

**International Driving Symposium on Human Factors in Driver Assessment,  
Training and Vehicle Design  
August 14-17, 2001**

**Monday August 13, 2001**

**6:00 PM – 7:30 PM**                      **Early Registration**  
Cabaret Room Lobby, Silvertree Hotel

**Tuesday August 14, 2001**

**9:00 AM – 7:00 PM**                      **Registration Open**  
Cabaret Room Lobby, Silvertree Hotel

**10:00 AM – 12:00 noon**                      **TRB Mid-year Meeting for Committee A3B02**  
Vehicle User Characteristics  
Cabaret Room, Silvertree Hotel

**3:30 PM – 5:00 PM**                      **2<sup>nd</sup> Driving Simulation Collaboratory Meeting**  
Cabaret Room, Silvertree Hotel

**6:00 PM – 9:00 PM**                      **WELCOME RECEPTION**  
Fanny Hill Tent, Silvertree Hotel

**7:15 PM**                                      **OPENING REMARKS**

Daniel McGehee  
John Lee  
Matthew Rizzo  
General Chairs, Driving Assessment 2001  
University of Iowa

Professor Peter Hancock  
University of Central Florida

Individuals with disabilities are encouraged to attend all University of Iowa-sponsored events. If you are a person with a disability who requires an accommodation in order to participate in this program, please contact Kathy Holeton, Driving Assessment 2001 in advance at (319) 335-6804.

**Wednesday August 15, 2001**

**6:30 AM – 4:30 PM Registration Open**  
Cabaret Room Lobby, Silvertree Hotel

**6:30 AM – 8:30 AM Continental Breakfast**  
Cabaret Room Lobby, Silvertree Hotel

**7:00 AM – 8:10 AM TRB Mid-year Meeting for Committee A3B06**  
Simulation and Measurement of Vehicle and Operator Performance  
Cabaret Room, Silvertree Hotel

**TECHNICAL SESSION 1**  
**Attention and Distraction**

**8:15 AM – 10:00 AM**  
Cabaret Room, Silvertree Hotel

Session Chair: Andrew Parkes, TRL Limited (Transport Research Laboratory) — UK

**8:20 AM Mental Workload and Task Performance for Indirect Vision Driving with Fixed Flat Panel Displays (1)**  
Christopher C. Smyth, U.S. Army Research Laboratory — *USA*

**8:45 AM Evaluation of Manual vs Speech Input When Using a Driver Information System in Real Traffic (2)**  
Ulrich Gärtner, Winfried König, Thomas Wittig, Robert Bosch GmbH — *Germany*

**9:10 AM Cell Phone-Induced Perceptual Impairments During Simulated Driving (3)**  
David L. Strayer, Frank A. Drews, Robert W. Albert, William A. Johnston  
University of Utah — *USA*

**9:35 AM Distraction Potential of Speech-Based Driver Interfaces (4)**  
John Lee, Kristi Schmidt, Toby Braul, University of Iowa — *USA*

**10:00 AM – 10:15 AM BREAK-Refreshments**  
Cabaret Room Lobby, Silvertree Hotel

**Wednesday August 15, 2001**

**TECHNICAL SESSION 2**

**Driver Training and Licensing Issues**

**10:15 AM – 12:00 noon**

Cabaret Room, Silvertree Hotel

Session Chair: Michael Mollenhauer, KQ Corporation — *USA*

**10:20 AM      Driver Assessment and Training in the 1980s and 1990s: An Analysis of the Most-Cited Publications (5)**

Michael Sivak, Michael J. Flannagan, Brandon Schoettle  
University of Michigan Transportation Research Institute — *USA*

**10:45 AM      Development of a National Licence Assessment Program for Older Drivers in Australasia, (6)**

Brian Fildes, Nicky Pronk, Judith Charlton  
Monash University Accident Research Centre — *Australia*  
Jim Langford, Department of Infrastructure, Energy and Resources — *Australia*  
Bill Frith, Land Safety Traffic Authority — *New Zealand*

**11:10 AM      Disconnect Between Driver Behavior/Performance Studies and Crash Experience: Lessons from the Study of Young/Inexperienced Drivers (7)**

Neil Lerner, Westat — *USA*

**11:35 AM      Low-Cost PC-Simulation Technology Applied to Novice Driver Training (8)**

R. Wade Allen, Marcia L. Cook, Theodore J. Rosenthal  
Systems Technology, Inc. — *USA*

**12:15 PM - 1:30 PM**

**LUNCH & INVITED SPEAKER**

Fanny Hill Tent, Silvertree Hotel

Professor Barry Kantowitz, Director  
University of Michigan Transportation Research Institute — *USA*  
**Using Microworlds to Design Intelligent Interfaces that Minimize Driver Distraction (9)**

**Wednesday August 15, 2001**

**TECHNICAL SESSION 3**

**Fatigue and Impairment**

**1:45 PM – 3:45 PM**

Cabaret Room, Silvertree Hotel

Session Chair: Nicholas Ward, University of Minnesota — *USA*

- 1:45 PM      Monitoring Driver Drowsiness and Stress in a Driving Simulator (10)**  
Maria Rimini-Doering, Dietrich Manstetten, Tobias Altmueller, Ulrich Ladstaetter  
Michael Mahler, Robert Bosch GmbH — *Germany*
- 2:10 PM      Drowsy Driver Monitor and Warning System (11)**  
Richard Grace, Carnegie Mellon University — *USA*
- 2:35 PM      An Evaluation of the Effects of a Functional Energy Drink on Post-lunch  
and Early Evening Driving Performance (12)**  
Andrew Parkes, B.F. Sexton, Sue Burton, TRL Limited (Transport Research  
Laboratory) — *UK*, Henglong Hu, Jacquie Shaw, Bruce Daggy, GlaxoSmithKline — *UK*
- 3:00 PM      Depth Perception in Driving: Alcohol Intoxication, Eye Movement Changes,  
and the Disruption of Motion Parallax (13)**  
Mark Nawrot, North Dakota State University — *USA*
- 3:25 PM      Technologies for the Monitoring and Prevention of Driver Fatigue (14)**  
Martin Moore-Ede, Anneke Heitmann, Rainer Guttkuhn, Acacia Aguirre, Udo  
Trutschel, Circadian Technologies, Inc. — *USA*
- 3:50 PM – 4:00 PM      BREAK-Refreshments**  
Max Park Room, Wildwood Lodge  
(Note: Wildwood Lodge is the hotel across from the main entrance to Silvertree)

**POSTER SESSION 1**

**4:00 PM – 5:30 PM**

Max Park Room, Wildwood Lodge

(Note: Wildwood Lodge is the hotel across from the main entrance to Silvertree)

**Driver Behaviour Studies in the Motorway Operations Platform Grant (15)**

Mark Brackstone, Mike McDonald (University of Southampton — *UK*)

**The Use of a Multi-modal Interface to Integrate In-Vehicle Information Presentation  
(16),** David Wheatley, Joshua Hurwitz (Motorola Labs — *USA*)

## **Wednesday August 15, 2001**

### **POSTER SESSION 1 (cont.)**

**4:00 PM – 5:30 PM**

Max Park Room, Wildwood Lodge

(Note: Wildwood Lodge is the hotel across from the main entrance to Silvertree)

**Performance on Cue Recognition and Evasive Action Skills as Predictors of Effective Driving in College-Age Drivers (17)**, Dong-Yuan Debbie Wang (Purdue University — *USA*), David F. Pick (Purdue University Calumet — *USA*), Robert W. Proctor (Purdue University — *USA*)

**BEI's Driver Skill Enhancement Program (D-SEP): Brief Review of Experimental Mini-Program and Conclusions (18)**, Seymour M. Bogdonoff (Princeton University — *USA*)

**Ergonomics Specifications and Design of a HMI for an Informational Safe Driving Support System (19)**, Laurent Nicolas (PSA Peugeot Citroën — *France*)

**Effects of Cellular Telephone Use While Driving Based on Objective and Subjective Mental Workload Assessment (20)**, Roberto Abraham Tokunaga, Akihiro Shimojo (Civil Engineering Research Institute of Hokkaido I.A.I. — *Japan*), Toru Hagiwara, Seiichi Kagaya, Ken-etsu Uchida (Hokkaido University — *Japan*)

**The Trainer Project: Matching Training Curricula to Drivers' Real Needs Using Multimedia Tools (21)**, Daniel Herregods, Herve Nowe (Driving Know-How, POLE ProMotions SPRL — *Belgium*), Angelos Bekiaris (Laboratory of Transport Engineering of Aristotles University of Thessaloniki — *Greece*), Guido Baten (CARA-Belgian Institute for Road Safety — *Belgium*), Christian Knoll, Harald Widlroither (University of Stuttgart — *Germany*)

**The Trainer Project: A New Simulator-Based Driver Training Curriculum (22)**, Juan F. Dols, J. Pardo (Polytechnic University of Valencia — *Spain*), T. Falkmer (Swedish National Road and Transport Research Institute — *Sweden*), E. Uneken (University of Groningen — *The Netherlands*), W. Verwey (Institute for Occupational Physiology IFADO — *Germany*)

**Relation of Owner's Manuals to Safety (23)**, S. David Leonard (University of Georgia — *USA*)

**The Effect of Physical Changes in Aging on Driving Performance (24)**, Hideaki Nemoto, Takayuki Yanagishima, Mitsuru Taguchi (Nissan Motor Company, Ltd. — *Japan*)

**Measures of Driver Behavior and Cognitive Workload in a Driving Simulator and in a Real Traffic Environment - Experiences from Two Experimental Studies in Sweden (25)**, Ruggero Ceci (Swedish National Road Administration — *Sweden*), Lennart Högman (Stockholm University — *Sweden*), Christopher Patten (Swedish National Road Administration — *Sweden*)

**The Effect of a Vehicle Control Device on Driver Performance in a Simulated Tank Driving Task (26)**, Ellen Haas (U.S. Army Research Laboratory — *USA*), Micaela Kunze (Bundesamt für Wehrtechnik und Beschaffung — *Germany*)

## **Wednesday August 15, 2001**

### **POSTER SESSION 1 (cont.)**

**4:00 PM– 5:30 PM**

Max Park Room, Wildwood Lodge

(Note: Wildwood Lodge is the hotel across from the main entrance to Silvertree)

**The Effects of Age and Distraction on Reaction Time in a Driving Simulator (27)**, Justin M. Owens, Richard Lehman (Franklin & Marshall College — *USA*)

**Bilingual Variable Message Signs: A Study of Information Presentation and Driver Distraction (28)**, Samantha L. Jamson, Fergus N. Tate, A. Hamish Jamson (University of Leeds — *UK*)

**Assessing and Predicting the Impact of Cowshake in Convertible Cars on Subjective Comfort (29)**, Harald Kolrep (Kolrep-Rometsch, Human Factors Consultants — *Germany*)

**A Simulator Study of Driver Response to Changeable Message Signs of Differing Length and Format (30)**, José Guerrier (University of Miami School of Medicine — *USA*), Jerry Wachtel (The Veridian Group, Inc. — *USA*)

