E-mail Tasks While Driving: The Impact of Speech-Based Tasks on Visual Detection (46) Joanne L. Harbluk, Simone Lalande (Transport Canada — *Canada*)

Road Environment and Driver Fatigue (47) Tal Oran-Gilad, Peter A. Hancock (University of Central Florida)

Toward a Driving Competency Assessment Encouraging Elderly's Automobility: A French Point of View (48) Catherine Gabaude, Laurence Paire-Ficout (INRETS, LESCOT — *France*)

Driving Simulators for Commercial Truck Drivers — Humans in the Loop (49) Talleah Allen, Ronald Tarr (University of Central Florida)

The Concept of Cooperative Automation in Cars: Results from the Experiment "Overtaking on Highways" (50) Lars Biester (Robert Bosch GmbH — *Germany*)

What Drivers Don't Know; or Don't Care (51) S. David Leonard (University of Georgia), G. William Hill IV, Jeffrey A. Overdorff (Kennesaw State University)

Do In-Vehicle Advance Signs Benefit Older and Younger Driver Intersection Performance? (52) Susan L. Chisholm, Jeff K. Caird, Julie A. Lockhart, Natalie H. Vacha (University of Calgary — *Canada*), Christopher J. Edwards (Virginia Tech Transportation Institute)

Gender Differences in Predicting Unsafe Driving Behaviors in Young Adults (53) Nicole R. Skaar, John E. Williams (University of Northern Iowa)

Driving Performance in a Simulator as a Function of Pavement and Shoulder Width, Edgeline Presence, and Oncoming Traffic (54) Susan T. Chrysler, Alicia A. Williams (Texas A&M University System)

Evaluating First-time and Infrequent Use of In-Car Navigation Devices (55) Elliott Noel, Blair Nonnecke, Lana Trick (University of Guelph — *Canada*)

Adaptation to a Motion-Based and Non-Motion-Based Simulator (56) Renee F. Slick, Tuan Q. Tran, Elizabeth T. Cady (Kansas State University)

Longitudinal Assessment of Older Drivers in a DMV Setting (57) Karlene K. Ball (University of Alabama at Birmingham), Daniel L. Roenker (Western Kentucky University), Virginia G. Wadley (University of Alabama at Birmingham), Gayla Cissell, Melissa Matthews (Western Kentucky University), David Ball, David Vance, Martha Frankel, Kathy McConnell (University of Alabama at Birmingham)

Traffic Violations and Errors: The Effects of Sensation Seeking and Attention (58) H. Belgin Ayvaşik (Middle East Technical University — *Turkey*), Nurhan Er (Ankara University — *Turkey*), Nebi Sümer (Middle East Technical University — *Turkey*)

The Spatial Extent of Attention During Driving (59) George J. Andersen, Rui Ni (University of California, Riverside)

Got Info? Examining the Consequences of Inaccurate Information Systems (60) Ing-Marie Jonsson, Helen Harris (Toyota InfoTechnology Center), Clifford Nass, Leila Takayama (Stanford University)

Withdrawn (61)

The Relation Between Speed-Lane Choice and Road Accidents in Jordan (62) Lina Shbeeb, Wa'el Awad, Mohd. R. Suliman (Al Balqa' Applied University — *Jordan*), Jamil Mujahed (Jordan Traffic Institute — *Jordan*)

Shut up I'm Driving! Is Talking to an Inconsiderate Passenger the Same as Talking on a Mobile Phone? (63) Natasha Merat, A. Hamish Jamson (University of Leeds — *United Kingdom*)

Driver Performance Assessment with a Car Following Model (64) Erwin R. Boer (LUEBEC), Nicholas J. Ward, Michael P. Manser (University of Minnesota), Tomohiro Yamamura, Nobuyuki Kuge (Nissan Motor Co. Ltd. — *Japan*)

Steering Entropy Changes as a Function of Microsleeps (65) Amit Paul, Linda Ng Boyle (University of Iowa), Erwin R. Boer (LUEBEC), Jon Tippin, Matthew Rizzo (University of Iowa)

6:30 PM – 9:30 PM	**SOCIAL HOUR & LOBSTER BAKE**
6:30 PM – 7:30 PM	**Social Hour** (cash bar)
7:30 PM	**Buffet Dinner Served**
	Pen Bay Gardens, Samoset Resort on the Ocean

Thursday June 30, 2005

7:30 AM – 12:30 PM **Registration Open**
Knox County Hallway, Samoset Resort on the Ocean

7:30 AM – 8:15 AM **Continental Breakfast**
Vinalhaven Room, Samoset Resort on the Ocean

SESSION 8 – Lectures
Training & Assessment
8:15 AM – 10:00 AM
Knox County Ballroom

Session Chair: Ron Knipling (Virginia Tech Transportation Institute)

8:20 AM **Evaluating the Safety Implications and Benefits of an In-Vehicle Data Recorder to Young Drivers (66)**
Tsippy Lotan (OR YAROK — *Israel*)
Tomer Toledo (Israel Institute of Technology — *Israel*)

8:45 AM **The Use of a Driving Simulator to Assess Senior Driver Performance: Increasing Situational Awareness Through Post-Drive One-on-One Advisement (67)**
Matthew R.E. Romoser, Donald L. Fisher (University of Massachusetts, Amherst)
Ronald Mourant (Northeastern University)
Jerry Wachtel (The Veridian Group, Inc.)
Konstantin Sizov (Drive Square LLC)

9:10 AM **The Development and Evaluation of a High Fidelity Simulator Training Program for Snowplow Operators (68)**
David L. Strayer, Frank A. Drews (University of Utah)
Stan Burns (Utah Department of Transportation)

9:35 AM **Can Novice Drivers Recognize Foreshadowing Risks as Easily as Experienced Drivers? (69)**
Lisandra Garay-Vega, Donald L. Fisher (University of Massachusetts, Amherst)

10:00 AM – 10:15 AM **BREAK-Refreshments**
Vinalhaven Room, Samoset Resort on the Ocean

Thursday June 30, 2005

SESSION 9 – Lectures
Driver Distraction & Response
10:15 AM – 12:00 PM
Knox County Ballroom, Samoset Resort on the Ocean

Session Chair: Maria Rimini-Doering (Robert Bosch GmbH — *Germany*)

10:20 AM **A Meta-Analysis of Driving Performance and Crash Risk Associated with the Use of Cellular Telephones While Driving (70)**
Jeff K. Caird, Chip T. Scialfa (University of Calgary — *Canada*)
Geoff Ho (Honeywell)
Alison Smiley (Human Factors North — *Canada*)

10:45 AM **Driver Performance While Interacting with the 511 Travel Information System in Urban and Rural Traffic (71)**
Laura M. Stanley, Michael J. Kelly, Suzanne Lassacher (Montana State University)

11:10 AM **Deciphering Psychological-Physiological Mappings While Driving and Performing a Secondary Memory Task (72)**
John K. Lenneman (General Motors R&D and Planning)
Jonathon R. Shelley, Richard W. Backs (Central Michigan University)

11:35 AM **Deciding to be Distracted (73)**
Neil D. Lerner (Westat)

12:00 PM – 12:15 PM **CONFERENCE WRAP-UP**
Knox County Ballroom, Samoset Resort on the Ocean

12:15 PM – 1:00 PM **BOX LUNCH**
Vinalhaven Room, Samoset Resort on the Ocean

3rd International Driving Symposium on Human Factors in Driver Assessment, Training, and Vehicle Design
June 27-30, 2005

Summaries

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

Nissan Distinguished Keynote Lecture
Tuesday, June 28, 2005
9:00 AM – 10:00 AM

(01) Sex and the Single-Vehicle Crash Leonard Evans (Science Serving Society)

The characteristics of the more than 15 million drivers involved in traffic crashes in the U.S. annually depart markedly from those of a random sample of the U.S. population. In particular, males are far more likely to crash than females and young drivers far more likely to crash than older drivers. Sex and age differences are examined not only for drivers, but for road users who are not drivers, and for situations unrelated to traffic. Consistent differences are found, and these relate to intrinsic hormonal differences. While much of the traffic-crash problem originates at a fundamental behavioral and physiological level, this does not mean that there cannot be highly effective countermeasures. However, it does underline that such intrinsic human characteristics must be acknowledged when countermeasures are sought.

SESSION 1 – Lectures
Quantification of Driver Performance
Tuesday, June 28, 2005
10:15 AM – 12:00 PM

(02) Evidence and Dimensions of Commercial Driver Differential Crash Risk Ronald R. Knipling (Virginia Tech Transportation Institute)

This paper highlights evidence from several instrumented vehicle studies that crash risk varies significantly among commercial truck drivers, and also cites findings from surveys of fleet safety managers and other experts on the topic of individual differences in commercial driver crash risk. Within various subject groups, 10-15% of the drivers typically account for 30-50% of the crash risk. This pattern is seen in measures of driver errors associated with crashes and also in measures of driver drowsiness. The evidence also suggests, but does not yet prove, that these individual differences are long-term. To the extent that such differences are long-term, they may be considered personal traits. This paper conceptualizes driver risk factors, provides illustrative examples of differential individual risk within groups of drivers, identifies driver factors thought to be most associated with crash risk, and considers the opportunities for improved commercial driving safety presented by differential crash risk.

(03) Quantifying Driver Response Times Based upon Research and Real Life Data Jeffrey W. Muttart (Eastern Connecticut State University)

The purpose of this paper was to build upon previous research, identify the variables that significantly influence driver response times, and to determine the amplitude (constant) of that influence. The goal is that this research will explain why seemingly analogous published studies have come to very different driver response time results. An analogous driver response situation is defined as being in one of four groups: (1) lead vehicles that were stopped or moving slowly, (2) being cut off (when a slower moving vehicle changes lanes into the path of the responding driver), (3) path intrusions, or (4) known lights, icons or sounds. It was found that research that measured response times in analogous situations can be used to estimate the mean response time for a particular situation if adjustments are made to account for methodological differences between the studies. Non-analogous studies are poor predictors of driver response (An anticipated light stimulus response cannot accurately predict the response time to a path intrusion or lead vehicle). Mean driver response times can be predicted within 400 ms without accounting for individual difference. Therefore, external validity can be obtained regardless of the testing method (closed course, simulator or road), as long as the subject is unaware of either the stimulus or the appropriate response. Having a subject respond to multiple events does not (by itself) suggest that drivers will respond significantly faster.

(04) Variability of Driving Performance During Microsleeps Amit Paul, Linda Ng Boyle, Jon Tippin, Matthew Rizzo (University of Iowa)

This study aimed to evaluate the value of measuring microsleeps as an indicator of driving performance impairment in drowsy drivers with sleep disorders. Drivers with sleep disorders such as obstructive sleep apnea/hypopena syndrome (OSAHS) are at increased risk for driving performance errors due to microsleep episodes, which presage sleep onset. To meet this aim, we tested the hypothesis that OSAHS drivers show impaired control over vehicle steering, lane position and velocity during microsleep episodes compared to when they are driving without microsleeps on similar road segments. A microsleep is defined as a 3-14 sec episode during which 4-7 Hz (theta) activity replaces the waking 8-13 Hz (alpha) background rhythm. Microsleep episodes were identified in the electroencephalography (EEG) record by a neurologist certified by the American Board of Sleep Medicine. Twenty-four drivers with OSAHS were tested using simulated driving scenarios. Steering variability, lane position variability, acceleration and velocity measures were assessed in the periods during a microsleep, immediately preceding (pre) microsleep, and immediately following (post) microsleep. In line with our introductory hypothesis, drivers with OSAHS did show significantly greater variation in steering and lane position during the microsleep episodes compared to the periods pre and post microsleep. The results indicate that identification of microsleep episodes can provide a marker for declining vehicle control of drivers with OSAHS.

(05) Steering Entropy Revisited Erwin R. Boer (LUEBEC), Michael E. Rakauskas, Nicholas J. Ward (University of Minnesota), Michael A. Goodrich (Brigham Young University)

Drivers aim to maintain their vehicle within a number of individual situated safety margins. Safety margin violations are characterized by rapid strong corrective steering. Steering entropy was introduced to quantify drivers' efforts to maintain their lateral safety margins. In the original steering entropy, several computational assumptions were made. The objective is to scrutinize and motivate these choices and exemplify the effects of deviations from these choices with data from a driver distraction study. The new optimized algorithm is shown to yield significances where a number of classical metrics fail to find any significance. Its sensitivity is attributed to the fact that a number of observed changes in steering behavior all manifest in a widened steering prediction error distribution which the algorithm picks up sensitively with its log-based weighting of prediction error outliers and its use of a prediction filter that is maximally sensitive to the spectral characteristics of the baseline data.

SESSION 2 – Lectures
Visual Performance
Tuesday, June 28, 2005
1:45 PM – 3:25 PM

(06) Assessing Driving Performance with Moderate Visual Field Loss Alex R. Bowers, Eli Peli (Harvard Medical School), Jennifer Elgin, Gerald McGwin, Jr., Cynthia Owsley (University of Alabama at Birmingham)

The minimum binocular horizontal field extent for driver licensing varies widely between states in the USA. We examined the relationship between visual field extent and open-road driving performance using a scoring method that measured the quality of specific skills for a range of general driving maneuvers, as well as maneuvers that we expected to be difficult for people with restricted fields. Twenty-eight current drivers with mild to moderate peripheral visual field restrictions (123 ± 20°, V4e target) drove the 14-mile route. While most subjects were scored as safe drivers, those with more restricted horizontal and vertical binocular field extents showed significantly poorer skills in maneuvers for which a wide field of vision is likely to be important ($p \leq 0.05$): speed matching when changing lanes, and maintaining lane position and keeping to the path of the curve when driving around curves. Further studies using similar assessment methods with drivers with more restricted fields are necessary to determine the minimum field extent for safe driving.

(07) Peripheral Motion Contrast Sensitivity and Older Drivers' Detection Failure Accident Risk Steven Henderson (Transportation Safety Board of Canada — *Canada*), Don C. Donderi (McGill University — *Canada*)

Eighteen older drivers (66-88) and their passengers both reported on the drivers' performance using detection deficit questionnaires that elicited responses related to attention and to speed and accuracy of object motion perception. The measure of detection deficit was an equally weighted combination of standardized responses from the 17-item driver questionnaire and the 11-item passenger questionnaire.

Peripheral stationary and drifting contrast sensitivity was determined for 0.4 cycles per degree sine wave gratings at fifteen degrees eccentricity. The temporal two-alternative forced choice staircase procedure consisted of randomly interleaved left and right visual field grating presentations. The correlation between $\log_{10}$ motion contrast sensitivity and detection deficit was -.63 ($p < .01$), between age and detection deficit was .56 ($p < .05$), and between age and $\log_{10}$ motion contrast sensitivity was -.54 ($p < .05$). The partial correlation between $\log_{10}$ motion sensitivity and detection deficit, independent of age, was -.47 ($p = .054$). We concluded that some age-related driving performance deficits are associated with reduced sensitivity to motion in the visual periphery. Peripheral motion contrast sensitivity was discussed in relation to "useful field of view" (UFOV®) measures of visual function, and offered as a primary deficit of high risk drivers with Alzheimer's disease.

(08) Predicting Driving Performance in Older Adults with the Useful Field of View Test: A Meta-Analysis Karlene K. Ball, Olivio J. Clay, Virginia G. Wadley, David L. Roth (University of Alabama at Birmingham), Jerri D. Edwards (University of Alabama in Huntsville), Daniel L. Roenker (Western Kentucky University)

This investigation examines the Useful Field of View (specifically the UFOV® test), as a predictor of objective measures of driving performance. PubMed and PsycInfo databases were searched to retrieve eight independent studies reporting bivariate relationships between the UFOV® test and driving measures (driving simulator performance, state-recorded crashes, and on-road driving). Cumulative meta-analysis techniques were used to examine the predictive utility of the test, to determine whether the effect size was stable across studies, and to assess whether a sufficient number of studies have been conducted to conclude that the test is an effective predictor of driving competence. Results showed that the study samples could have been drawn from the same population. The weighted mean effect size across all studies revealed a large effect, Cohen's d=0.945, with poorer UFOV® test performance associated with negative driving outcomes. This relationship was robust across multiple indices of driving performance and several research laboratories. A concrete measure of sufficiency revealed that an additional 513 studies averaging a null result must be conducted to bring the p-value for the cumulative effect size to greater than .05. This convergence of evidence across different points in time and different research teams confirms the importance of the UFOV® assessment as a valid and reliable index of driving performance and safety. Corroborating this finding, a recent large field study in Maryland has further established the UFOV® test as a useful screening instrument to identify at-risk older drivers.

(09) Distance Perception with a Camera-Based Rear Vision System in Actual Driving Michael J. Flannagan, Mary Lynn Mefford (The University of Michigan Transportation Research Institute)

Participants drove an instrumented car equipped with conventional rearview mirrors and with a camera rear vision system. They observed the approach of an overtaking car in the alternative rear vision systems and indicated the last moment at which it would be safe to initiate a lane-change maneuver in front of it. Their judgments were strongly affected by the type of display used to observe the overtaking car. The longest distances were obtained with the camera-based display at unit magnification. Distances were substantially shorter with the conventional mirror and with the camera-based display at 0.5 minification. These results are consistent with results from an earlier study conducted under static conditions.

SESSION 3 – Poster Session A
Tuesday, June 28, 2005
3:30 PM – 5:00 PM

(10) The Perceptions of Emergency Vehicle Drivers Using Simulation in Driver Training Jeffrey T. Lindsey, Ann E. Barron (University of Southern Florida)

The number of accidents over the past decade involving emergency vehicles is a major concern for emergency service providers. This study assessed the perception of adding a driving simulator to a traditional training program. The sample population consisted of Emergency Medical Technician students attending the National EMS Academy in Lafayette, LA. The study included 52 participants in the control group and 50 participants in the treatment group. The treatment group used a driving simulator prior to driving on the competency course. Surveys were used to assess the emergency vehicle operators' perceptions of using a driving simulator as part of an emergency vehicle training course. The simulator allowed the treatment group to understand the course prior to actually driving the course. The control group thought the simulator would have afforded them the opportunity to learn the course before actually driving it. Both groups thought the simulator should be a part of the driver training course, but did not see the simulator replacing actual driving

experience. Emergency Medical Technician students in both the treatment and control group thought the simulator would improve their driving ability.

(11) The Effects of Speech Production and Speech Comprehension on Simulated Driving Performance Tate T. Kubose, Kathryn Bock, Gary S. Dell, Susan M. Garnsey, Arthur F. Kramer, Jeff Mayhugh (University of Illinois, Urbana-Champaign)

Two experiments compared the effects of speech production and speech comprehension on simulated driving performance. In both, participants completed a speech task and a simulated driving task under single- and dual-task conditions, with language materials matched for linguistic complexity. In Experiment 1, concurrent production and comprehension resulted in more variable velocity compared to driving alone. Experiment 2 replicated these effects in a more difficult simulated driving environment, with participants showing larger and more variable headway times when speaking or listening while driving than when just driving. In both experiments, concurrent production yielded *better* control of lane position relative to single-task performance, while concurrent comprehension had little impact on control of lane position. On all other measures, production and comprehension had very similar effects on driving. The results show, in line with previous work, the detrimental consequences on driving of concurrent language use. Our findings imply that such consequences may be roughly the same whether drivers are producing speech or comprehending it.

(12) The Effects of PC-Based Training on Novice Drivers' Risk Awareness in a Driving Simulator Anuj K. Pradhan, Donald L. Fisher, Alexander Pollatsek (University of Massachusetts, Amherst)

Novice drivers are almost nine times more likely to die in a crash as more experienced drivers. This increased risk has been found to be largely due to novice drivers' inability to predict the risks in the roadway ahead. Current driver education curriculum does not specially train for risk awareness skills. A PC-Based Risk Awareness and Perception Training Program was developed to teach novice drivers about different categories of risky situations likely to be encountered while driving. The program was an interactive multimedia presentation with plan (top down) and perspective views of roadway geometry to illustrate general risky scenarios along with information about type of risks and how attention should be allocated in order to detect them. A set of novice drivers were trained with this program, and scores of the participants were recorded in tests conducted before and after the training. The participants were then evaluated on virtual scenarios developed in a driving simulator. A separate set of untrained novice drivers were also tested on the driving simulator. The eye-movements of the participants were used to evaluate the effects of the training by comparing the fixations of the two groups during designated times and locations in the simulated drives. The ability of the novice driver to recognize risks in static views improved after they completed the training program. Furthermore, the trained novice drivers were significantly more likely to correctly fixate on risk-relevant areas in the simulated driving environment as compared to the untrained drivers.

(13) Effects of Lane Departure Warning on Drowsy Drivers' Performance and State in a Simulator Maria Rimini-Doering, Tobias Altmueller, Ulrich Ladstaetter, Markus Rossmeier (Robert Bosch GmbH — *Germany*)

Driver drowsiness is a major cause of severe accidents, many of which involve a single vehicle lane departure. The objective of the experiment described in this paper is to determine the relationships between drowsiness, lane departure events (LDE) and effects of a warning system. While in case of driver distraction the impact of such a warning system can be tested in real traffic, for reasons of safety (and reproducibility), a laboratory-based driving simulator is being used in this project. The experiments were conducted with a cohort of 63 healthy male subjects aged 22 to 27 driving for about 2.5 hrs in a stimuli-deprived scenario with a six-fold repetition under carefully controlled conditions. Several hundreds micro-sleep episodes were identified in the 53 successful trials by electrooculogram and video signal and confirmed by behavioral analysis; more than 800 lane departure warnings (LDW) occurred in the assisted sub-cohort of 17 drivers. A combined analysis of the LDE with and without LDW shows significant reduction in number, time, departure length and out-of-lane area for the assisted subjects. The timing and design of the warning could furthermore prevent almost 90% of the lane departure events caused by sleepiness.