**Distraction Effects of Phone Use During a Crucial Driving Maneuver (31)**, Peter Hancock (University of Central Florida — *USA*), Mary Lesch, Lucy Simmons (Liberty Mutual Research Center for Safety and Health — *USA*), Mustapha Mouloua (University of Central Florida — *USA*)

**Role of Monotonous Attention in Traffic Violations, Errors, and Accidents (32)**, Nebi Sümer, Belgin Ayvasik (Middle East Technical University — *Turkey*), Nurhan Er (Ankara University — *Turkey*), Türker Özkan (Middle East Technical University — *Turkey*)

**Effects of a Speed-of-Processing Intervention on Driving Performance: The ACCELERATE Study (33)**, Karlene Ball, David Ball, Meredith Rumble, David Edwards, Virginia Wadley (University of Alabama at Birmingham — *USA*)

**Visual Attention and Roadway Landmark Identification in At-Risk Older Drivers (34)** Amy Crowe, Tara Smyser, Mireille Raby, Kirk Bateman, Matthew Rizzo (University of Iowa — *USA*)

**Virtual Truck Driver Training and Validation: Preliminary Results for Range and Skid Pad (35)**, Gerard Meyer, Renee Slick, Daniel Westra, Nicolas Noblot, Lois-Ann Kuntz (Carnegie Mellon Driver Training and Safety Institute — *USA*)

**Thursday August 16, 2001**

**7:30 AM – 4:30 PM**                      **Registration Open**  
Cabaret Room Lobby, Silvertree Hotel

**7:30 AM – 8:30 AM**                      **Continental Breakfast**  
Cabaret Room Lobby, Silvertree Hotel

**TECHNICAL SESSION 4**  
**Driver Performance Assessment**  
**8:15 AM – 10:00 AM**  
Cabaret Room, Silvertree Hotel

Session Chair: Louis Tijerina, Ford Motor Company — *USA*

**8:20 AM**                      **Can We Predict the On-Road Performance of Older Drivers? (36)**  
Dianne Parker, University of Manchester — *UK*

**8:45 AM**                      **Image Characteristics and Their Effect on Driving Simulator Validity (37)**  
Hamish Jamson, University of Leeds — *UK*

**9:10 AM**                      **Prediction of Driver Decisions to Turn at Intersections (38)**  
Jeff K. Caird, C.J. Edwards, J. Creaser, University of Calgary — *Canada*  
W.J. Horrey, University of Illinois — *USA*

**9:35 AM**                      **Examination of Older Driver Steering Adaptation on a High-Performance Driving Simulator (39)**  
Daniel McGehee, John Lee, Matthew Rizzo, Kirk Bateman  
University of Iowa — *USA*

**10:00 – 10:15 AM**                      **BREAK-Refreshments**  
Cabaret Room Lobby, Silvertree Hotel

**Thursday August 16, 2001**

**TECHNICAL SESSION 5**

**Information Display Issues in Driver-Vehicle Interface Design**

**10:15 AM– 12:00 noon**

Cabaret Room, Silvertree Hotel

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

**10:20 AM They Drive at Night - Can Visual Enhancement Systems Keep the Driver in Control? (40)**

Erik Hollnagel, Johan Karlsson, Thomas Magnusson, Ulrika Taube  
University of Linköping — *Sweden*

**10:45 AM Evaluation of Driving-Assistance Systems Based on Drivers' Workload (41)**

Yuji Takada, Osamu Shimoyama, Nissan Motor Co., Ltd — *Japan*

**11:10 AM The Relative Importance of Pictorial and Nonpictorial Distance Cues for Driver Vision (42)**

Michael J. Flannagan, Michael Sivak, Julie K. Simpson  
University of Michigan Transportation Research Institute — *USA*

**11:35 AM Preliminary Studies of Mono-Pulse Braking Haptic Displays for Rear-End Collision Warning (43)**

Louis Tijerina, Ford Motor Company — *USA*

**12:15 PM - 1:30 PM LUNCH & INVITED SPEAKER**

Fanny Hill Tent, Silvertree Hotel

Erwin R. Boer, Ph.D., Senior Staff Scientist  
Wingcast — *USA*

**Behavioral Entropy as a Measure of Driving Performance (44)**

**1:30 PM – 1:45 PM OUTSTANDING STUDENT PAPER AWARDS CEREMONY**

Fanny Hill Tent, Silvertree Hotel

**Determinants of Driving After Stroke (45)** Aboidun Emmanuel Akinwuntan, Hilde Feys, Willy De Weerd, Jan Pauwels (Katholieke Universiteit Leuven — *Belgium*), Guido Baten, Emmanuel Strypstein (CARA, Belgian Institute for Road Safety — *Belgium*)

**Acceleration Behavior of Drivers in a Platoon (57)** Ghulam H. Bham, Rahim F. Benekohal (University of Illinois at Urbana-Champaign — *USA*)

**Evaluating the Presence of In-Vehicle Devices on Driver Performance: Methodological Issues (58)** Christian Jerome, H.C. Neil Ganey, Patrick Commarford, Brian Oakley, Mustapha Mouloua, Peter A. Hancock (University of Central Florida — *USA*)



**Thursday August 16, 2001**

**TECHNICAL SESSION 6**

**Medical Factors**

**1:45 PM – 3:45 PM**

Cabaret Room, Silvertree Hotel

Session Chair: Matthew Rizzo, University of Iowa — *USA*

**1:45 PM**

**Determinants of Driving After Stroke (45)**

Abiodun Emmanuel Akinwuntan, Hilde Feys, Willy De Weerd, Jan Pauwels

Katholieke Universiteit Leuven — *Belgium*

Guido Baten, Emmanuel Strypstein, CARA, Belgian Institute for Road Safety — *Belgium, Outstanding Student Paper Award Winner*

**2:10 PM**

**Dynamic Evaluation of the Useful Field of View in Driving (46)**

Daniel R. Mestre, Cognitive Neurosciences Centre, Centre National de la Recherche Scientifique — *France*

**2:35 PM**

**Time-to-Contact and Collision-Detection Estimations as Measures of Driving Safety in Old and Dementia Drivers (47)**

Nicoleta L. Read, University of Leeds — *UK*

Nicholas J. Ward, University of Minnesota — *USA*

Andrew M. Parkes, TRL Limited (Transport Research Laboratory) — *UK*

**3:00 PM**

**Recent European Projects on Driver Impairment (48)**

Nicholas J. Ward, University of Minnesota — *USA*

Karel Brookhuis, University of Groningen — *The Netherlands*

**3:25 PM**

**An Analysis of Driving Performance Measures Used to Assess the Effects of Medications on Drowsiness, Sedation and Driving Impairment (49)**

Ginger Watson, John M. Weiler, George G. Woodworth, Julie Qidwai, Susan Quinn  
University of Iowa — *USA*

**3:50 PM- 4:00 PM BREAK-Refreshments**

Max Park Room, Wildwood Lodge

(Note: Wildwood Lodge is the hotel across from the main entrance to Silvertree)

## **Thursday August 16, 2001**

### **POSTER SESSION 2**

**4:00 PM – 5:30 PM**

Max Park Room, Wildwood Lodge

(Note: Wildwood Lodge is the hotel across from the main entrance to Silvertree)

**Traffic Maneuver Problems and Crashes of Young Drivers (50)**, Adam Kirk, Nikiforos Stamatiadis (University of Kentucky — *USA*)

**Driver License Renewal Issues and Concerns (51)**, Nikiforos Stamatiadis (University of Kentucky — *USA*)

**Detection of Collision Events by Older and Younger Drivers (52)**, George John Andersen, Asad Saidpour, AnnJudel Enriquez (University of California, Riverside — *USA*)

**The Role of Simulation in a Staged Learning Model for Novice Driver Situational Awareness Training (53)**, Loren Staplin (TransAnalytics, LLC — *USA*), James C. Dowdell (SafeDrive Technologies — *USA*)

**Driving Tests: Reliability and the Relationship Between Test Errors and Accidents (54)**, Chris Baughan, Barry Sexton (TRL Limited (Transport Research Laboratory) — *UK*)

**Feasibility of Evaluating Design Ideas for Reducing Vehicular Entrapment at Railroad Crossings Using a Laboratory Experiment (55)**, One-Jang Jeng, Tirthankar Sengupta, Satya Vallepalli (New Jersey Institute of Technology — *USA*)

**Modeling Driver Cognition (56)**, Delphine Delorme (University of California at Berkeley — *USA*)

**Acceleration Behavior of Drivers in a Platoon (57)**, Ghulam H. Bham, Rahim F. Benekohal (University of Illinois at Urbana-Champaign — *USA*), Outstanding Student Paper Award Winner

**Evaluating the Presence of In-Vehicle Devices on Driver Performance: Methodological Issues (58)**, Christian J. Jerome, H.C. Neil Ganey, Patrick Commarford, Brian Oakley, Mustapha Mouloua, Peter A. Hancock (University of Central Florida — *USA*), Outstanding Student Paper Award Winner

**Driver and Driving Assessment Issues Associated with the Application of a Secondary Task Technique: A Case Study (59)**, Michael P. Manser, Jacqueline Jenkins (Texas A & M University — *USA*)

**Evaluation of a Low-Cost, PC-Based Driving Simulator to Assess Persons with Cognitive Impairments Due to Brain Injury (60)**, Jerry Wachtel (The Veridian Group, Inc. — *USA*), William K. Durfee (University of Minnesota — *USA*), Theodore J. Rosenthal (Systems Technology, Inc. — *USA*), Elin Schold-Davis (Sister Kenny Institute — *USA*), Erica B. Stern (University of Minnesota — *USA*)

**Driver Advocate™ Tool (61)**, Chip Wood, Robert Leivian, Noel Massey, Jack Bieker, John Summers (Motorola Labs — *USA*)

**Thursday August 16, 2001**

**POSTER SESSION 2 (cont.)**

**4:00 PM – 5:30 PM**

Max Park Room, Wildwood Lodge

(Note: Wildwood Lodge is the hotel across from the main entrance to Silvertree)

**A HMD-Based Virtual Reality Driving Simulator (62)**, Ronald R. Mourant (Northeastern University — *USA*), Maria T. Schultheis (Kessler Medical Rehabilitation Research and Education Corporation — *USA*)

**Meta-Analysis of Crash Risk Factors Among Older Drivers: Application to a Model Program of Driver Screening (63)**, Karlene Ball, Virginia Wadley, Jerri Edwards, David Ball (University of Alabama at Birmingham — *USA*), Daniel Roenker (Western Kentucky University — *USA*)

**Effects of Speed of Visual Processing Training upon Non-Visual Attention in "At-Risk" Older Drivers (64)**, Nicole Skaar, Matthew Rizzo, Kirk Bateman, Steven Anderson (University of Iowa — *USA*)

**A Computational Model of Driver Decision Making at an Intersection Controlled by a Traffic Light (65)**, Terry Stanard, Robert J.B. Hutton (Klein Associates, Inc. — *USA*), Walter Warwick, Stacey McIlwaine, Patricia L. McDermott (Micro Analysis and Design — *USA*)

**Investigating Drivers' Traffic Knowledge in Jordan (66)**, Wa'el Awad, Mohammad Rasoul S. Al-kharabsheh (Al-Balqa' Applied University — *Jordan*)