(14) Cognitive and Psychomotor Correlates of Self-Reported Driving Skills and Behavior Nebi Sümer, H. Belgin Ayvasik (Middle East Technical University — *Turkey*), Nurhan Er, (Ankara University — *Turkey*)

The purpose of this study is to predict self-reported driving and safety skills, traffic violations, and errors by using measures of cognitive and psychomotor abilities. Male drivers (N = 716, mean age = 36.59) were administered the computerized measures of monotonous and selective attention, visual pursuit, eye-hand

coordination, reaction time, and peripheral perception. They also responded to measures of driving skills and behaviors. The results indicated that the indices of visual pursuit, coordination, peripheral perception, and reaction time significantly correlated with driving skills and aberrant behaviors. The results of the sequential regression analyses controlling for age, level of education, and annual km revealed that selective attention negatively and significantly predicted both types of skills and positively predicted violations and errors. Peripheral perception, visual pursuit, and reaction time were the significant predictors of driving skills and errors in the expected direction. Cognitive and psychomotor abilities accounted for 11% to 17% of the variances in the self-reported driving variables. Results suggested that although the magnitude of the associations was relatively weak, psychomotor and cognitive/perceptual abilities are associated with self-reported driving performance and behaviors for young and middle-aged drivers. These findings indicated that certain measures of cognitive and psychomotor abilities, such as peripheral perception and selective attention, have implications for driver assessment systems and should be examined in future research.

(15) An Evaluation of Driving Ability in a Simulator: A Good Predictor of Driving Ability After Stroke? Ann-Helen Patomella, Anders Kottorp (Karolinska Institutet — *Sweden*)

The aim of this pilot-study was to evaluate the predictive quality of a driving evaluation in a simulator for people with stroke. Twenty-seven participants with stroke completed a driving evaluation in a technically advanced driving simulator. The participants also completed an on-road driving evaluation with a pass or fail outcome. Measures generated from the assessment tool, P-Drive, were compared to the on-road driving evaluation, in order to determine a definitive cut-off score. The definitive cut-off score of P-Drive was determined to 1,5 logits, however this score did not show satisfactory sensitivity. Instead of a definitive cut-off score, a cut-off zone of 1,4 to 1,7 logits was recommended. Six drivers within the cut-off zone were recommended for further evaluation of their driving ability.

(16) Withdrawn

(17) Enhancing the Messages Displayed on Dynamic Message Signs Chun-Ming Yang, Dusty Waters, Carmeris C. Cabrera, Jyh-Hone Wang, Charles E. Collyer (University of Rhode Island)

A human factors study was carried out to help enhance ways to communicate with highway motorists through dynamic message signs (DMS). Overhead mounted DMSs have been increasingly used by highway authorities in the United States to present real-time traffic information and travel advice to motorists. It is critical to post sign messages that can be quickly and clearly understood by motorists, especially in high-volume traffic and construction/repair zones. Properly worded and formatted sign messages could spell the difference between comprehension and confusion. Message display factors investigated in the study include display effects, color schemes, wording, and formats. Two approaches were employed in this study. First, a questionnaire survey was developed to collect motorists' preferences regarding various message display factors. Second, a series of lab driving simulation experiments were set up to assess the effects of these factors and their interactions on motorists' comprehension of DMS messages. Study results suggested that static, one-framed messages with more specific wording and no abbreviations were preferred. Amber or green or a green-amber combination were the most favored colors. Younger subjects took less response time to the DMS stimuli with higher accuracy than older subjects. There were no significant gender differences.

(18) Visual Field Defects and the Risk of Motor Vehicle Collisions Among Patients with Glaucoma Gerald McGwin, Jr., Aiyuan Xie, Andrew Mays, Wade Joiner (University of Alabama at Birmingham), Dawn K. DeCarlo (Nova Southeastern University), Tyler Andrew Hall, Cynthia Owsley (University of Alabama at Birmingham)

This study sought to evaluate the association between visual field defects in the central 24° field and motor vehicle collisions (MVC) among patients with glaucoma. A case-control study was conducted on glaucoma patients aged 55 and older being treated at three university-affiliated eye care practices. Cases were patients with a police-reported motor vehicle collision (MVC); controls were those who did not have an MVC. For each patient, an Advanced Glaucoma Intervention Study (AGIS) score was calculated on automated visual fields collected with the 24-2 or 30-2 programs. Demographic, behavioral, driving and clinical characteristics were obtained via chart abstractions and a telephone survey. With respect to the better eye AGIS score, compared to patients with no visual field defect, those with severe defects (scores 12-20) had an increased risk of MVC (odds ratio [OR] 3.2, 95% confidence interval [CI] 0.9–10.4), although this association was not statistically significant (p=0.0576). Moderate (6-11) or minor field defects (1-5) in the better eye were not associated with the risk of crash involvement. For the worse eye, patients with moderate and severe field defects were at significantly increased risk of a MVC (OR 3.6, 95% CI 1.4-9.4 and OR 4.4, 95% CI 1.6-12.4 respectively) compared to those with no defects. Minor field defects in the worse eye did not increase MVC risk (OR 1.3,

95% CI 0.5-3.4). Glaucoma patients with moderate or severe visual field impairment in the central 24° radius field in the worse functioning eye are at increased risk for involvement in a vehicle crash.

(19) Verbal Collision Avoidance Messages of Varying Perceived Urgency Reduce Crashes in High Risk Scenarios Carryl L. Baldwin, Jennifer F. May (Old Dominion University)

Collision Avoidance Systems (CASs) are increasingly being installed in motor vehicles. Concurrently, verbal warnings are increasingly utilized in aviation, surface transportation, and medical environments. The current driving simulation investigation examined crash avoidance behaviors in high risk driving situations and crash rate reduction as a function of exposure to different types of verbal CAS messages. CAS messages varied in presentation level (PL) and signal word. Post-drive ratings of perceived urgency, alerting effectiveness, and annoyance were also examined. The type of CAS warning presented resulted in significant differences in appropriate crash avoidance behaviors and crash rates. In the current paradigm, the most effective CAS warnings were those of moderate PU, specifically the low PU signal word "notice" presented at high PL and the high PU signal word "danger" presented at low PL. Results are discussed in terms of their implications for CAS warning design and hazard matching applicability.

(20) Withdrawn

(21) Tracking Driver Eye Movements at Permissive Left-Turns Michael A. Knodler, Jr. (University of Massachusetts, Amherst), David A. Noyce (University of Wisconsin, Madison)

This analysis sought to identify the sources of information used by left-turning drivers. To complete the experiment, a virtual network of signalized intersections was created for use in a driving simulator equipped with head and eye tracking equipment. Fourteen drivers were recruited to participate in the experiment, which included two independent variables (permissive signal indication and presence of opposing traffic). The primary dependent variable was the associated eye movements at permissive left-turns, including the magnitude of time focused on each potential cue and the pattern in which cues were detected. To complete the analysis, eye movements were tracked and the screen was divided into "areas of interest," which coincided with potential cues used in the completion of a permissive left turn. For each permissive scenario, drivers used more total cues when no opposing traffic was present. Specifically, in the absence of opposing traffic, drivers fixated on a wider array of available information. When opposing traffic was present, drivers spent a majority of time focused on opposing traffic and would use this as a base point from which they would glance at other data sources. Overall, drivers looked at least once at the protected/permissive left-turn (PPLT) signal display and the opposing traffic stream. Drivers tended to scan the intersection from right to left, after initially locating the PPLT signal display and opposing traffic and/or stop bar area. The results of the eye movement analysis are consistent with data obtained in a follow-up static evaluation.

(22) Age Related Decrements in Steering Control: The Effects of Landmark and Optical Flow Information Rui Ni, George J. Andersen (University of California, Riverside), Sean McEvoy, Matthew Rizzo (University of Iowa)

This study examined age related decrements in the use of optical flow and landmark information for the control of steering. Older and younger drivers viewed computer generated displays simulating vehicle motion through a random dot ground plane scene. The horizontal position of the driver was perturbed according a sum of sines function and the driver had to keep steering straight (resembling the task of steering a car on a gusty day). On half the trials, landmark information was presented by color coding one of the dots on the ground plane. Overall, older drivers showed greater steering error magnitude (RMS error) than younger drivers. Unlike the younger drivers, the older drivers showed no reduction in steering errors when landmark information was present. These results suggest that older drivers are more reliant on optical flow information for controlling a vehicle and have a reduced ability to use alternative sources of information, such as landmarks, for steering control.

(23) Psychophysiological Measures of Driver Distraction and Workload While Intoxicated Michael E. Rakauskas, Nicholas J. Ward, Edward Bernat, Meredith Cadwallader, Christopher Patrick (University of Minnesota), Dick de Waard (University of Groningen — *The Netherlands*)

The crash risk associated with cell phone use while driving is a contentious issue. Many states are introducing Advanced Traveler Information Systems (ATIS) that may be accessed with cell phones while driving (e.g., 511 Traveler Information Services). In these contexts, there is a need for relevant research to determine the risk of cell phone use. This study compared driver performance while conversing on a hands-free cell phone to conditions of operating common in-vehicle controls (e.g., radio, fan, air conditioning) and alcohol intoxication (BAC 0.08). In addition, the study examined the combined effects of being distracted and

being intoxicated given that there may be a higher risk of a crash if the driver engages in a combination of risk factors. During simulated traffic scenarios, resource allocation was assessed through an event-related potential (ERP) novelty oddball paradigm. Intoxicated drivers were less attentive to all stimuli and drivers engaged in secondary tasks had weaker responses to unexpected novel sounds in brain regions associated with evaluative processing. Drivers conversing on the cell phone and in-vehicle tasks while sober had *lower accuracy* during the target tone task than intoxicated drivers not completing any secondary task.

(24) Workload Changes in Teenaged Drivers Driving with Distractions Renee F. Slick, Elizabeth T. Cady, Tuan Q. Tran (Kansas State University)

Workload refers to the amount of cognitive resources necessary to perform a task, and it can be manipulated by incorporating secondary tasks into a primary task such as driving. The present study incorporated answering a phone and removing a plastic bottle top into a driving task for teen drivers. Results showed few performance differences between driving with and without distractions, although subjective workload did increase for the drive that included distractions compared to the non-distraction drive. This indicates that teens may be able to maintain driving performance while performing secondary tasks, although their workload appears to increase.

(25) Driver Assessment with Measures of Continuous Control Behavior R. Wade Allen (Systems Technology, Inc.), Thomas D. Marcotte (University of California at San Diego), Theodore J. Rosenthal, Bimal L. Aponso (Systems Technology, Inc.)

This paper reviews past research on stimulus/response analysis methods in continuous control tasks, and describes procedures for specifically measuring driver behavior in a car following task. Example driving simulator data is given for drivers with disease and drug impairments. The data processing methods are summarized and example results are given to demonstrate the data analysis approach. Analysis of driver steering and speed control behavior have been used to identify normal highway operations and effects of various impairments, including drugs, alcohol, fatigue and medical conditions. Typical measures might include characteristics of control (steering, throttle, brake) activity, such as control reversals and expected values such as mean and standard deviation. More powerful time series analysis methods look at the relationship between stimulus and response variables. Fourier analysis procedures have been used to carry out stimulus/response relationships, such as steering response to wind gusts and roadway curvature, and speed response to lead vehicle speed variations. These methods allow the analysis of driver time delay in responding to stimulus inputs, and the correlation of driver response to the stimulus input. Typically, driver impairments lead to responses with increased time delay and decreased correlation.

(26) Matching In-Car Voice with Driver State: Impact on Attitude and Driving Performance Ing-Marie Jonsson (Toyota Information Technology Center), Clifford Nass (Stanford University), Helen Harris (Toyota Information Technology Center), Leila Takayama (Stanford University)

This study examines whether characteristics of a car voice can influence driver behavior and attitudes, and furthermore, if the driver's emotional state will influence the perception of the car voice. Participants in a 2 (driver emotion: happy or upset) x 2 (car voice emotion: energetic or subdued) experimental study, had emotion induced by video clips and then spent 20 minutes using a driving simulator. While they were driving, a voice in the car spoke 36 questions (e.g., "Have we passed the sign for Lucia yet?") and comments ("My favorite part of this drive is the lighthouse.") in either an energetic or subdued voice. Participants were invited to interact with the car voice. Matching the car voice to the drivers' emotions had enormous consequences. Drivers who interacted with voices that matched their own emotional state had less than half as many accidents on average as drivers who interacted with mismatched voices! Drivers paired with matched voices also communicated much more with the voice (the voice said exactly the same thing in all conditions). The effects of matching emotion versus mismatching emotion were so powerful that neither driver emotion nor gender had an expected effect on driving performance. There was a slight tendency for happy drivers and female drivers to be better drivers, even though this effect was minimal compared to the effects of matching. In other words, finding the appropriate in-car voice for the driver's emotion stood out as the most critical factor in enabling a safe driving experience.

(27) Assessing Driver Fitness to Participate in FHWA Field Experimentation at Night John A. Molino (Science Applications International Corporation), Kenneth S. Opiela (Federal Highway Administration), Bryan J. Katz (Science Applications International Corporation), M. Joseph Moyer (Federal Highway Administration)

A Driving Fitness Form was developed to ensure that drivers are ready to participate in field driving experiments at night. The form was tested in a field experiment conducted in Delta, Pennsylvania, during

August 2004. The field experiment was part of a cooperative research program conducted by the Federal Highway Administration and the Pennsylvania Department of Transportation. Sixteen research participants drove a curvy stretch of rural two-lane highway each night for eight nights with different pavement markings and markers on the roadway. Partly due to the Driving Fitness Form, the experiment was completed successfully by all participants without any incidents or crashes. The Driving Fitness Form performed well, and summary data were collected on the sample of 16 drivers.

(28) The Impact of Cognitive Deficits and Spasticity on Driving Simulator Performance in Multiple Sclerosis Thomas D. Marcotte (University of California), Theodore J. Rosenthal (Systems Technology, Inc.), Jody Corey-Bloom, Erica Roberts, Sara Lampinen (University of California), R. Wade Allen (Systems Technology, Inc.)

Multiple Sclerosis (MS) is a demyelinating disease that can result in numerous sequelae. Although spasticity and cognitive dysfunction are common in MS, few studies have examined the impact of both factors on driving abilities in persons with physical impairments. The present study assessed driving performance in control participants and MS patients with documented spasticity using two brief simulations designed to measure lane tracking (under high cognitive load) and car following behavior. Seventeen MS patients and nine controls participated in the study. The MS cohort exhibited a broad range of cognitive functioning and disability. Eight of the MS patients had significant spasticity in their right knee based upon the Modified Ashworth Spasticity Scale. MS patients had greater difficulty on the simulations, particularly on the car following task. MS participants also tended to drive at higher speeds than the control participants. Within the MS cohort, cognitive dysfunction was most strongly associated with lane tracking decrements, whereas the possible relationship between cognitive function and car following behavior was eclipsed by lower limb spasticity. Spastic individuals had greater difficulty mirroring speed changes in the lead car, and were approximately one second slower in responding to its accelerations and decelerations. The current simulations provide important data regarding the impact various MS sequelae may have on driving performance, and may ultimately lead to clinical recommendations regarding specific driving behaviors and their associated risks.

(29) Change Detection Performance Under Divided Attention with Dynamic Driving Scenarios Yi-Ching Lee, John D. Lee, Linda Ng Boyle (University of Iowa)

This study investigated the effect of cognitive load on the relationship between confidence in detecting changes and actual change-detection performance. Two experiments simulated glancing away from the roadway by periodically blanking the driver's view for one second. Experiments were conducted in a driving simulator where participants were asked to detect changes in the location and appearance of other vehicles while driving on a multi-lane suburban roadway. In addition, cognitive load was imposed using messages that participants were asked to listen to and answer questions about. Participants' sensitivity (d') to vehicle changes was calculated and was compared with subjective ratings of confidence in detecting those changes. Results indicated a positive relationship between d' and confidence, suggesting that participants were aware of the factors that influenced their change-detection performance. However, the strength of the relationship was situation-dependent. The strength of the relationship decreased when the detection task was more difficult and in the presence of cognitive load.

(30) Driver Workload Management During Cell Phone Conversations Chip Wood, Joshua Hurwitz (Motorola Labs)

This study tested if intelligently suspending cell phone conversations during demanding driving situations would improve driver's performance and lessen subjective workload. Using a simulator, drivers followed a lead car approximately 2 seconds ahead and braking randomly. The drivers engaged in spontaneous "Neutral," "Intense," or "No" cell phone conversations with the experimenter, who sustained all conversations with scripted non-directive utterances. When the lead car started to decelerate, the conversations were suspended or not. Objective driving performance and subjective "workload" estimates showed significant differences between conversation topic types. Engaging in an "Intense" conversation during deceleration produced (1) smaller decreases in forward velocity, and (2) delays in releasing the accelerator, applying the brake and decelerating. Suspending "Intense" conversations counteracted these effects, producing larger decreases in forward velocity, and speeding up drivers' responses on the vehicle controls. Furthermore, suspending conversations increased drivers' headways and temporal distances with the lead car. The results show that cell phone conversation intensity has significant effects on both performance and workload. The results also show positive effects of suspending cell phone conversations during critical driving situations, perhaps counteracting the negative effects of the workload imposed by the conversations. Subjective ratings and value judgments for this system indicate generally positive assessments of the system.

(31) Simulator Performance vs. Neurophysiologic Monitoring: Which is More Relevant to Assess Driving Impairment? Henry J. Moller, Leonid Kayumov, Eric L. Bulmash, Colin M. Shapiro, Sidney H. Kennedy (Toronto Western Hospital, University of Toronto — *Canada*)

In a pilot study of healthy individuals, we reported on circadian variation in driving simulator performance and neurophysiologic evidence of sleep intrusion into consciousness. We expanded this "normative" sample and ran a prospective comparison study with a sample of clinical patients reporting excessive daytime sleepiness (EDS). Thirty healthy adults (mean age of 31.3 $\pm$ 11.5) and 27 EDS patients (47.0 $\pm$ 13.7) with valid driver's licenses were included. Subjects performed four intentionally soporific 30-minute driving simulations at two-hour intervals while undergoing continuous EEG monitoring for microsleep (MS) episodes. Measured variables included: subjective ratings of sleepiness and alertness prior to each drive, lane position accuracy, mean speed, speed deviation, mean reaction time (RT) to "virtual" wind gusts as well as off-road events, or "crashes." Significant between-group differences were found between subjective ratings, RT, crashes and MS. Objective EEG MS monitoring demonstrated escalating sleep intrusion with repeated drives in both groups, but particularly for the EDS group. Total crash rates were three times higher in EDS patients, with an increasing trend in the late afternoon. EEG monitoring was able to document increased propensity towards MS episodes in patients with EDS, which we suggest is causative in creating this impairment. It is unclear whether a neurophysiologic or simulator approach captures impairment due to sleepiness with greater sensitivity and specificity. A hybrid approach combining data from both sources may be optimal.

(32) Assessment of a Driver Interface for Lateral Drift and Curve Speed Warning Systems: Mixed Results for Auditory and Haptic Warnings Tina Brunetti Sayer (Visteon Corporation), James R. Sayer, Joel M. Devonshire (The University of Michigan Transportation Research Institute)

Lateral Drift Warning (LDW) and Curve Speed Warning (CSW) systems were developed to address two main critical events in run-off-road crashes, which are road edge departure and excessive speed. The LDW system used a two-stage alert system, with the first stage activating when the driver departed a lane with a dashed boundary and the imminent, or second stage, when departing a lane with a solid boundary. The CSW also employed a two-stage alert, with the level based on the degree of over-speed for the upcoming curve. The haptic modality, in the form of seat vibration, was chosen as the first level warning for both systems, and auditory was chosen as the second or most urgent level. The two systems were installed in a fleet of instrumented vehicles and loaned to 78 randomly selected licensed drivers for approximately four weeks. Debriefing questions detailing the driver's experience with the system were administered and analyzed in a two by two design of modality by system. After examination of both the statistical results and the open-ended comments, the question of which modality is most appropriate is still uncertain. Each modality had positive aspects. Haptic does not alert the entire car and participants also considered it less distracting. Auditory provided better recognition between warnings and participants were better able to understand the meaning and the required response for each warning.

(33) Withdrawn

SESSION 4 – Lectures
Driver Assistance Systems
Wednesday, June 29, 2005
8:15 AM – 10:00 AM

(34) Comparison Between Visual and Tactile Signal Detection Tasks Applied to the Safety Assessment of In-Vehicle Information Systems Johan Engström, Nina Åberg, Emma Johansson (Volvo Technology Corporation — *Sweden*), Jakob Hammarbäck (Uppsala — *Sweden*)

The Peripheral Detection Task (PDT) is a widely applied method for safety assessment of in-vehicle information systems (IVIS). In this study, the PDT was compared to a Tactile Detection Task (TDT) where the visual stimulus used for the PDT was replaced by tactile vibrators, placed on the wrists. The sensitivity of the two methods to different cognitive and visual secondary tasks was investigated in different real-world driving conditions. The results showed that both methods were sensitive to visual and cognitive secondary task load in a range of different driving environments. The sensitivity was generally stronger for TDT than PDT. It was concluded that the TDT could be viable alternative to the PDT for IVIS assessment.