**Socioeconomic Characteristics of Speeding Behavior (67)**, Kyungwoo Kang (Hanyang University — *Korea*)

**Driver Alertness Detection Research Using Capacitive Sensor Array (68)**, Philip W. Kithil (Advanced Safety Concepts, Inc. — *USA*)

**The Influence of Conversation, Low-Dose Alcohol and Driving Experience on the Peripheral Vision System (69)**, Peter Langer, M. Kopp, B. Holzner (University of Innsbruck — *Austria*), W. Magnet (Kuratrium fuer Verkehrssicherheit — *Austria*)

**Human Factors in Highway-Rail Crossing Accidents: The Influence of Driver Decision Style (70)**, Mansour Rahimi, Najmedin Meshkati (University of Southern California — *USA*)

**Fatigue Countermeasure Using Automatic Real-Time Video Processing of Eye Characteristics (71)**, Jeffrey B. Bishop (Future of Technology and Health, LC — *USA*), Isaac K. Evans (Evolutionary Heuristics — *USA*)

**6:30 PM – 9:00 PM**

**DINNER BARBEQUE/CONCERT**

Fanny Hill Tent, Silvertree Hotel

**Friday August 17, 2001**

**7:30 AM – 2:30 PM**                      **Registration Open**  
Cabaret Room Lobby, Silvertree Hotel

**7:30 AM – 8:30 AM**                      **Continental Breakfast**  
Cabaret Room Lobby, Silvertree Hotel

**TECHNICAL SESSION 7**  
**Commercial Vehicle Operations**

**8:15 AM – 10:30 AM**  
Cabaret Room, Silvertree Hotel

Session Chair: Richard Hanowski, Virginia Tech Transportation Institute — *USA*

**8:20 AM**                      **Design of a Guidebook for the Acquisition and Use of Driving Simulators for Training Transit Bus Operators (72)**  
John F. Brock, Cynthia Jacobs, Richard Buchter, Milestone Group — *USA*

**8:45 AM**                      **Improving Safety for Drivers and Fleets: Historical and Innovative Approaches (73)**  
Richard Grace, Carnegie Mellon University — *USA*

**9:10 AM**                      **Re-Assessment of Driving Simulators for the Training, Testing and Licensing of Commercial Vehicle Drivers (74)**  
John Pierowicz, Veridian Engineering — *USA*, Jerry Robin, Federal Motor Carrier Safety Administration — *USA*, Valerie J. Gawron, Veridian Engineering — *USA*

**9:35 AM**                      **Federal Motor Carrier Safety Administration's Research and Technology Initiatives to Enhance Commercial Driver Training, Licensing and Performance Management (75)**  
Jerry Robin, Ronald Knipling, Federal Motor Carrier Safety Administration — *USA*

**10:00 AM**                      **Value Assessment and Implementation Tradeoffs for Production-Heavy Truck Active Noise Control (76)**  
Daniel J. Maguire, Cooper Advanced Technologies — *USA*

**10:30 AM – 10:45 AM**                      **BREAK-Refreshments**  
Cabaret Room Lobby, Silvertree Hotel

**Friday August 17, 2001**

**TECHNICAL SESSION 8**

**Commercial Vehicle Operations — Panel Discussion**

**Current Issues in CVO Driver Assessment: A Multi-Disciplinary Perspective**

**10:45 AM – 12:00 noon**

Cabaret Room, Silvertree Hotel

Session Chair: Bill Rogers, Motor Freight Carrier Association — *USA*

Steve Wreggit, Daimler Chrysler

Jerry Robin, Federal Motor Carrier Safety Administration

Bill Rogers, Motor Freight Carrier Association

Richard Hanowski, Virginia Tech Transportation Institute

**12:15 PM - 1:30 PM**

**LUNCH & INVITED SPEAKER**

Fanny Hill Tent, Silvertree Hotel

Richard Young, Ph.D.

General Motors

**Recent Human Factors Issues in the Use of Embedded Telematics Devices in a Vehicle**

**TECHNICAL SESSION 9**

**Infrastructure and In-Vehicle Systems**

**1:45 PM – 3:10 PM**

Cabaret Room, Silvertree Hotel

Session Chair: Tom Granda, Federal Highway Administration — *USA*

**1:45 PM**      **Developments in Cooperative Intelligent Vehicle-Highway Systems and Human Factors Implications (77)**

Richard Bishop, Richard Bishop Consulting — *USA*

**2:05 PM**      **Infrastructure Systems for Intersection Collision Avoidance (78)**

Robert A. Ferlis, Federal Highway Administration — *USA*

**2:25 PM**      **Vehicle-Infrastructure Cooperative Systems for Intersection Collision Avoidance: Driver Assessment Challenges (79)**

Vaughan Inman, Ted Shafer

Science Applications International Corporation (SAIC) — *USA*

**2:45 PM**      **Effects of Traffic Control Devices and Road Scenes on a Driver's Judgment of Curve Sharpness (80)**

Kenta Suzuki, Takashi Uchida, Toru Hagiwara, Hokkaido University — *Japan*

Takahiro Ohmi, Roberto A. Tokunaga, Motoki Asano

Civil Engineering Research Institute, Hokkaido Development Bureau — *Japan*

**3:10 PM**      **WRAP UP**

# International Driving Symposium on Human Factors in Driver Assessment, Training and Vehicle Design August 14-17, 2001

## Summaries

**Please note:** Some summaries have been edited for space and clarity. The conference proceedings will contain complete abstracts and papers.

### **TECHNICAL SESSION 1** **Attention and Distraction** **Wednesday, August 15, 2001** **8:15 AM – 10:00 AM**

(1) **Mental Workload and Task Performance for Indirect Vision Driving with Fixed Flat Panel Displays** Christopher C. Smyth (U.S. Army Research Laboratory — *USA*)

Of interest to designers of future combat vehicles is the effect of indirect vision upon vehicle driving, and in particular the effect of the camera lens field of view (FOV). In a field study, driving performance was measured for natural and indirect vision with eight participants negotiating a road course in a military vehicle. The indirect vision system was driven with fixed panoramic flat panel, liquid crystal displays in the cab and a forward viewing monocular camera array mounted on the front roof of the vehicle and tilted slightly downward. The results are that the participants successfully drove the vehicle with indirect vision for the different FOVs of the cameras: near unity, wide, and extended. However, they drove the course faster with natural vision than they did with the indirect vision systems. Further, the course speed significantly decreased with increased camera FOV. Workload ratings show a significant increase in perceived workload with increased FOV. Most participants reported a discomfort associated with motion sickness while they were in the moving vehicle with the displays. Finally, cluster analysis of the mental workload measures supports a skills-rules-knowledge model of information processing for the driving task.

(2) **Evaluation of Manual vs Speech Input When Using a Driver Information System in Real Traffic** Ulrich Gärtner, Winfried König, Thomas Wittig (Robert Bosch GmbH — *Germany*)

This study evaluated the influence of manual and speech inputs to a Driver Information System (DIS) on driving quality, driver stress, and user acceptance. The study is part of the EU-project SENECA. Sixteen subjects took part in the experiment. A car was equipped with a modified DIS to carry out the evaluation in real traffic situations. The DIS was a standard product with manual input control elements; it was extended by the addition of a speech input system with an independent speech recogniser. Subjects were assigned 12 different representative tasks in using the different DIS devices (radio, CD player, telephone, navigation). It was found that independently of the type of task, speech input required longer operation times than manual input. In the case of complex tasks, a distinct improvement was observed in driving quality with the speech inputs. Subjective feelings of safety were also stronger with speech than with manual inputs. However, with speech input the number of glances at the mirrors and away from the road were higher. The most frequent user errors were due to problems with spelling with selecting the correct speech commands. Speech recognition errors averaged 20.6%, which suggests that recognition performance of the speech system should be improved. Improved system performance will thus be the development task in the 2<sup>nd</sup> half of the SENECA project.

(3) **Cell Phone-Induced Perceptual Impairments During Simulated Driving** David L. Strayer, Frank A. Drews, Robert W. Albert, William A. Johnston (University of Utah — *USA*)

Our research assessed the effects of cellular phone conversations on driving performance. When subjects were deeply involved in cellular phone conversations using either a hand-held or hands-free device, they were more than twice as likely to miss simulated traffic signals presented at the center of fixation than when they were not distracted by the cell phone conversation. By contrast, performance was not disrupted by listening to radio broadcasts or listening to a book on tape. One might argue that when subjects were conversing on a cell phone that they detected the simulated traffic signals, but that the responses to them were suppressed. To assess this, we examined the implicit perceptual memory for items that were presented at fixation but called for no response. Implicit perceptual memory was strong when subjects were not engaged in a cell-phone conversation but impaired when they were so engaged. We suggest that active participation in a cell phone conversation disrupts performance by diverting attention to an engaging cognitive context other than the one immediately associated with driving.

- (4) **Distraction Potential of Speech-Based Driver Interfaces** John Lee, Kristi Schmidt, Toby Braul (University of Iowa — *USA*)

A common assumption concerning speech-based interaction with an in-vehicle information system is that the speech-based interaction does not distract driver, because the driver is not required to take his eyes off the road. This assumption does not take into consideration the cognitive demand placed on the driver. This cognitive demand may be highly dependent upon the nature of the interaction and may increase when errors occur in the interchange between the driver and the speech-based system. When the automatic speech recognition system makes an error, the driver must first recognize that an error has been made, determine how to recover from the error, trace back to the previous menu, and repeat the command to get the desired result. These additional steps and the error recovery process may place significant cognitive demands on driver. Understanding how these errors and the recovery process affects driver attention to the road is a critical design consideration for speech-based interaction with in-vehicle information systems. This paper describes an initial experiment to address this issue and provides a theoretical framework to help identify the requirements of a speech-interface needed to support easy error recovery. Because speech interactions will always be subject to human and system error, understanding how to support the robust interaction is critical in minimizing driver distraction.

## **TECHNICAL SESSION 2**

### **Driver Training and Licensing Issues**

**Wednesday, August 15, 2001**

**10:15 AM – 12:00 noon**

- (5) **Driver Assessment and Training in the 1980s and 1990s: An Analysis of the Most Cited-Publications** Michael Sivak, Michael J. Flannagan, Brandon Schoettle (University of Michigan Transportation Research Institute — *USA*)

This study analyzed the most-cited publications in the area of driver assessment and training. The citation counts were obtained from both the Science Citation and Social Science Citation databases, which at the time of the analysis contained a total of over 27 million items. The search was restricted to items that were published during the 20-year period from 1980 through 1999. The focus of the search was on the assessment and training of driving-related skills. In addition to documenting the most influential publications, the results are also presented in terms of changes over time by topic and by publication outlets.