(35) Road-to-Lab: Validation of the Static Load Test for Predicting On-Road Driving Performance While Using Advanced In-Vehicle Information and Communication Devices Richard Young, Bijaya Aryal, Marius Muresan, Xuru Ding, Steve Oja, S. Noel Simpson (General Motors Engineering)

Information, communication, and navigation devices need to be evaluated for ease-of-use and safety while driving. Lab tests, if validated, can evaluate prototype designs faster, more economically, and earlier than on-road tests. The *Static Load Test* was evaluated for its ability to predict on-road driver performance while using in-vehicle devices. In this test, participants perform various in-vehicle tasks in a lab while viewing a videotaped road scene on a monitor, tapping a brake pedal when a central or peripheral light is observed. For the on-road comparison test, the device, tasks, and lights are the same, but the participants also drive the vehicle while performing the tasks and responding to the lights. In both the lab and road tests, ten driver performance variables were measured. Our goal was to produce a linear model to predict an on-road variable from the lab data with low residual error, high percent variance explained, and few errors in classifying tasks as meeting or not meeting on-road driver performance criteria. Separate test data from a replicated Static Load Test at an independent lab were used to further validate the models. The results indicate a simple, inexpensive, and low-fidelity Static Load Test can accurately predict a number of on-road driver performance variables suitable for assessing the safety and ease-of-use of advanced in-vehicle devices while driving.

(36) Driver Distraction and Reliance: Adaptive Cruise Control in the Context of Sensor Reliability and Algorithm Limits Bobbie D. Seppelt, Monica N. Lees, John D. Lee (University of Iowa)

This study investigated how system failures influenced drivers' reliance on Adaptive Cruise Control (ACC). A medium-fidelity driving simulator was used to evaluate the effect of driving condition (traffic, rain) and automation (manual control, ACC) on headway maintenance and brake response. In conditions of rain, the signal continuity of the ACC sensors was degraded and in conditions of heavy traffic, the braking limits of the ACC system were exceeded. Dependent variables included response time to lead vehicle (LV) braking, number of collisions, and both time headway (THW) and time-to-collision (TTC) at instant of the brake response. Throughout the drive, a continuous (forced-paced) secondary task was introduced to determine how an in-vehicle task interacted with ACC reliance. Results showed that the failure type influenced driver's reliance on ACC with drivers relying more on ACC in traffic periods than in rain periods. ACC appeared to offer a safety benefit when drivers were distracted with complex mental tasks in periods of heavy traffic.

(37) Driver Distraction: A Naturalistic Observation of Secondary Behaviors With the Use of Driver Assistance Systems James R. Sayer, Mary Lynn Mefford, Kezia Shirkey, Jessica Lantz (University of Michigan Transportation Research Institute)

This report describes the naturalistic observation of secondary behaviors performed by 66 drivers who took part in the Automotive Collision Avoidance System Field Operational Test (ACAS FOT). The ACAS FOT included two driver assistance systems, adaptive cruise control (ACC) and forward collision warning (FCW). Each driver participated in both baseline (no driver assistance systems for one week) and treatment conditions (both ACC and FCW available for 3 weeks). The method employed was to sub-sample video data, and code drivers' secondary behaviors using 4 s video clips of the driver, collected every 5 minutes. Eight-hundred and ninety video clips were reviewed and coded while participants drove manually, with conventional cruise control, ACC, and FCW. The results show that drivers who took part in the field test were no more likely to engage in secondary behaviors when driving with ACC and FCW in comparison to manual control. When the driver assistance systems became available to the participants, there was an increase in the number of conversations drivers had with passengers, probably related to the driver explaining the novel ACAS system to passengers. The results have important implications in that, at least for the duration of exposure examined, they counter the concern often raised that driver assistance systems will promote driver distraction, lapses in attention or modification in perceived risk.

SESSION 5 – Lectures
Medical Factors
Wednesday, June 29, 2005
10:15 AM – 12:10 PM

Driving Assessment in Maine — A Medical Perspective Bruce Sigsbee, MD (American Academy of Neurology, senior member)

(38) Unsafe Rear-End Collision Avoidance in Alzheimer's Disease Ergun Y. Uc, Matthew Rizzo, Steven W. Anderson, Qian Shi, Jeffrey D. Dawson (University of Iowa)

Avoiding a crash requires continuous monitoring of neighboring vehicles, and anticipating and adjusting to changes in their speeds and positions. This relies on visual perception, attention, memory, recognition of contextual cues such as approaching an intersection, and executive functions (decision making and implementation). AD impairs these processes. Sixty-one subjects with probable AD of mild severity, and 115 neurologically normal older adults were tested on a battery of visual, cognitive, and motor tests of abilities critical to safe automobile driving. Participants also drove in a high-fidelity driving simulator where, after a segment of uneventful driving, they suddenly encountered a lead vehicle stopped at a 4-way intersection. The main dependent measure was the occurrence of an "improper response," which included crashing into the lead vehicle, swerving out of the traffic lane, or stopping abruptly and prematurely. Eighty-nine per cent of drivers with AD responded improperly to the stopped lead vehicle at the intersection compared to 65% of normal controls. Crash rates were similar in AD and normal controls (5% and 3%, respectively, P=0.4188), however drivers with AD were at higher risk of stopping abruptly (P<0.0001) or prematurely (P=0.0115). These differences persisted after adjusting for differences in age, education, driving exposure, or level of simulator discomfort. The drivers with AD performed worse in almost all cognitive, visual, and motor tests on the battery, consistent with their mild dementia.

(39) Innovative Fatigue Management Approach in the Trucking Industry Anneke Heitmann, Rainer Guttkuhn (Circadian Technologies, Inc.), Dean Croke (FleetRisk Advisors, LLC), Martin Moore-Ede (Circadian Technologies, Inc.)

Driver fatigue, a major safety problem in the transportation industry, is strongly influenced by employee work and sleep schedules. The work and rest hours of truck drivers are regulated by Hours-of-Service (HoS) rules in the U.S, but it has become increasingly apparent these rules are inconsistent with the science of sleep and fatigue. We present and assess an innovative alternative safety management system, which takes a pro-active, science-based complimentary approach. This Risk-Informed Performance-Based (RIPB) safety system was implemented at one major trucking company, and involved the training of managers and dispatchers on scientific aspects of work assignments and a regular feedback system that assessed the fatigue risk of work schedules. Driver fatigue was assessed using the Circadian Alertness Simulator (CAS) software system for simulating sleep and alertness based on work-rest patterns (Moore-Ede et al., 2004). Each driver was assigned a cumulative fatigue risk score based on logbook data processed for multiple one-month periods before and after the implementation of the system. The implementation of the RIPB safety management system resulted in a significant reduction of fatigue risk scores, a reduction of the rate and costs of accidents, and improvement of other operational parameters. The success of the RIPB system was sustained over an extended time period of more than three years.

(40) Quantifying the Benefits of Enhancing Medications on Driving Performance: Comparing OROS® MPH vs. se-AMPH ER® in Driving Safety of ADHD Teenagers as Case Example Frances P. Thorndike, Daniel J. Cox, R. Larry Merkel, Melissa Moore, Roger Burket, Carrie Muller, Boris Kovatchev (University of Virginia Health System)

Driving simulation is the best way to safely and reliably assess the impact of medical parameters on driving. Driving performance should be evaluated using a composite driving score, since the pathway to impaired driving is highly idiosyncratic and may involve any number of individual driving parameters. Although simulators still do not have accepted standards for hardware, driving scenarios, or performance variables, we propose a partial solution to permit comparisons of composite scores across simulators. We recommend a standardized average effect size, which we call the Impaired Driving Score (IDS). We describe how the IDS is calculated, and present data comparing 16 male and 15 female teenage drivers with ADHD in a double-blind, placebo-controlled, cross-over study. We compared the effects of 72 mg of OROS® MPH (Concerta®), 30mg of se-AMPH XR® (Adderall XR®) and placebo on driving performance. Twice, participants drove

our Atari Research Driving Simulator at 5, 8, and 11 pm under all three medication conditions. The primary outcome measure was IDS. Performance on Concerta® was superior to placebo (p=.005), while Adderall XR® was not (p=.14). When analyzed separately, only one variable was statistically significant (seconds spent speeding, p<.01). Composite driving scores permit the comparison of driving performance across various experimental conditions and with a normative database

(41) Cognitive Abilities Related to Driving Performance in a Simulator and Crashing on the Road Steven W. Anderson, Matthew Rizzo, Qian Shi, Ergun Y. Uc, Jeffrey D. Dawson (University of Iowa)

This study examined the relationships between performances on standardized neuropsychological measures of cognitive abilities, simulated driving performance, and state crash records in drivers with cognitive decline due to aging and dementia. Participants were 202 experienced older adult drivers ages 55 years and older: 70 had mild dementia due to probable early Alzheimer's disease and 132 had no neurological disease. All completed a battery of neuropsychological tests and drove on a high fidelity simulator. The participants' State Department of Transportation driving records were monitored for up to two years after testing. The simulator composite score, reflecting overall driving ability, was significantly correlated with overall cognitive ability, as indexed by the neuropsychology composite score, as well as with individual cognitive tests of attention, memory, visuospatial and visuomotor abilities. Drivers who crashed during an intersection incursion scenario performed significantly worse on the composite measure of cognitive function. Crashers had specific cognitive deficits on measures of visuomotor abilities and attention. Memory test performances for both verbal information and visual material were associated with subsequent on-road crashes. The findings support the validity of driving simulation as a safe means of evaluating a range of driving responses that cannot be tested on the road, and suggest that relatively simple and inexpensive neuropsychological tests of specific cognitive abilities could be used to help evaluate older drivers' risk of unsafe driving.