- (6) **Development of a National Licence Assessment Program for Older Drivers in Australasia** Brian Fildes, Nicky Pronk, Judith Charlton (Monash University Accident Research Centre — *Australia*)  
Jim Langford (Department of Infrastructure, Energy and Resources — *Australia*), Bill Frith (Land Safety Traffic Authority — *New Zealand*)

Licensing requirements in Australasia vary across jurisdictions with little evidence of any safety benefit for any existing procedure. In 1998, Austroads (a collaboration of State Traffic Authorities in Australia and New Zealand) commissioned the Monash University Accident Research Centre to develop and trial a model licence re-assessment program for older drivers in Australasia. The procedure was developed in 1999 and involved input from a number of key experts in Australia and New Zealand. A pilot study was undertaken in Tasmania early in 2000 to evaluate the procedural aspects of the model. A study of four off-road screening tests also commenced in 2001 to validate these instruments against a range of driving performance measures. This paper reports preliminary findings from these studies.

- (7) **Disconnect Between Driver Behavior/Performance Studies and Crash Experience: Lessons from the Study of Young/Inexperienced Drivers** Neil Lerner (Westat — *USA*)

The quantitative measurement of driver behavior has been central to much of the systematic research underlying highway safety issues during the past forty years. It has contributed to the way in which we design roads, vehicles, training programs, signs and markings, and intelligent transportation systems. Yet the methods we use to conduct driver behavior experiments may result in a disconnect with the circumstances under which crash events occur. This is particularly evident in problems related to young, inexperienced drivers. This paper discusses some of the systematic biases that characterize the quantitative driver behavior research base regarding youthful drivers. Some broader implications for the general study of driver behavior and performance are then considered.

- (8) **Low-Cost PC-Simulation Technology Applied to Novice Driver Training** R. Wade Allen, Marcia L. Cook, Theodore J. Rosenthal (Systems Technology, Inc. — *USA*)

This paper describes a low-cost driving simulator designed to test the feasibility of training novice drivers. The simulator, based on personal computer technology, was fully interactive with steering, throttle and brake controls. Training and testing scenarios were defined procedurally using a scenario definition language (SDL) that required drivers to maintain safe speeds, negotiate curves and right angle turns, obey traffic control devices (markings, signs and signals) and interact with traffic and pedestrians that were controlled to represent cognitively challenging hazards. The SDL also allowed the event sequences in the scenarios to be conveniently rearranged from run to run to avoid drivers anticipating the occurrence of critical events. A pilot experiment was conducted to compare the simulation performance of a group of novice (unlicensed) drivers with a group of experienced drivers (more than ten years of driving) during two sessions. Performance measures included accidents and speed limit exceedances. Statistically reliable differences in performance were found between the novice and experienced drivers. These encouraging pilot study results suggest that low cost simulation may offer a way to teach novice drivers how to cope with cognitively complex driving hazards.

**INVITED SPEAKER**  
**Wednesday, August 15, 2001**

- (9) **Using Microworlds to Design Intelligent Interfaces that Minimize Driver Distraction** Barry Kantowitz (University of Michigan Transportation Research Institute — *USA*)

While recent developments in telematics have produced great interest in driver distraction, this is hardly a new topic. An early UMTRI report (Treat, 1980) defined internal distraction as a diversion of attention from the driving task that is compelled by an activity or event inside the vehicle. Based on data collected in Monroe County Indiana, Treat (1980) concluded that internal distraction was a factor in 9% of in-depth reports and 6% of on-site investigations. In the period of data collection (1972-1975) conversation with a passenger and increasing use of entertainment tape decks were the major sources of distraction. Now a host of modern infotronic devices offers even greater opportunities for internal distraction (Kantowitz, 2000). Intelligent driver-vehicle interfaces present a wonderful opportunity to successfully manage this increased in-vehicle workload. This smart interface would be adaptive, making dynamic allocation of function decisions in real time. Designing such an intelligent interface presents many problems. In particular, since new infotronic devices are being developed and deployed rapidly, it seems difficult to evaluate all these new designs. This chapter focuses upon using microworlds to swiftly assess effects of in-vehicle infotonics upon driver distraction. Microworlds vary along several dimensions such as realism, tractability and engagement (Ehret, Gray, & Kirschbaum, 2000). The traditional driving simulator is only one example of a relevant microworld. By considering a wider range of microworlds, we can gain insight into how to best utilize driving simulators. Issues of validity are also illuminated when considered from a microworld perspective. If appropriate intelligent interfaces are designed, telematics should never increase driver distraction.

**TECHNICAL SESSION 3**  
**Fatigue and Impairment**  
**Wednesday, August 15, 2001**  
**1:45 PM – 3:45 PM**

- (10) **Monitoring Driver Drowsiness and Stress in a Driving Simulator** Maria Rimini-Doering, Dietrich Manstetten, Tobias Altmueller, Ulrich Ladstaetter, Michael Mahler (Robert Bosch GmbH — *Germany*)

Driver drowsiness, compounded by the high workloads and stress of the ever-increasing complexity of car and traffic environments, is a major cause of severe accidents. The objective of the project described in this paper is to develop reproducible and flexible methods for studying the relationships between physiological driver states and human-factor issues in a driving environment. For reasons of safety and reproducibility, a laboratory-based driving simulator is being used for the project experiments. Initial experiments were conducted with a cohort of about 60 healthy male subjects aged 22 to 28 under carefully controlled conditions. Performance was measured before, during, and after a 120 km stretch of stimulus-deprived, foggy highway that was intended to induce fatigue and stress. Across all trials 69% of the subjects experienced sleep events lasting several seconds, and 7 potentially fatal crashes occurred. Lane tracking behavior degraded by a factor of 2 to 3 prior to each crash. Much of the extensive data acquired by these experiments remains to be analyzed using both standard statistical techniques and high-dimensional clustering algorithms. ALISA image-processing software is being applied to video images of the driver eyes and face to detect the onset of sleep and other critical situations.



(11) **Drowsy Driver Monitor and Warning System** Richard Grace (Carnegie Mellon University — *USA*)

The design and use of a low-cost drowsy driver monitor and warning system are presented. The monitor consists of a digital camera integrated with a low-cost digital signal processor (DSP). The new monitor is a functionally enhanced version of a previous monitor that has been successfully used in a variety of research projects in simulators and in over-the-road vehicles. Compared to its predecessor, the new monitor is small and easy to use proving an effective research tool in the field or in the laboratory. The monitor measures slow eyelid closures as represented by PERCLOS (Percent Eyelid Closure), which is the proportion of time that a subject's eyes are closed over a specified period. PERCLOS has been separately validated in two independent laboratories as an accurate predictor of performance degradation in sleep deprived subjects. The current driver interface is based on recent experimental results that drowsiness feedback can reduce drowsiness and improve driver performance for sleep deprived truck drivers operating a truck simulator. This controlled experiment was undertaken with 16 Commercial Driving License (CDL) holders driving a high-fidelity truck simulator (TruckSim®) to establish the effects of drowsiness feedback on: (1) driver alertness-drowsiness; (2) driving performance and (3) driver-initiated behaviors. Subjects served as their own controls, driving one simulated 4-hr night drive without drowsiness feedback (control condition) and one simulated 4-hr night drive with drowsiness feedback. Although there was significant between-subject variability in drowsiness and consequently in the number of drowsiness-based alarms and warning alerts, drowsiness feedback tended to have consistent effects on key classes of outcome variables, including reduced drowsiness levels, improved driver performance and self-alerting activities (driver movements). The warning triggers are associated with PERCLOS calculated over three minutes. The current interface consists of an audible tone that is associated with the readings of a visual gauge. Work is continuing over the next year to refine the driver interface.

(12) **An Evaluation of the Effects of a Functional Energy Drink on Post-lunch and Early Evening Driving Performance** Andrew Parkes, B.F. Sexton, Sue Burton (TRL Limited (Transport Research Laboratory) — *UK*) Henglong Hu, Jacquie Shaw, Bruce Daggy (GlaxoSmithKline — *UK*)

This paper reports the results of a pilot study designed to evaluate the effect of an energy drink on mental performance and driving. Twenty-four healthy subjects were tested after consumption of a placebo or an energy drink in a double-blind crossover study. Measures included a laboratory test of Adaptive Tracking (AT), and a simulated drive involved a 40 Km motorway route in an advanced motion-based simulator. Self-report scales of sleepiness revealed a significant difference between placebo and energy drink. Though both drinks provided an alerting effect, both the level and duration of the effect observed after consumption of the energy drink was greater. Performance on the AT task was significantly improved. This improvement in hand-eye coordination was reflected in better lane-keeping performance in the simulated driving task. There was also a consistent tendency when the drivers drank placebo to drive slightly faster in traffic than when drinking the energy drink. These preliminary findings, which demonstrate that consumption of even a relatively small volume (250ml) of an energy drink can have an effect on sleepiness, lane keeping and speed choice in simulated traffic, could have implications for future highway safety.

(13) **Depth Perception in Driving: Alcohol Intoxication, Eye Movement Changes, and the Disruption of Motion Parallax** Mark Nawrot (North Dakota State University — *USA*)

Motion parallax, the ability to recover depth from retinal motion, is a crucial part of the visual information needed for driving. Recent work indicates that the perception of depth from motion parallax relies on the slow eye movement system. It is well known that alcohol intoxication reduces the gain of this slow eye movement system, the basis for the "horizontal gaze nystagmus" field sobriety test. The current study shows that alcohol intoxication also impairs the perception of depth from motion parallax due to its influence on the slow eye movement system. Observer thresholds in both active and passive motion parallax tasks are significantly increased by acute alcohol intoxication. Perhaps such a failure of motion parallax plays a role when intoxicated drivers must make quick judgements with what could be inaccurate or missing perceptual information about the location of obstacles around them.

(14) **Technologies for the Monitoring and Prevention of Driver Fatigue** Martin Moore-Ede, Anneke Heitmann, Rainer Guttkuhn, Acacia Aguirre, Udo Trutschel (Circadian Technologies, Inc. — *USA*)

A series of driving simulation pilot studies on various technologies for alertness monitoring (head position sensor, eye-gaze system), fitness-for-duty testing (two pupil-based systems), and alertness promotion (in-seat vibration system) has been conducted in Circadian Technologies' Alertness Testbed. The results indicate that all tested technologies show promise for monitoring/testing or preventing driver fatigue. However, particularly for fatigue monitoring, no single measure may be sensitive and reliable enough to quantify driver fatigue. Since alertness is a complex phenomenon, a multi-parametric approach needs to be used. Such a multi-sensor approach imposes challenges for online data interpretation. We suggest using a neural-fuzzy hybrid system for the automatic assessment of complex data streams for driver fatigue. The final system output can then be used to trigger the activation of alertness countermeasures.

**POSTER SESSION 1**  
**Wednesday, August 15, 2001**  
**4:00 PM– 5:30 PM**

- (15) **Driver Behaviour Studies in the Motorway Operations Platform Grant** Mark Brackstone, Mike McDonald (University of Southampton — *UK*)

This paper will report on a four-year project being undertaken in the U.K., which intends to address the causative mechanisms of motorway congestion, and how these may be overcome by the use of in-vehicle Intelligent Transport Systems (ITS). The project comprises five studies, two focussing on driver behaviour and performance, and three on microscopic simulation and road operations. This paper will provide an overview of progress made and work in progress in the former of these topics, in particular: Phase 1: an instrumented vehicle study collecting microscopic time series on how drivers behave in slow moving dense traffic. An overview of results from this phase will be presented. Phase 2: to be initiated in late 2001, looks to examine how drivers behave when faced with the requirement for an emergency deceleration. The study will use a combination of a surrogate vehicle/test track approach and a fixed base driving simulator study, in order to examine the advantages of the differing methodologies and (if validity is proven) to increase database size. A brief review will be given of the intended use of outputs from these studies in subsequent simulation modelling studies to be undertaken in future years.

- (16) **The Use of a Multi-modal Interface to Integrate In-Vehicle Information Presentation** David Wheatley, Joshua Hurwitz (Motorola Labs — *USA*)

The car of the future will have many new information sources—including telematics systems, navigation systems and Advanced Driver Assistance Systems (ADAS)—that will compete for a driver's limited cognitive attention. If they are implemented as completely separate systems then cognitive overload and driver distraction are inevitable outcomes. However, if they are implemented as an integrated intelligent system with a multi-modal interface, then the benefits of such functionality will be achieved with much less impact on driving safety. Such a system will support the task of safe driving by filtering and mediating information in response to real-world driving demands. This paper outlines the Human Factors research program being undertaken by Motorola Labs to evaluate key elements of such a multi-modal interface as well as the key human factors issues involved in a multi-modal interface.

- (17) **Performance on Cue Recognition and Evasive Action Skills as Predictors of Effective Driving in College-Age Drivers** Dong-Yuan Debbie Wang (Purdue University — *USA*), David F. Pick (Purdue University Calumet — *USA*), Robert W. Proctor (Purdue University — *USA*)

Two experiments compared self-reported driving effectiveness of licensed drivers (mean age 19 years) to their performance on two simulated driving tasks. For both experiments, drivers first completed a driving history questionnaire. In Experiment 1, they then performed Cue Recognition, which uses stationary line drawings of vehicles as stimuli and requires a turning or braking response to an appropriate stimulus. Males responded faster than females, especially for the most complex choice responses, and reported more tickets. Drivers reporting no tickets responded slower than those reporting at least one ticket, and they reported fewer accidents. In Experiment 2, drivers also performed Evasive Action Skills, which uses more realistic recorded driving scenarios in which the appearance of a hazard is the imperative stimulus that commands the appropriate turn or brake response. Number of errors on Evasive Action Skills correlated significantly with number of self-reported accidents. Response times on Cue Recognition and Evasive Action Skills were correlated, but there was no relation between response times on Cue Recognition and errors on Evasive Action Skills. However, a comparison of the 10 fastest and 10 slowest drivers on Cue Recognition showed that the fastest responders committed significantly more errors on Evasive Action Skills than did the slowest responders. The data in both experiments reflect a speed-accuracy tradeoff.

- (18) **BEI's Driver Skill Enhancement Program (D-SEP): Brief Review of Experimental Mini-Program and Conclusions** Seymour M. Bogdonoff (Princeton University — *USA*)

BEI has developed a Drivers Skill Enhancement Program (D-SEP). Many of the elements of this program have been verified through a "mini-program" (two days, 20 clients). It is known that driving is a combination of skills: visual, cognitive and physical. The D-SEP program adds the following items: the driver, in their car. P+A=a good driver. P is Preparation: what drivers in their cars can actually do. A is Anticipation: the visual-cognitive process that buys time to carry out the physical activities involved in making a car perform. Training and practice will, in most cases, considerably enhance the skills required for driving. Details of the mini-program and the full program are included in the paper. The study found that most drivers in the program had never practiced with ABS. The "stationary car" review was included as a "quick introduction." The author found that drivers performed quite differently with the instructor in the car versus their practice sessions alone. Training and practice with ABS is critical. Almost all clients were either "tentative" or "pumped" the brakes. Further examination of instrumenting the car and the driving course holds the potential to significantly reduce the cost of the program.

(19) **Ergonomics Specifications and Design of a HMI for an Informational Safe Driving Support System** Laurent Nicolas (PSA Peugeot Citroën — *France*)

This paper describes the first step in the ergonomic design of an HMI for an informational safe driving support system. The objective of the study was to establish initial settings for an alert and to collect subjective evaluations of the HMI. In an on-road experiment, a panel of drivers chose the settings they felt best corresponded to alerts for the system. The variable alerts examined included an auditory alert, flashing lights, flashing arrows, a vibrating steering wheel, and a vibrating seat. A content analysis of driver interviews determined that participants evaluated the HMI based on seven ergonomic criteria: attraction; alert level; representation of nature of danger; incitement to act; comfort; and, distinguishability. A second study will evaluate the global system, its function, and remaining HMI. **Please note:** This paper will not be presented at the conference but will be included in the final proceedings.

(20) **Effects of Cellular Telephone Use While Driving Based on Objective and Subjective Mental Workload Assessment** Roberto Abraham Tokunaga, Akihiro Shimojo (Civil Engineering Research Institute of Hokkaido I.A.I. — *Japan*), Toru Hagiwara, Seiichi Kagaya, Ken-etsu Uchida (Hokkaido University — *Japan*)

A series of studies were performed to investigate the effects of cellular telephone use while driving on driver mental workload. In these surveillance studies objective and subjective methods were used to document the driver mental workload behaviour. In the first study, the results indicated that the hands-free system had less effect on the driver's mental workload than the hand-held system. In the second study, experience in using a cellular telephone while driving had no positive effect on reaction time. The operation task and talking task had little effect on the subjective mental workload of experienced subjects, but had statistically significant effects on the subjective mental workload of the non-experienced subjects. In the third study, as in the second, the results indicated that telephone tasks increased the mental workload of drivers. The results also indicated that the complex conversation task produced an increase in driver mental workload as compared to the simple conversation task and the other tasks independent of age group.

(21) **The Trainer Project: Matching Training Curricula to Drivers' Real Needs Using Multimedia Tools** Daniel Herregods, Herve Nowe (Driving Know-How, POLE ProMotions SPRL — *Belgium*), Angelos Bekiaris (Laboratory of Transport Engineering of Aristotles University of Thessaloniki — *Greece*), Guido Baten (CARA-Belgian Institute for Road Safety — *Belgium*), Christian Knoll, Harald Widloither (University of Stuttgart — *Germany*)

One of the more important issues in road insecurity is that drivers are not conscious enough of all the dynamics involved in driving a vehicle. Historically, driver training has focused on vehicle control skills and traffic rules without working to provide risk awareness and other higher order skills. The European Union-supported "TRAINER" project addresses this problem with the development of a cost-effective, Pan-European driver-training methodology based on realistic, interactive, off-road tools: a new interactive multimedia training tool, and a low-cost stationary and medium-cost semi-dynamic driving simulator. This paper describes the interactive multimedia tool requirements and scenarios design to support driver training and assessment in strategic and manoeuvring tasks. The more than 100 different scenarios developed allow training and assessment of higher cognitive skills and familiarisation of novice drivers with the basic principles of driving: safety belt use, alcohol driving influence, gap acceptance, headway tailgating, peripheral view, yielding, lane changing, turning, unforeseen events, hazard perception, overtaking manoeuvres, visual cues, parked cars, intersection turning, pedestrians and children, and so on. After verification of the methodology and assessment of the effect on risk-awareness enhancement of learning drivers through tests with 30 novice drivers (and an equal control group) in 4 European countries, the TRAINER tools will be integrated into a common European driver education and assessment methodology that will contribute to the safe integration of novice drivers into the traffic environment.

(22) **The Trainer Project: A New Simulator-Based Driver Training Curriculum** Juan F. Dols, J. Pardo (Polytechnic University of Valencia — *Spain*), T. Falkmer (Swedish National Road and Transport Research Institute — *Sweden*), E. Uneken (University of Groningen — *The Netherlands*), W. Verwey (Institute for Occupational Physiology IFADO — *Germany*)

The purpose of the EU-funded TRAINER project is to develop a new, cost-effective, Pan-European driver-training curriculum, including computer-based interactive multimedia and simulator technology. The curriculum will pay significant attention to higher order skills including risk awareness. For this purpose, a number of scenarios were developed that address the most important needs of learner drivers. These scenarios are used in a PC-based interactive multimedia tool, as well as in a driving simulator. The interactive multimedia tool allows training and assessment of higher cognitive skills (i.e., strategic and manoeuvring tasks), familiarisation with the basic principles of driving, and a better understanding of (potential) risks. A low-cost stationary driving simulator is used to teach skills in vehicle handling and negotiating common traffic situations (i.e., manoeuvring and control tasks). In addition, a medium-cost semi-dynamic driving simulator is developed for supporting the needs of specific driver cohorts, such as novice drivers with enhanced knowledge problems and drivers in high-risk groups. Application of such an

advanced computer-based curriculum also implies development of criteria to allow driving instructors to determine training progress. These criteria are based on a database of normative driver behaviour. This paper mainly focuses on the description of the technical (soft- and hardware) requirements for both low-cost and mean-cost simulators.

(23) **Relation of Owner's Manuals to Safety** S. David Leonard (University of Georgia — *USA*)

Safe behavior is predicated on the individual's capability to perform appropriate acts when required. That capability involves both the requisite psychomotor skills and the knowledge of what acts are appropriate in the given situation. Knowledge of appropriate acts may be obtained in various ways. Signs, verbal commands, instruction, and written materials are all means of conveying such knowledge. The present study examines the influence of one form of written material associated with safe driving—the owner's manual. Specifically, two surveys were designed to evaluate drivers' use of the safety information in the manual and their awareness of the presence of safety information in the manual. The results suggested that owner's manuals are infrequently read, except for some specific sorts of information. Only two respondents in Experiment 1 indicated looking for safety information in the manual. Experiment 2 suggested that while respondents were aware of the possibility that safety information was in the manual, there was little indication that the manual was used for that purpose. A possible approach to reaching more of the target population might be to produce a separate safety manual for owners and drivers.

(24) **The Effect of Physical Changes in Aging on Driving Performance** Hideaki Nemoto, Takayuki Yanagishima, Mitsuru Taguchi (Nissan Motor Company, Ltd. — *Japan*)

The growing population of older drivers has led to societal demands for the development of technologies better suited to the characteristics of older people. One effective way to address this situation is to examine closely the structure that causes the performance of older drivers and to use that information to develop technologies. In this research, a first step was made toward identifying significant elements of the structure from a human factors standpoint. A questionnaire survey, an observation of driving behavior, and an interview survey were conducted with older drivers. Significant perspectives on driving were extracted from the results. Tests were then conducted with a driving simulator to verify those perspectives. Based on the surveys and tests, two significant characteristics were identified concerning the influence of aging on driving behavior. One concerns the disintegration of the stimulus-perception-cognition-response system and the other concerns the transition in attention.