SESSION 6 – Presentation and Panel Discussion
Naturalistic Driving and the Virginia Tech 100 Car Study
Wednesday, June 29, 2005
1:45 PM – 3:25 PM

SESSION 7 – Poster Session B
Wednesday, June 29, 2005
3:30 PM – 5:00 PM

(42) Examination of the Efficacy of Proximity Warning Devices for Young and Older Drivers Arthur F. Kramer, Nicholas D. Cassavaugh, William J. Horrey, Ensar Becic, Jeffery Mayhugh (University of Illinois)

This study examined the efficacy of uni- and multi-modal proximity warning devices for forward object collision and side-object detection. Two experiments were conducted with 20 young (18 to 30 years of age) and 20 older (61 to 80 years of age) healthy and high functioning drivers. In each, participants drove a series of brief (~ 4 minute) highway scenarios with temporally unpredictable forward and side collision events. The experiments used a fixed-base Drive Safety simulator with a 135-degree wrap-around forward field and a 135-degree rear field. Light cross-winds were included in Experiment 1, and heavier crosswinds in Experiment 2. A secondary visual read-out task was also included in the second experiment. We focused on the response time (as measured by steering wheel deflections or removal of the foot from the accelerator) to potential collision events, as well as the number of collisions in different experimental conditions. In both experiments, the auditory+visual warning device produced the most rapid response and resulted in the fewest collisions. Older adults responded just as quickly as younger adults to the potential collision events in both experiments. Older adults also displayed the same performance benefits (in terms of speeded response time and reductions in collisions) from the proximity warning devices, particularly the auditory+visual device. We conclude that proximity warning devices, particularly auditory+visual devices, can substantially speed response time and reduce potential collisions in simulated driving.

(43) Effect of Simulator Training on Driving After Stroke: A Randomized Controlled Trial Abiodun Emmanuel Akinwuntan, Willy De Weerdt, Hilde Feys, Jan Pauwels (Katholieke Universiteit Leuven — *Belgium*), Guido Baten, Patricia Arno (CARA, Belgian Road Safety Institute — *Belgium*), Carlotte Kiekens (University Hospital Pellenberg — *Belgium*)

Neurologically impaired persons seem to benefit from driving training programs, but there is no convincing evidence to support this notion. We investigated the effect of simulator-based training on driving after

stroke. Eighty-three first ever sub-acute stroke patients entered a 5-week, 15-hour training program in which they were randomly allocated to either an experimental (simulator-based training) or control (driving-related cognitive tasks) group. Performance in off-road evaluations and an on-road test were used to assess the driving ability of subjects pre- and post-training. Outcome of an official pre-driving assessment administered 6 to 9 months post stroke were also considered. Both groups improved in a visual and many neuropsychological evaluations and in the on-road test after training. There were no significant differences between both groups in improvements from pre- to post-training except in the "road sign recognition test," where experimental subjects improved more. Statistically significant improvements in the three-class decision ("fit to drive," "temporarily unfit to drive" and "unfit to drive") were found for the experimental group. Academic qualification and overall disability together determined subjects who benefited most from the simulator-based training. Significantly more experimental subjects (73%) than controls (42%) passed the follow-up official pre-driving assessment and were legally allowed to resume driving..

(44) Can Sea Bands® Be Used to Mitigate Simulator Sickness? Amy D. Wesley (UGS Corporation), Tina Brunetti Sayer (Van Buren Township, Michigan), Steve Tengler (Nissan North America)

A North American tier-one automotive supplier (TOAS) conducted a study in 2002 using a vehicle driving simulator to study simulator sickness. The goals of the study were twofold: (a) determine a screening process to identify those individuals who should be excluded from future simulator studies due to their susceptibility to simulator sickness and (b) explore a mitigation technique to lessen the severity of simulator sickness symptoms using the FDA-approved Sea Bands® acupressure wrist bands. The study revealed that prior experience with motion sickness is not necessarily a good predictor of who will become sick in a simulator, but one's own perception of susceptibility to motion and simulator sicknesses may be a reliable predictor. It also revealed that the acupressure wrist bands may be an effective method for managing simulator sickness among older participants.

(45) Gaze Behavior During Simulated Driving: Elements for a Visual Driving Aid Daniel R. Mestre (UMR Mouvement et Perception, CNRS/Universite de la Mediterranee — *France*), Franck Mars (Institut de Recherche en Communications et Cybernetique de Nantes — *France*), Sylvain Durand (UMR Mouvement et Perception, CNRS/Universite de la Mediterranee — *France*), Fabrice Vienne, Stéphane Espié (Modelisations, Simulations et Simulateurs de Conduite —*France*)

Analyses of optic flow due to observer self-motion and analyses of the driver's gazing behavior during curve driving have suggested that the driver has a tendency to look at a location close to the tangent point on the inside edge of the road. Psychophysical experiments have further demonstrated that this visual strategy can be partly explained as an optimization of information pick-up. The main objective of the present study was to investigate, in an interactive simulation context, if this perceptual strategy might be used to define a visual aid for curve driving. In the framework of the French ARCOS project (Research action for secure driving; www.arcos2004.com), we used a mini-simulator developed by INRETS (MSIS-CIR group) in collaboration with FAROS company, with two main original characteristics: (1) during curve driving, the tangent point can be calculated and inserted in the visual scene in real-time and (2) a real-time eye-recording system (EYELINK,® SMI) allows us to evaluate the relationships between driving performance, gaze direction and the on-line presentation of the tangent point.

(46) Performing E-mail Tasks While Driving: The Impact of Speech-Based Tasks on Visual Detection Joanne L. Harbluk, Simone Lalande (Transport Canada — *Canada*)

Drivers listened and responded to e-mail messages presented in a human voice and two types of synthetic speech (concatenative and formant) while driving a simulator. Their performance for visual event detection, vehicle control, and message responses was assessed. Results indicated that the type of speech output system affected drivers' detection of visual changes in the driving environment; they were poorer at detecting these events when either of the synthetic speech systems was used. No effects of the speech system type or e-mail message difficulty were observed on the vehicle control measures. Drivers were also less accurate when responding to message content for messages presented in synthetic speech (concatenative) compared with recorded human voice. Subjective ratings indicated that listening to the synthetic speech required more mental effort than listening to the recorded human voice. Preference ratings for the interfaces decreased as mental effort increased. The results indicated that although drivers were not required to direct their attention away from the road, using the speech-based interfaces reduced drivers' visual event detection and their response accuracy to messages themselves.

(47) Road Environment and Driver Fatigue Tal Oran-Gilad, Peter A. Hancock (University of Central Florida)

We distinguish between fatigue caused by the demands of the driving task itself (see Hancock & Desmond, 2001) from the standard traditional approach that links fatigue predominately to the lack of sleep. Fatigue can be caused by two sources: (1) the driver's initial state before starting the drive, or (2) the characteristics of the drive and the road environment; both sources can have a cumulative effect. It is not clear what principles are involved in making one road environment more prone to inducing driver fatigue than another. For the purpose of the current presentation we provide empirical data on road environment and driver fatigue summarized from a series of three experiments that the first author has conducted at Ben-Gurion University (see Oron-Gilad, 2003; Oron-Gilad, et al., 2001). Those are examined in relation to the Hancock and Warm (1989) model of adaptability. The most significant and consistent findings of the three experiment is in the way that fatigue is reflected in driving performance across different road environments. These findings suggest that drivers are flexible in the way they handle fatigue over the course of time. They can adopt different strategies to compensate for their performance decrement, by focusing efforts on critical elements of each different type of roadway. Understanding of this dependency of fatigue symptoms on road conditions is of especial relevance to designers of technological fatigue countermeasures as well as those of future roadway systems.

(48) Toward a Driving Competency Assessment Encouraging Elderly's Automobility: A French Point of View Catherine Gabaude, Laurence Paire-Ficout (INRETS, LESCOT — *France*)

The purpose of this paper is to suggest a methodology for approaching French elderly driver assessments. More precisely, the objective is to evaluate the impact of visual and cognitive declines in older drivers on real road driving performances. A case control study was conducted with 40 senior drivers (aged between 61 to 80 years old) recruited via their insurance company: 20 case volunteers who had caused 3 or more accidents during a three-year period and 20 control volunteers who had caused no accidents during the same period. The experiment consisted of non-driving laboratory tests, including visual and cognitive tests, and a driving assessment in a real traffic situation. Results showed that, compared to the control group, elderly drivers with a history of accidents, have poorer performance on the cognitive tests. Moreover, data from the multiple regression analysis showed that the two measures entering the model were Zazzo time and movement perception (age and group being controlled). Some considerations that shape construction of a driving assessment are discussed. We discuss the fact that such an approach can be used to estimate the driving skills of drivers, not to deliver an aptitude or inaptitude certificate, but to adapt the advice given to drivers.

(49) Driving Simulators for Commercial Truck Drivers — Humans in the Loop Talleah Allen, Ronald Tarr (University of Central Florida)

This paper reports the findings of a research study that addresses differences in human performance outcomes based on various driving simulators, as measured by comparison of scores resulting from completion of the Virtual Check Ride System (VCRS), a simulator-based, blended learning Commercial Drivers License (CDL) application. The objective of the project was to examine human performance across four different levels of driving simulators and to determine if driving simulators can contribute to human performance improvement. Each level of simulator has a definite set of tasks that can be performed on it to enhance human performance. By identifying which level of driving simulator is the best fit according to the skill, knowledge, and attitude task element, we can now prescribe for diagnostic, testing, pre-hire, remediation, safety issues and advanced driving skills.

(50) The Concept of Cooperative Automation in Cars: Results from the Experiment "Overtaking on Highways" Lars Biester (Robert Bosch GmbH — *Germany*)

As the interaction between human and machine continues to change, due to the increase of system functionalities, a concept of human-car cooperation covering the effects of this change has been developed. Proceeding from this concept, an initial analysis of the actual human-car interaction including the wishes of today's drivers will be the main subject of this paper. An experimental design, based on the concept of cooperation and preliminary studies, was developed. First results on the quality of cooperation, situational awareness and trust indicate the concept's profound adaptableness to future human-car interactions.

(51) What Drivers Don't Know; or Don't Care S. David Leonard (University of Georgia), G.William Hill IV, Jeffrey A. Overdorff (Kennesaw State University)

Many behaviors of drivers and passengers in automobiles are not the safest practices that might be used. Three surveys were conducted to determine whether or not some of the behaviors examined previously by us and other investigators were currently occurring. In addition, we asked the questions of whether or not people knew their behaviors were unsafe and if they were aware of the possible risks, why did they continue to perform the behaviors? Further, information was gathered about the extent to which having experienced a formal driving course affected the responses. With the exception of a few items, the participants indicated some awareness of the risks, but did not show that they understood the relative levels of risk involved in some activities. There was little effect of having taken a formal driving course.

(52) Do In-Vehicle Advance Signs Benefit Older and Younger Driver Intersection Performance? Susan L. Chisholm, Jeff K. Caird, Julie A. Lockhart, Natalie H. Vacha (University of Calgary — *Canada*), Christopher J. Edwards (Virginia Tech Transportation Institute)

An experimental study was conducted to determine if intersection behavior of those 18 to 24 and 65+ benefited from advanced in-vehicle signs presented in a head-up display (HUD) format. The University of Calgary Driving Simulator (UCDS) was used to determine whether intersection performance improved in the presence of several advanced signs or whether unwanted adaptive behaviors occurred (e.g., increasing speed to run the light instead of stopping). In-vehicle signs facilitated an increase in stopping occurrences for both younger and older drivers at intersections with relatively short yellow onsets. In addition, eye movement analysis revealed significant age effects with regard to vertical and horizontal gaze variablity, with younger drivers showing increases in vertical gaze variability compared to the older drivers. Younger drivers also looked more often and had longer percentage of durations fixating on the HUD compared to the older drivers.