(25) **Measures of Driver Behavior and Cognitive Workload in a Driving Simulator and in a Real Traffic Environment - Experiences from Two Experimental Studies in Sweden** Ruggero Ceci (Swedish National Road Administration — *Sweden*), Lennart Högman (Stockholm University — *Sweden*), Christopher Patten (Swedish National Road Administration — *Sweden*)

A general increase in the use of ITS (Intelligent Transportation System) is increasing the external demands on driver attention and cognitive functioning. In-vehicle systems such as navigation and onboard PCs with Internet and e-mail connections are on the market in many parts of the world. Two different studies are presented in this paper. The first focused upon mental performance as a result of driving in a tunnel simulation with a route choice task; the second looked at the effect of various in-vehicle navigation tasks in a real traffic environment. Results indicate future orientation and road choice problems. As much as 50% of test-drivers missed important road sign information and made critical road choice errors at specific points, i.e. entering the tunnel system from main roads. The second study found significant effects for visual and visual/verbal instructions but no significant effects for verbal instructions on mental performance. These results are discussed with respect to requirements regarding suitable standard methods for assessment of cognitive workload caused by external information (i.e. road/tunnel environment) and from in-vehicle systems.

(26) **The Effect of a Vehicle Control Device on Driver Performance in a Simulated Tank Driving Task** Ellen Haas (U.S. Army Research Laboratory — *USA*), Micaela Kunze (Bundesamt für Wehrtechnik und Beschaffung — *Germany*)

The purpose of this study was to determine the effect of different vehicle controllers on driver performance in a simulated tank-driving task. Eight male civilian volunteers with normal visual acuity drove a simulated tank on a digitized road terrain. The subject monitored his speed by means of a speedometer shown on the monitor. Independent variables were driving controller (joystick, or steering wheel with attached brake and accelerator pedal), and assigned driving speed of 15 or 45 mph (the maximum speed at which the subject was permitted to travel). Dependent variables were mean driving speed (the average speed at which the subject actually drove), and the proportion of time the center of the vehicle remained on the road during travel. Results indicated that subjects using the steering wheel obtained a significantly greater mean driving speed than those using the joystick. Only they were permitted to drive a maximum speed of 45 mph. This difference may have little practical significance because the mean driving speed for the two controllers differed by less than 5 mph. There was no significant difference between controllers for the proportion of time the driver was able to keep the center of the vehicle on the road. Results implied that the ergonomic placement of the joystick could be an important factor in enhancing driver performance, and that joystick controls have potential as an alternative control technology.

- (27) **The Effects of Age and Distraction on Reaction Time in a Driving Simulator** Justin M. Owens, Richard Lehman (Franklin & Marshall College — *USA*)

The objective of this study was to investigate the effects of driver distraction – both cognitive and visual – on reaction time to unexpected road hazards. Participants operated a driving simulator while intermittently answering prerecorded questions of various difficulty (holding a “conversation” with the computer), or dialing specified numbers into a cellular telephone. Two road hazards were presented at unpredictable times and locations, including red brake lights and a red pedestrian-shape of approximately the same area as the brake lights. Targets were presented in two different locations: directly in front of the driver at the bottom of the screen, and off to the side of the road. The results showed a significant overall increase in reaction time for older subjects, as well as a strong interaction with the dialing task condition. There were no significant differences from the control for either easy or difficult verbal response conditions. In addition, stimuli on the side of the road took significantly longer to respond to, especially when combined with the dialing task. These data suggest a strong link between age, visual task load, stimulus location, and increased reaction time to unexpected stimuli.

- (28) **Bilingual Variable Message Signs: A Study of Information Presentation and Driver Distraction** Samantha L. Jamson, Fergus N. Tate, A. Hamish Jamson (University of Leeds — *UK*)

Research on static bilingual signs has confirmed increased reading times compared to their monolingual counterparts; however there is little empirical research on bilingual Variable Message Signs (VMS). The study reported here evaluates the effect of various bilingual VMS configurations on driver behaviour and safety. The aim of the study was to determine whether or not the visual distraction associated with bilingual VMS signs of different configurations (length, complexity) impacted on driving performance. The results suggest that four-line bilingual VMS signs comprising 2 lines of text in each language are read by both monolingual and bilingual drivers in a manner that more closely approximates a two-line monolingual sign. This being the case it is likely that the deployment of four-line bilingual signs on Welsh motorways is unlikely to result in a significant reduction in safety.

- (29) **Assessing and Predicting the Impact of Cowlshake in Convertible Cars on Subjective Comfort** Harald Kolrep (Kolrep-Rometsch, Human Factors Consultants — *Germany*)

Torsional oscillations of the car body of convertible cars give rise to cowlshake of the wind-shield frame and the rear-view mirror, the dashboard, steering wheel, and seats. Drivers can perceive these oscillations which might impair subjective comfort and driving safety. Intensity ranges from just noticeable movements up to annoying shake of the steering wheel and distorted view in the mirror. A method to assess drivers’ subjective comfort is suggested which allows one to determine a functional relation between objective parameters of cowlshake and subjective comfort. This study is a first step towards simulation of cowlshake that includes prediction of comfort impairment.

- (30) **A Simulator Study of Driver Response to Changeable Message Signs of Differing Length and Format** José Guerrier (University of Miami School of Medicine — *USA*), Jerry Wachtel (The Veridian Group, Inc. — *USA*)

Highway congestion nationwide continues to increase, and three Florida urban areas rank among the top ten. Congestion costs the State \$3.5 billion annually in fuel and lost time, and is steadily worsening. Florida has been studying and implementing ITS technologies to address its congestion problems, with a focus on its special populations such as the elderly and groups for which English is not the primary language. One of the technologies most widely deployed is the changeable message sign (CMS). Although CMS have the potential to facilitate travel, they may also exacerbate congestion problems. Research has resulted in guidelines that address message visibility, legibility and understandability. While these guidelines are helpful in informing the use of CMS, sign operation varies widely across jurisdictions, often without the basis of empirical support. Because successful CMS operation depends, in part, on driver information processing speed and linguistic ability, there is a need to evaluate CMS with Florida's special populations. This study, funded by the National Institute on Aging, reports on one key CMS operational issue—the number of phases required to present a complete message. This study used a low-cost, interactive driving simulator supplemented with a video monitor above the main display. Simulator screens presented interactive road and traffic conditions, and the supplemental monitor displayed the CMS. Young and old drivers drove the simulator and responded to road closure/detour information on the CMS. All CMS displays were developed in accordance with accepted guidelines and were reviewed for content by independent experts. Results showed consistent and significant age effects across all tested conditions. In addition, we found significantly poorer response for all drivers under the two-phase (versus the one-phase) CMS despite the fact that our message “on-time” was nearly 2 seconds longer than that used in two major Florida jurisdictions. These findings have implications for CMS design and operation in Florida and in other jurisdictions with large elderly populations.

- (31) **Distraction Effects of Phone Use During a Crucial Driving Maneuver** Peter Hancock (University of Central Florida — *USA*), Mary Lesch, Lucy Simmons (Liberty Mutual Research Center for Safety and Health — *USA*), Mustapha Mouloua (University of Central Florida — *USA*)

Forty-two licensed drivers were tested in an experiment that required them to react to an in-vehicle phone at precisely the same time as they were faced with making a crucial driving decision. Using test track facilities, we extended a previous evaluation of this form to include examination of the influence of driver gender and driver age. Specifically, each driver was given task practice and then performed two blocks of twenty-four trials each, where one trial represented a circuit of the test track. Half of the trials were control conditions in which neither the stop-light was activated nor the in-vehicle phone triggered. Four trials required only stopping and a further four only phone response. The remaining four trials required the driver to complete each task simultaneously. The order of presentation of specific trials was randomized. The in-vehicle phone response task also contained an embedded memory task that was evaluated at the end of each trial. Results confirmed previous observations of slower task response followed by increased braking and that these patterns varied by driver age and gender. Most importantly, we recorded a critical 15% increase in non-response to the stop light in the presence of the phone distraction task which represents stop light violations on the open road. Further, results showed that age had a much larger effect on response than gender, especially on task components that required speed of response. Since driving represents a highly complex and interactive environment, it is not possible to specify a simplistic relationship between these distraction effects and outcome accident patterns. However, we can conclude that such technologies erode performance safety margin and distract drivers from their critical primary task of vehicle control. As such there is expectedly a causal relation in accident outcome that is a crucial concern for in-vehicle device designers and for all others seeking to ameliorate the adverse impact of vehicle accidents.

- (32) **Role of Monotonous Attention in Traffic Violations, Errors, and Accidents** Nebi Sümer, Belgin Ayvasik (Middle East Technical University — *Turkey*), Nurhan Er (Ankara University — *Turkey*), Türker Özkan (Middle East Technical University — *Turkey*)

Recent traffic Law in Turkey requires that drivers whose driving licenses were withheld because of their serious traffic offences be subjected to "psychotechnical assessment" tests. These tests must include measures for psychomotor and mental abilities such as monotonous attention, peripheral perception, and reasoning. Currently, we are in the process of developing a computer-based psychotechnical driver test system. This study investigates the validity of the monotonous attention test that is one of the measures in our system. Participants were 79 volunteer drivers from Ankara, Turkey. Drivers first completed the Driver Behavior Questionnaire (DBQ) measuring violations and errors and demographic items regarding drivers' history of offences and accidents. Participants then were asked to respond to the Traffic Monotonous Attention Test, which is a cancellation task. Initial analysis revealed that the correlations between the scores of the attention index and other major variables were not significant. Therefore, a tripartite split was performed on the participants' attention scores. The results of ANOVAs revealed that those who had a medium level of attention (incorrect responses) reported higher levels of driving errors than either the high or low attention groups. An examination of the relationships between accident type and the continuous attention scores indicated that those having active accidents also had higher levels of both incorrect and omitted responses than those in the no-accident and passive-accident groups. Findings of this study seem to imply that individual differences in the monotonous attention index should be correlated with accident involvement. They should also therefore be considered in devising a computer-based system.

- (33) **Effects of a Speed-of-Processing Intervention on Driving Performance: The ACCELERATE Study** Karlene Ball, David Ball, Meredith Rumble, David Edwards, Virginia Wadley (University of Alabama at Birmingham — *USA*)

Useful Field of View performance, as measured by UFOV<sup>®</sup>, is a valid and reliable predictor of crash involvement among older drivers, and UFOV<sup>®</sup> performance improves with Speed of Processing (SOP) training. The ACCELERATE Study is examining the effects of SOP training on other cognitive functions and on everyday mobility among older adults at risk for impaired mobility. To date, 59 participants have been randomly assigned to SOP training and 59 to an Internet training control group (total n = 118). At baseline and post-test, participants are given extensive cognitive, sensory, health, and mobility assessments, as well as driving assessments in either a driving simulator or an instrumented vehicle. Preliminary results indicate that performance on the UFOV<sup>®</sup> improves significantly more in the SOP training group than in the control group. Furthermore, means on most other cognitive variables are in the direction of greater improvement for SOP trainees than controls, with significant transfer of training on select speeded measures. Preliminary analyses of driving indicate that relative to controls, SOP trainees have improved in the speed with which they are able to detect moving targets originating in the periphery and moving toward central vision, but not in the detection of static targets originating in central view. Thus, some driving tasks appear to benefit from SOP training, while others do not. Results suggest that Speed of Processing training may transfer to other cognitive functions as well as to everyday mobility performance, such as driving.