(53) Gender Differences in Predicting Unsafe Driving Behaviors in Young Adults Nicole R. Skaar, John E. Williams (University of Northern Iowa)

Past research has uncovered personality influences on dangerous driving behavior and vehicle crashes (Furnham & Saipe, 1993; Matthews, Dorn, & Glendon, 1991). Recently, females between 16 and 20 years of age showed an increase in overall crash rate, while males within the same age group showed a decrease in overall crash rate (NHTSA, 2004; NHTSA, 2002). Adolescent and young adult females have become a critical cohort in the study of unsafe driving behavior. The purpose of this study was to examine gender differences in risky driving behavior and personality influences on these behaviors. Data presented are first year cross-sectional results in a 5-year longitudinal study. Participants were 141 male and female drivers who completed the NEO PI-R, the DDDI and a driving behavior questionnaire. In addition, the driving record of each participant was obtained from the State Department of Transportation. Females reported a higher rate of traffic violations and crashes than males. No personality traits were significantly related to crashes, but Extroversion was positively related to total traffic violations within females. The DDDI scales were not significantly related to traffic violations or vehicle crashes, but gender differences were shown within the risky driving and aggressive driving scales. Gender differences were also shown in the relationship between personality traits and DDDI scales. This data indicates that researchers and insurance companies should make an effort to consider females in their work.

(54) Driving Performance in a Simulator as a Function of Pavement and Shoulder Width, Edgeline Presence, and Oncoming Traffic Susan T. Chrysler, Alicia A. Williams (Texas A&M University System)

Driving simulation has primarily been used to study issues of driver distraction and to evaluate in-vehicle devices. The visualization and driver performance capabilities of simulators can be applied to more traditional traffic engineering problems as well. This project aims to demonstrate the usefulness of a driving simulator in evaluating geometric designs for two-lane roads. Paved surface width has been shown to be correlated with crash rates and travel speeds on two-lane rural roads throughout Texas. The current project examines how travel lane width, edge line striping, and shoulder width affect driver errors on these roadway types. Issues of simulator validity, scenario development, and simulator sickness are discussed.

(55) Evaluating First-time and Infrequent Use of In-Car Navigation Devices Elliott Noel, Blair Nonnecke, Lana Trick (University of Guelph — *Canada*)

Learnability and memorability, important components of usability, are frequently overlooked by existing research with respect to in-car navigation devices. To remedy this, a protocol for evaluating the learnability and memorability of an in-car navigation device is presented. Representative tasks are identified and then used in conjunction with paired-user methods. The protocol is applied effectively to a device and problems are identified.

(56) Adaptation to a Motion-Based and Non-Motion-Based Simulator Renee F. Slick, Tuan Q. Tran, Elizabeth T. Cady (Kansas State University)

This study (N=129, including 59 males and 61 females) examined the issue of realism and motion sickness between motion-based and non-motion-based simulators. Specifically, this research address whether enhancing a driving simulator with motion capabilities increases the realism of the simulator and, if so, does this increase in subjective realism increase participants' vulnerability to motion sickness. Approximately half of the participants drove a motion-based simulator while the other half drove a non-motion-based simulator on four independent drives within an experimental session. Results showed that the motion-based simulator was rated more realistic than the non-motion-based simulator. However, it was also found that participants in the motion-based simulator had higher negative physical health ratings than participants in the non-motion-based simulator. Our results suggest that training programs need to consider the trade-off between realism and motion sickness.

(57) Longitudinal Assessment of Older Drivers in a DMV Setting Karlene K. Ball (University of Alabama at Birmingham), Daniel L. Roenker (Western Kentucky University), Virginia G. Wadley (University of Alabama at Birmingham), Gayla Cissell, Melissa Matthews (Western Kentucky University), David Ball, David Vance, Martha Frankel, Kathy McConnell (University of Alabama at Birmingham)

A brief battery of functional assessments designed to detect crash risk among older drivers was developed and evaluated initially in 1999 in Maryland motor vehicle licensing sites following the routine vision screening exam. This battery contained a number of cognitive tests (e.g., UFOV® subtest 2, the closure subtest of the Motor Free Visual Perception Test (MVPT), Trails A and B), and several physical measures (e.g., Rapid Pace Walk, Head and Neck Rotation, Foot Tap, Arm Reach). Older adults (N=4,173; mean age = 69 years) were approached by the staff after license renewal and asked to help evaluate the brief battery. Of the 4,173 older adults approached, 2,114 individuals 55-96 years of age participated. The original sample of 2,114 participants was invited to come in again, during their five-year license renewal cycle, and the functional tests were administered again. To date, 939 individuals have completed the second screening evaluation. An examination of the crash data from the interval between assessments for these individuals indicates that the same cognitive measures are predictive of at-fault crashes. Furthermore, approximately 10% of those passing the assessment in 1999 are now failing the assessment in 2004. Performance-based cognitive measures are predictive of future at-fault motor vehicle collisions among older adults. Cognitive performance, in particular, is a salient predictor of subsequent crash involvement among older adults. High-risk older drivers can be identified through brief, performance-based measures administered in a DMV setting.

(58) Traffic Violations and Errors: The Effects of Sensation Seeking and Attention H. Belgin Ayvaşik (Middle East Technical University — *Turkey*), Nurhan Er (Ankara University — *Turkey*), Nebi Sümer (Middle East Technical University — *Turkey*)

The purpose of this study was to examine the effects of sensation seeking and attention in traffic violations and errors. Participants were 716 volunteer male drivers from Ankara, Turkey. Drivers were asked to respond to computerized measures of monotonous and selective attention tests, and also to complete the Driver Behavior Questionnaire, Driving Skills Inventory, and Arnett Inventory of Sensation Seeking. We first categorized participants into four groups according to their correct responses of monotonous and selective attention tests using a median-split: Group 1 = low scores on both monotonous and selective attention tests, Group 2 = high scores on both monotonous and selective attention tests, Group 3 = low on monotonous attention and high on selective attention, and Group 4 = high on monotonous attention and low on selective attention. Participants were also classified into two groups regarding their total sensation seeking scores as low and high sensation seekers. A 4 (attention groups) X 2 (sensation seeking groups) MANOVA was conducted on traffic violations and errors as dependent variables. MANOVA analysis indicated that high sensation seekers with high monotonous and selective attention are more likely to have more traffic violations and errors than other groups. Since these drivers also reported lower levels of safety skills than other groups, it could be interpreted as an indication of drivers' overconfidence in their skills and underestimation of the hazards in traffic. Such drivers were more likely to be risk takers in traffic situations throughout.

(59) The Spatial Extent of Attention During Driving George J. Andersen, Rui Ni (University of California, Riverside)

The present study examined the limits of spatial attention during driving using a dual-task performance paradigm. Drivers were asked to follow a lead vehicle that varied in speed while also detecting a light change in an array located above the roadway. Reaction time increased and accuracy decreased as a function of the horizontal location of the light change and the distance, from the driver, of the light change. In addition, RMS error in car following increased immediately following the light change. These results demonstrate that when drivers attend to a centrally located task, their ability to respond to other events varies as a function of horizontal visual angle and distance in the scene.

(60) Got Info? Examining the Consequences of Inaccurate Information Systems Ing-Marie Jonsson, Helen Harris (Toyota InfoTechnology Center), Clifford Nass, Leila Takayama (Stanford University)

It is a desirable goal to balance information given to the user with the potential adverse effects on cognitive processing and perception of information systems. In this experiment, we investigated the minimum level of information accuracy necessary in an in-car information system to elicit positive behavioral and attitudinal responses from the driver. There were 60 participants, and each drove in a simulator for 25 minutes; driving performance data was automatically collected, and drivers later completed questionnaires for attitudinal data. Participants were divided into three groups of drivers: a group driving with a 100% accurate system, another driving with a 70% accurate system, and one group driving without an in-car system. There was a definite positive effect on driving performance with the in-car system, and results show that decreasing the accuracy of the system decreases both the driving performance and the trust of the in-car system. Data also indicates that female drivers have a higher tolerance of inaccuracies in an in-car system; design implications are discussed.

(61) Withdrawn

(62) The Relation Between Speed-Lane Choice and Road Accidents in Jordan Lina Shbeeb, Wa'el Awad, Mohd. R. Suliman (Al Balqa' Applied University — *Jordan*), Jamil Mujahed (Jordan Traffic Institute — *Jordan*)

More than 96% of traffic casualties in Jordan take place on non-intersection roadway segments. Speed variation and improper lane change are considered to be some of the main factors contributing to these casualties. This research paper describes an attempt made to study speed-lane choice behavior in Jordan. Drivers' behaviors with regard to their choice of speed and/or traveled lane are assessed. One-fifth of the observed drivers are speeding and one-forth of them changes lanes along the tested segment. Two models are developed and investigated to describe the relationships between speed and lane choice using binary and linear regression models. Results indicate that driving behavior varies with respect to roadway geometry and lane. Speed influences the driver choice of lane changing and his/her decision about changing lanes influences his/her speed choice.

(63) Shut up I'm Driving! Is Talking to an Inconsiderate Passenger the Same as Talking on a Mobile Phone? Natasha Merat, A. Hamish Jamson (University of Leeds — *United Kingdom*)

The objective of this study was to compare driving performance whilst talking on a hands-free mobile (cellular) telephone with performance during conversations with "considerate" and "inconsiderate" passengers. Using the Leeds Advanced Driving Simulator, participants were asked to drive four scenarios: (1) car following along a straight road section, (2) car following along a curved section of road, (3) a braking event, and (4) a coherence event. A working memory digit recall and sentence verification task were used to simulate conversation in three conversation conditions: (1) "considerate passenger," where the experimenter asked drivers to respond to the working memory task before and after a driving event, (2) "inconsiderate passenger," where the experimenter asked drivers to respond to the working memory task *throughout* a driving event, and "3) "mobile phone task," which involved digital presentation of the working memory task via a mobile telephone throughout the driving events. A silent condition was also used as control. The effect of the three conversation conditions on driving performance was the same during the simple car following scenarios. However, talking to an "inconsiderate" passenger was found to be as disrupting as a mobile phone conversation, and different from conversing with a considerate passenger, during the braking and coherence conditions. Therefore, the high workload imposed by conversation was only detrimental during the more difficult driving conditions, when demand for central attentional resources from both tasks was at its highest.