- (34) **Visual Attention and Roadway Landmark Identification in At-Risk Older Drivers**, Amy Crowe, Tara Smyser, Mireille Raby, Kirk Bateman, Matthew Rizzo (University of Iowa — USA)

The purpose of the current study was to examine the extent to which on-road landmark identification during the driving task is predicted by off-road measures of visual attention. Thirty drivers, ages 66-92 enrolled in a larger ongoing study of at-risk older drivers. All subjects participated in a battery of tests of visual and cognitive ability. Speed of visual processing, divided attention and selective attention were measured using the Visual Attention Analyzer, 3000. They also took part in an on-road drive that tested their performance on several attention-related tasks. One of these tasks, a landmark identification task, was developed to evaluate driver perception and attention to relevant stimuli along the roadway. This task required drivers to identify restaurants (N=10) and safety-related signs (N=7-9) while driving an experimental vehicle along a commercial segment of a four-lane divided state highway. Performance on the landmark identification task was scored in terms of percent correct. Spearman correlation coefficients were calculated between the attention scores and the percent of correct scores on the Landmark Recognition task. **Results:** The 30 drivers generally showed impaired performances on tasks of visual processing speed divided attention speed and selective attention with identification of a foveal target and with same/different foveal discrimination. Results showed 76.35 % identification for safety signs and 40.3 % correct performance for restaurant identification. A selective attention subtest showed a significant correlation ( $p=0.032$ ) with performance on the restaurant portion of the landmark identification task, yet, surprisingly, other relationships were not significant. **Conclusions:** This study shows that scores on a test of selective visual attention task correlated with ability to identify landmarks (restaurants) on a commercial highway, yet visual processing speed and divided attention showed no significant correlation. Moreover, ability to identify safety signs did not correlate with any of the visual measures. Several factors may have affected the percentage of landmarks (signs and restaurants) identified. One factor is the variability of ambient traffic, which causes a variation of driver workload, which in turn affects the ability to search the roadway for visual targets. Also some drivers tended to call out indiscriminately every landmark they encountered, which would tend to increase their percent correct responses. In future analyses we will apply the theory of signal detection to address this response bias.

- (35) **Virtual Truck Driver Training and Validation: Preliminary Results for Range and Skid Pad** Gerard Meyer, Renee Slick, Daniel Westra, Nicolas Noblot, Lois-Ann Kuntz (Carnegie Mellon Driver Training and Safety Institute — USA)

This poster presentation will describe preliminary work done at the Carnegie Mellon Driver Training and Safety Institute (CM-DTSL) to test the validity of truck driver simulator training for backing maneuvers, and the digitalization of a skid pad. Preliminary results supported the validity of simulator training for straight-line and reverse-lane-change backing skills. Results for the skid pad work indicated that stopping distances during hard braking on the virtual skid pad were somewhat shorter than on the physical skid pad at the same initial speed. The shorter stopping distance in the simulator was the result of the functional limit of 0.2 surface coefficient of friction in the simulation dynamic model. A virtual skid pad with a slope of 9% was created to test the effect of slope on braking distance. Results showed that stopping distances in the simulator increased as a result of increasing the slope, indicating that the functional limit of the dynamic model can be overcome by varying the virtual slope.

## **TECHNICAL SESSION 4**

### **Driver Performance Assessment**

**Thursday, August 16, 2001**  
**8:15 AM – 10:00 AM**

- (36) **Can We Predict the On-Road Performance of Older Drivers?** Dianne Parker (University of Manchester — UK)

A study of drivers aged 50-90 was carried out to assess which, if any, of a range of measures were useful in predicting on-road performance. The study had three phases. In Phase One almost 2000 drivers completed an extensive self-report questionnaire, the Aging Driver Questionnaire, or ADQ. In the ADQ they described their personal and driving history, their driving behaviour and their attitudes and opinions on a variety of driving issues. Measures of general health, personality and intelligence were also taken. In Phase Two a subsample of those completing the ADQ (N=600) completed an extensive battery of laboratory tests of their cognitive and physiological capacities. In Phase Three 200 of this laboratory test sample completed two assessed on-road drives. The key results were that a) scores on the Manchester Driver Behavior Questionnaire (DBQ) showed that relatively high levels of errors and lapses behind the wheel were predictive of involvement in active accidents, while passive accident involvement was associated with a relatively high number of lapses, b) lapses were also associated with some indices of on-road performance, c) in general, performance on the cognitive and physiological laboratory tests was not associated with on-road performance and c) the best predictor of on-road performance was a relatively good score on a 'driving theory test', an assessment of driving knowledge offered in multiple choice format.

- (37) **Image Characteristics and Their Effect on Driving Simulator Validity** Hamish Jamson,  
(University of Leeds — *UK*)

Due to financial and computational limitations, the image quality presented in driving simulators is often a trade-off between resolution, pixel density and field of view. The current study examined this trade-off by investigating the effect of image resolution and horizontal field of view on the validity of the Leeds Driving Simulator. There were three levels of pixel density: low (3.6 arc min per pixel), high (2.6 arc min per pixel) and real world, and four levels of field of view: narrow (50°), medium (120°), wide (230°) and real world. Results seemed to show that widening the field of view improved the validity of speed choice and lane position between simulated and real world driving conditions, whilst there was no significant effect of image resolution.

- (38) **Prediction of Driver Decisions to Turn at Intersections** Jeff K. Caird, C.J. Edwards, J. Creaser,  
(University of Calgary — *Canada*), W.J. Horrey (University of Illinois — *USA*)

The present study examined the effect of time constraints on middle-aged and younger driver intersection decisions. It was expected that less time to decide, process and act upon intersection decisions would adversely affect drivers. The change blindness or flicker paradigm was modified to address these questions. Typically, an image (A) is alternated with a modified image (A') each for a short duration (250 ms) with a blank field or mask (80 ms) between A and A'. In the present study, a focus screen (or prime) that indicated the expected direction of travel (i.e., left, right, or straight) was added prior to the alternation of images. Forty-eight images were selected from 2500 intersection approaches in Calgary, Winnipeg and Montreal that were filmed using a digital camera during the day. A variety of elements including pedestrians, vehicles, signs, and signals were manipulated. The goal of the participant was to decide if the indicated direction of travel in the pair of intersection images was safe (press accelerator) or not (press brake). Length of image alternation (i.e., A and A') was the primary independent variable (5 and 8 s). Logistic regression analysis of the go no go decisions. Qualitative probes were also collected and frequency analyses illustrated the contextual demands on decisions. The implications of the results for intersection design and driver selective attention are discussed.

- (39) **Examination of Older Driver Steering Adaptation on a High-Performance Driving Simulator**  
Daniel V. McGehee, John D. Lee, Matthew Rizzo, Kirk Bateman (University of Iowa — *USA*)

The objective of this study was to examine how long it takes for older drivers to adapt their steering control on a fixed-base driving simulator. We hypothesized that older drivers achieve maximum training benefit within the first few minutes of a driving simulation. Thirteen drivers over 65 years of age drove a four-channel, 150° forward field-of-view, 50° rear field-of-view, fixed-base driving simulator for 25 minutes. We used a six-degree steering wheel reversal criterion to evaluate drivers' adaptation to the simulator. Since drivers adapt to a simulator over time, we examined the number of steering wheel reversals greater than six degrees that occurred per minute during each of three sections, the start, middle and end of the 25-minute drive. The results showed that older drivers needed about three minutes to adapt and get the "feel" of the simulator. Before this time driving behavior in the simulator may not be representative of actual driving performance. These results provide preliminary support for assuming that an adaptation period as short as five minutes may enable drivers to adapt to the driving simulator and drive normally.

**TECHNICAL SESSION 5**  
**Information Display Issues in Driver-Vehicle Interface Design**  
**Thursday, August 16, 2001**  
**10:15 AM– 12:00 noon**

- (40) **They Drive at Night - Can Visual Enhancement Systems Keep the Driver in Control?** Erik Hollnagel, Johan Karlsson, Thomas Magnusson, Ulrika Taube (University of Linköping — *Sweden*)

Driving requires a combination of open-loop and closed-loop control. The open-loop control is affected by the quality of visual input, and therefore constrained during driving at night. This study investigated the effects of a Visual Enhancement System (VES) during simulated night driving conditions. It was hypothesised that the VES would improve the driver's control, hence the quality of driving. Forty subjects drove about 120 km on a simulated Swedish road with and without a VES. At the time of writing, the experiments had just been completed. Data analysis will focus on derived measures that correspond to the driver's degree of control.



- (41) **Evaluation of Driving-Assistance Systems Based on Drivers' Workload** Yuji Takada, Osamu Shimoyama (Nissan Motor Co., Ltd — *Japan*)

This paper describes an experimental study in which advanced driving-assistance systems were evaluated using methods for estimating workload levels. The effects of such systems on drivers' mental workload and driving performance were measured experimentally using the driving simulator. Six subjects were instructed to drive the simulator in a highway environment with and without Adaptive Cruise Control (ACC) and/or a collision-warning system (CWS). To assess the effectiveness of these systems, subjects were asked to calculate sums of single- or double-digit figures displayed. The results show that higher accuracy was obtained with ACC than without it. To estimate the subjects' mental workload levels, electrocardiograms and respiration data were recorded during the sessions, and the RRI, heart rate variance and respiration frequency were calculated. The results indicate that the provision of the CWS and ACC reduced the subjects' mental workload compared to when the driving-assistance systems were not present.

- (42) **The Relative Importance of Pictorial and Nonpictorial Distance Cues for Driver Vision** Michael J. Flannagan, Michael Sivak, Julie K. Simpson, (University of Michigan Transportation Research Institute — *USA*)

There is evidence that nonpictorial distance cues, including accommodation and binocular disparity, play at most a minor role in driving relative to pictorial cues, such as relative size and linear perspective. However, the possibility that nonpictorial cues play a nontrivial role in at least some driving situations is of interest because of current and proposed applications of camera-based displays in driving. Such applications include the use of video systems as replacements for rearview mirrors and to enhance forward vision at night. By their nature, camera-based displays selectively eliminate or distort nonpictorial distance cues. This paper reviews analytical and experimental approaches for determining the relative importance of pictorial and nonpictorial cues in driving, and discusses the implications for the use of camera-based displays, as well as nonplanar rearview mirrors.

- (43) **Preliminary Studies of Mono-Pulse Braking Haptic Displays for Rear-End Collision Warning** Louis Tijerina (Ford Motor Company — *USA*)

This paper summarizes two studies of mono-pulse braking for rear-end collision avoidance applications. The first study was a single-vehicle parameter-setting study without a lead vehicle that produced recommended pulse braking display duration and jerk rate. However, results also indicated that pulse braking display magnitude influenced the magnitude of driver braking behavior. A second study examined the impact of this driver interface concept both when a lead vehicle was braking to a stop and when the display came on even though the lead vehicle was not slowing down. The results indicated that in the first case drivers modulated their response according to the constraints of the situation rather than the magnitude of the haptic display. On approximately one-third of false positive trials, brief and mild inappropriate braking responses were recorded.