(64) Driver Performance Assessment with a Car Following Model Erwin R. Boer (LUEBEC), Nicholas J. Ward, Michael P. Manser (University of Minnesota), Tomohiro Yamamura, Nobuyuki Kuge (Nissan Motor Co. Ltd. — *Japan*)

Driver performance is generally quantified by the state of the vehicle relative to the local road and traffic environment. Unfortunately these vehicle-state-based metrics are limited in their diagnostic value when it comes to trying to assess how: (i) drivers individually adopted different control strategies, (ii) how they individually adapted to the issues under investigation (e.g., in-vehicle task execution, driver support system exposure, or impairment), or (iii) why drivers individually were more or less affected by the factor under study. By representing a driver's behavior in an identifiable computational driver model, insight is gained into how drivers may differentially benefit or be impaired by the condition at hand. Such a model also shows how the myriad of possible performance metrics are all "necessarily" correlated. Based on test track car following data, a driver car following model is introduced and identified for each driver and used to show how drivers differ in their car following control strategies. It is demonstrated that the adopted target time headway (THW) strongly influences the associated control strategy (i.e., effort) as well as the safety margin (i.e., the minimum THWs experienced) and that subjects who adopt a longer target THW also exhibit a lower bandwidth control strategy (i.e., less effort).

(65) Steering Entropy Changes as a Function of Microsleeps Amit Paul, Linda Ng Boyle (University of Iowa), Erwin R. Boer (LUEBEC), Jon Tippin, Matthew Rizzo (University of Iowa)

This study aimed to assess steering entropy as a measure of decrements in driving performance caused by microsleeps. Microsleeps are brief, unintended episodes of loss of attention that last 3-14 seconds. These episodes, which are frequent in drivers with sleep disorders, can be long enough to impact steering performance and are particularly disruptive when driver action is imperative, as when driving around curved highway segments. Steering entropy is a driver-centered performance measure that can detect drivers' corrective responses to situations when the vehicle state falls outside the driver's expectations. This study tests the hypothesis that steering entropy is an indicator of increased erratic steering behavior during microsleep episodes in drivers with obstructive sleep apnea/hypopena syndrome (OSAHS). Twenty-four drivers with OSAHS were used in this study and their electroencephalography (EEG) defined microsleep (cases) and non-microsleep episodes (crossover control) were compared using a case-crossover method. Steering entropy was calculated from a time-series history of steering angle data and compared for each microsleep in the three-second intervals preceding and following each microsleep. Results showed that steering entropy was higher on curves during microsleeps and post microsleeps when compared to straight road segments and the no-workload baseline condition. This suggests that steering entropy can capture erratic steering behavior, allowing us to better understand how drivers correct for previous steering errors.

SESSION 8 – Lectures
Training & Assessment
Thursday, June 30, 2005
8:15 AM – 10:00 AM

(66) Evaluating the Safety Implications and Benefits of an In-Vehicle Data Recorder to Young Drivers Tsippy Lotan (OR YAROK — *Israel*), Tomer Toledo (Israel Institute of Technology — *Israel*)

Young drivers in Israel, as in other parts of the world, are involved in car crashes more than any other age group. Green Light for Life is a new program that seeks to improve the quality of the experience of young drivers during the mandatory accompanied driving period. As part of the efforts to evaluate the effectiveness of this program a novel experiment, which uses information gathered from an in-vehicle data recorder (IVDR) is conducted. The DriveDiagnostics IVDR system, which is used in this study, can identify over 20 different maneuver types in raw measurements and use this information to indicate overall trip safety. Drivers receive feedback through various summary reports, real-time text messages or an in-vehicle display unit. Preliminary validation tests with the system demonstrate promising potential. In the experiment, the DriveDiagnostics system is installed in the primary vehicle driven by the young driver in 120 families. The experiment is designed to test the impact on driving behavior of participation in the program and the type of feedback drivers receive from the system. The data collection part of the experiment is scheduled to run for 8 months for each family.

(67) The Use of a Driving Simulator to Assess Senior Driver Performance: Increasing Situational Awareness Through Post-Drive One-on-One Advisement Matthew R.E. Romoser, Donald L. Fisher (University of Massachusetts, Amherst), Ronald Mourant (Northeastern University), Jerry Wachtel (The Veridian Group, Inc.), Konstantin Sizov (Drive Square LLC.)

Older drivers are over-represented in angled impact crashes and experience a higher fatality rate than their younger counterparts. Due to the gradual deterioration of the senses, diminished cognitive processing capabilities and decreased mobility and flexibility, it is more difficult for older drivers to gather and process information about their environment. This can lead older drivers to incorrectly perceive their driving environment as safe, when in reality it is not. The current study investigates whether post-drive feedback following a simulated drive can effectively change older drivers' attitudes about their own driving ability and influence them to incorporate additional compensatory behaviors into their day-to-day driving.

(68) The Development and Evaluation of a High Fidelity Simulator Training Program for Snowplow Operators David L. Strayer, Frank A. Drews (University of Utah), Stan Burns (Utah Department of Transportation)

We report the results of a pilot training program incorporating high-fidelity simulation developed for snowplow operators. Ratings of user acceptance of the training were very high, with drivers of all levels of experience indicating that the training helped them prepare for several issues critical to the safe and efficient operation of a snowplow. In the 6-month period following training, the odds of getting in an accident were lower for the group of drivers who received training compared with a matched control group who did not receive it. In addition, the data indicate that fuel efficiency was greater for the trained drivers than for the control group.

(69) Can Novice Drivers Recognize Foreshadowing Risks as Easily as Experienced Drivers? Lisandra Garay-Vega, Donald L. Fisher (University of Massachusetts, Amherst)

Novice drivers (16 and 17 years old) are almost ten times more likely to be involved in motor vehicle fatalities as adults 45-55 (NHTSA 2002). Besides traffic signs and other traffic control devices, there are many cues that help drivers further predict the presence of a potential risk in the driving environment. These cues are called foreshadowing elements (e.g., a pedestrian walking towards a crosswalk). It was hypothesized that given that younger adults have much less experience on the roads, it is more difficult for them to predict where potential cues might be positioned when foreshadowing elements are not present. However, in the presence of foreshadowing elements it was predicted that novice drivers should recognize risks as well as more experienced drivers. This research uses eye movement data gathered on a driving simulator to evaluate the use and effectiveness of the foreshadowing elements by novice and experienced drivers as predictors of areas in a scenario where risks may materialize. The research has potential implications for the sorts of instructional programs that might be developed for novice drivers.

SESSION 9 – Lectures
Driver Distraction & Response
Thursday, June 30, 2005
10:15 AM – 12:00 PM

(70) A Meta-Analysis of Driving Performance and Crash Risk Associated with the Use of Cellular Telephones While Driving Jeff K. Caird, Chip T. Scialfa (University of Calgary — *Canada*), Geoff Ho (Honeywell), Alison Smiley (Human Factors North — *Canada*)

This paper addresses the effects of cell phones on driving by means of a review of the literature and an analysis of scientifically credible epidemiological and driver performance studies. A total of 84 articles were obtained covering the period from 1969 to 2004. Sixty-eight articles were research papers measuring driving performance while using a cell phone and 16 articles were epidemiological studies that examined cell phone usage and their relationship to vehicular crashes. Epidemiological findings consistently showed an increase in crashes associated with use of cell phones. However, these studies did not control for exposure to cell phone use or to driving. The negative impact of cell phone usage is larger for responses to critical events than for vehicular control. Drivers responded about a quarter of a second later to stimuli in the presence of a cell phone distractor for all studies that were analyzed. Hands-free cell phones produced similar performance decrements to hand-held phones.

(71) Driver Performance While Interacting with the 511 Travel Information System in Urban and Rural Traffic Laura M. Stanley, Michael J. Kelly, Suzanne Lassacher (Montana State University)

The national "511" highway information system is heavily used by drivers, especially during inclement weather, to plan and replan their trips. Few studies have explored the safety and usability of the 511 user interface, especially in the context of a mobile phone user who has the added workload of driving a vehicle. In this study, 36 drivers were divided into three groups (hand-held cell phone, hands-free cell phone, and control group) and drove a series of urban and rural scenarios in a high fidelity driving simulator. Drivers in the cell phone groups interacted with the Montana 511 travel information system to obtain road information on a segment of highway. Performance on the primary driving task (e.g., lanekeeping and speed control) was not affected by use of the 511 traveler information system. Driving tasks that required urgent attention (e.g., responding to unexpected traffic conflicts) were degraded by using the 511 travel system regardless of the type of phone used. Drivers using either cell phone to interact with the 511 information system were found to have a higher number of collisions and less situation awareness than those not interacting with the 511 system. Drivers using a hand-held cell phone were also found to have a higher frequency of braking responses. The increased crash risk of the phone users in our study (3.0 - 3.8) was very comparable to that reported by earlier studies of the risk of cell phone conversations.

(72) Deciphering Psychological-Physiological Mappings While Driving and Performing a Secondary Memory Task John K. Lenneman (General Motors R&D and Planning), Jonathon R. Shelley, Richard W. Backs (Central Michigan University)

An autonomic space model of sympathetic and parasympathetic influences on the heart has been proposed as a method of deciphering psychological-physiological mappings for driving-related tasks. In the current study, we explore the utility of the autonomic space model for deciphering mappings in a driving simulation environment by comparing a single-task driving-only condition to two dual-task, driving-with-a-secondary-working-memory task conditions. Although limited by a small sample size, the results illustrate the advantages physiological measures can have over performance measures for detecting changes in the psychological process required for driving-related task performance. Future research will include a repetition of this same study with more subjects as well the collection of on-the-road autonomic nervous system data.

(73) Deciding to be Distracted Neil D. Lerner (Westat)

This project investigated the decision process involved in a driver's willingness to engage in various technology-related and non-technology tasks. The project included focus groups and an on-road study, both employing participants from four age groups: teen, young, middle, and older. The focus groups discussed the perceptions, motivations, attitudes, and decision factors that underlie driver choices. The on-road study had two phases: an on-road drive and a take-home booklet. Participants drove their own vehicles over a specified route. They did not actually engage in in-vehicle tasks, but at specified points rated their willingness to engage in some specific task at that time and place. Eighty-one different situations (combination of in-vehicle task and driving circumstances) were included. Further information was collected regarding the participant's familiarity with in-vehicle technologies, additional situations for willingness and risk ratings, stated reasons underlying ratings, and self-ratings of certain aspects of driving behavior. Driver willingness to engage in various in-vehicle tasks was related to technology type, specific task attributes, driving conditions, personal motivations, driving style, and decision style. Specific project findings were related to potential countermeasure approaches, including public education; driver or device user training; user interface design; needs for warnings and information; criteria for function lock-outs; and driver assist system criteria.