**INVITED SPEAKER**  
**Thursday, August 16, 2001**

- (44) **Behavioral Entropy as a Measure of Driving Performance** Erwin R. Boer (Wingcast — *USA*)

Delayed event detection and degraded vehicle control are observed when drivers feel the need to perform extra-driving activities. Vehicle control and event detection are shown to degrade most when the in-vehicle task requires spatial cognitive resources and/or if the activity requires visual perception and/or manual control manipulation. In-vehicle tasks with auditory input and/or voice output that demand low levels of verbal cognitive resources appear to affect event detection only to a small degree, and seem to have no effect on vehicle control. This paper presents a theory-based approach to measuring, analyzing, and interpreting these performance assessments. Results from our SAE paper #1999-01-0892 are used to demonstrate that steering entropy (a measure of vehicle control) in conjunction with reaction times to unpredictable peripheral events (a surrogate measure for event detection) offer clear insight into the safety consequences of various in-vehicle tasks. These results are discussed here in the context of a simple linear predictive model that is based on Wickens' theory of multiple resources. The model is shown to offer useful predictions about and interpretations of the effects that various in-vehicle tasks have on driving performance in general and driver distraction in particular.

**TECHNICAL SESSION 6**  
**Medical Factors**  
**Thursday, August 16, 2001**  
**1:45 PM – 3:45 PM**

- (45) **Determinants of Driving After Stroke** Abiodun Emmanuel Akinwuntan, Hilde Feys, Willy De Weerd, Jan Pauwels (Katholieke Universiteit Leuven — *Belgium*), Guido Baten, Emmanuel Strypstein (CARA, Belgian Institute for Road Safety — *Belgium*), Outstanding Student Paper Award Winner

*Objective:* To identify from a predriving assessment the tests that best predict the driving ability of stroke patients. *Design:* Examination of records of 104 first ever stroke patients who visited the Belgian Institute for Road Safety in 1998 and 1999 and performed the medical, visual, perceptual and the 'on the road' assessments. *Measures:* Variables such as age, sex, side of lesion, driving experience, visual tests, neuropsychological assessments most of which are from the Test for Attentional Performance (TAP) battery and an 'on the road' test were considered. Based on performances of subjects on the tests, a suitable, not immediately suitable or not suitable to drive decision was jointly taken by the team of assessors. *Results:* Following a logistic regression analysis, a combination of side of lesion, kinetic vision, visual scanning and the 'on the road' tests led to the best model in predicting the final group decision ( $R^2=0.53$ ). The 'on the road' test was the most important determinant ( $R^2=0.42$ ). *Conclusion:* The predictive accuracy of the decision is moderate. Inclusion of assessments more closely related to real road situations should be considered.

- (46) **Dynamic Evaluation of the Useful Field of View in Driving** Daniel R. Mestre (Cognitive Neurosciences Centre, Centre National de la Recherche Scientifique — *France*)

The concept of "useful field of view" (UFOV) was introduced to describe the area from which useful visual information can be extracted in a single glance. It is not restricted to the fovea, nor does it involve the entire visual field. It is often claimed that the UFOV decreases with age, with increasing speed of travel, or under the influence of drugs or stress. However, this potentially important tool for evaluating the role of human sensorial factors in road safety suffers from a lack of measurement techniques. Within this framework, we evaluated the ability of subjects to discriminate variations in their direction of heading from optical flow patterns simulating self-motion relative to a simple toric surface (a curved "tunnel"). We systematically evaluated perceptual performance as a function of the part of the global optical flow observers were looking at. Inasmuch as experimental laboratory data can be generalized to the complex task of driving, the results suggest that the perception of heading is optimal in a limited part of the visual field, that area which is situated close to the future direction of travel. The results offer a novel approach to the concept of useful field of view. They can be discussed in terms of their implications for road infrastructure design and for the positioning of warning and traffic signs within the driver's dynamic visual environment.

- (47) **Time-to-Contact and Collision-Detection Estimations as Measures of Driving Safety in Old and Dementia Drivers** Nicoleta L. Read (University of Leeds — *UK*), Nicholas J. Ward (University of Minnesota — *USA*), Andrew M. Parkes (TRL Limited (Transport Research Laboratory) — *UK*)

The paper discusses the importance of Time-to-Contact (TTC) and collision detection (CD) estimations for safe driving. It describes a computerised testing tool that requires TTC and CD estimations while dividing attention, and discusses the association between performance on this task and several measures of driving safety. We report four studies showing that the task is sensitive to age effects and dementia effects and that the accuracy of Time-to-Contact estimations differentiates between old and dementia drivers recently involved in accidents and those not involved. We also found an association between performance on this task and on navigation and car-following tasks in a driving simulator.

- (48) **Recent European Projects on Driver Impairment** Nicholas J. Ward (University of Minnesota — *USA*), Karel Brookhuis (University of Groningen — *The Netherlands*)

It is estimated that at least 30% of all serious car accidents in Europe may be attributed to problems with the driver's state due to factors such as alcohol or drug use, fatigue, or health problems. This paper gives an overview of recent European Union projects to address this issue by assessing driver impairment. Whereas previous research has focused on vehicle technology (DREAM, DETER), or Human Machine Interfacing (SAVE, AWAKE), more recent efforts have been based on methods to detect the presence of substances (ROSITA) or the level of impaired performance at the roadside (CERTIFIED, IMMORTAL). This paper summarizes the objectives and main conclusions of the most recent research in this area.

- (49) **An Analysis of Driving Performance Measures Used to Assess the Effects of Medications on Drowsiness, Sedation and Driving Impairment** Ginger Watson, John M. Weiler, George G. Woodworth, Julie Qidwai, Susan Quinn (University of Iowa — *USA*)

The objective of this paper was to discuss the ability of driving scenarios and associated driving performance measures to demonstrate drowsiness, sedation, and driving impairment. The basis of this paper was a study that utilized a randomized, double-blind, double-dummy, four-treatment, four-period crossover trial in the Iowa Driving Simulator (IDS). Participants were 40 licensed drivers with seasonal allergic rhinitis who were 25 to 44 years of age. Treatments were Fexofenadine, diphenhydramine, alcohol, or placebo, given at weekly intervals before participants drove for 1 hour in the IDS. Measures examined included coherence, amplitude, phase angle, RMS error, following distance and behavior, lane keeping, response to unexpected vehicle intrusion and drowsiness. Study results show that sedating antihistamines impair driving performance as seriously as alcohol. Statistically significant but small correlations were found between subjective drowsiness and minimum following distance, steering instability, and left-lane excursions, although no correlation was greater than 0.21. Drowsiness was a weak predictor of driving impairment. This paper discusses these and other findings with an emphasis on the adequacy of driving scenarios and the sensitivity of the driving performance measures analyzed.

**POSTER SESSION 2**  
**Thursday, August 16, 2001**  
**4:00 PM – 5:30 PM**

- (50) **Traffic Maneuver Problems and Crashes of Young Drivers** Adam Kirk, Nikiforos Stamatiadis (University of Kentucky — *USA*)

While over the past decades the population of younger drivers has been decreasing, their crash rates have increased. Past research has associated their higher crash rates to societal influences and youthful behavior. The objective of this research is to identify the specific driving maneuvers whose unsuccessful undertaking results in specific types of crashes involving these drivers. Four types of crashes were identified as the most prominent for young drivers including crashes at intersections, rear end, crashes resulting from passing maneuvers and single vehicle crashes. The analysis was performed examining the Kentucky crash database for the 1994-1996 period using the quasi-induced exposure method. The results showed that for all crashes there is a general trend of decreasing involvement with increasing age, which indicates that their inexperience is the largest single contributor to their increased crash rates. Of significance is the fact that for all crashes a dramatic decrease of involvement after the first year of driving between the years of 16 and 17 is observed. This may be indicative of a steep learning curve in the first years of driving regarding the ability to control a vehicle. Therefore, very little can be made to improve this phenomenon. Increasing the level of awareness among young drivers about these issues and their likely crash involvement seems to be the only viable approach. However, preliminary efforts from the graduated license show that some of these trends seem to be reduced indicating a possible impact on the crash rates of young drivers.

- (51) **Driver License Renewal Issues and Concerns** Nikiforos Stamatiadis (University of Kentucky — *USA*)

Periodic renewal of driver licenses is an integral part of the licensing procedures for most states, including Kentucky. Renewal of driver licenses is usually required every four years, and many states conduct vision tests before granting renewal. A few states require additional testing, while several states, including Kentucky, have no vision or any other examinations at renewal. Past research has shown a relationship between crashes and driving records. Thus, it was considered important to develop mechanisms to identify potential problem drivers and to systematically review current practices regarding license renewal and retesting. Additional concerns included the increasing percentage of elderly drivers and the deterioration of their vision due to aging. There is a universal agreement that vision plays a significant role in driving performance, that there are age-related visual changes, and that drivers over age 75 have proportionally higher crash rates than younger drivers. However, there is no established standard for vision-screening policies. Age-based road tests are not considered to be a practical means for identifying drivers with deficiencies, and they would unnecessarily burden the license renewal process. However, using road tests as an additional means of evaluating select individuals, such as those failing vision tests or those referred by a physician or family member, could significantly improve the identification of deficient drivers. The work completed here indicates that safety gains might be achieved by implementing additional procedures for older drivers. Such procedures might include requiring drivers over 75 to renew their licenses every 2 years, and using vision screening tests that include a set of medical questions for older drivers. Allowing renewal examiners the discretion to require road testing as deemed necessary is also recommended. Despite our considerable knowledge about the physiological changes of older persons and the impact of these changes on driving, further research is needed. Such research should seek to design and evaluate license renewal programs that would provide older persons with a fair assessment of their driving abilities.

- (52) **Detection of Collision Events by Older and Younger Drivers** George John Andersen, Asad Saidpour, AnnJudel Enriquez (University of California, Riverside — *USA*)

Recently (Andersen et al., 2000; 1998) we found that older drivers performed more poorly than younger drivers in a situation that required them to detect an impending collision during braking. In the present study, we examined whether older drivers performed poorly compared to younger drivers in detecting a collision with a moving object. Twenty-two older and younger drivers were presented with computer-generated scenes of a roadway in a driving simulator. Located in the scene was a single object that moved independently of the vehicle motion, and that was or was not on a collision path with the vehicle. Overall older drivers were less sensitive to detect a collision than younger drivers, with performance worse for long as compared to short time-to-contact (TTC) conditions.

- (53) **The Role of Simulation in a Staged Learning Model for Novice Driver Situational Awareness Training** Loren Staplin (TransAnalytics, LLC — *USA*), James C. Dowdell (SafeDrive Technologies — *USA*)

This paper theorizes that an optimal strategy for training novice drivers to acquire situational awareness skills will rely on a hierarchical approach consistent with traditional models of cognitive development. The success of applying such models hinges upon information presentation techniques that can maximize depth of processing, and hence comprehension and retention, at a specific stage of learning. Our general discussion argues that the appropriate use of simulations is uniquely suited to meet this need.

- (54) **Driving Tests: Reliability and the Relationship Between Test Errors and Accidents** Chris Baughan, Barry Sexton (TRL Limited (Transport Research Laboratory) — *UK*)

In the British practical driving test, serious or dangerous faults are those judged to involve potential or actual danger, and a single such fault results in test failure. As part of a wider project to review the driving test, TRL conducted a study of test-retest reliability. Test and retest outcomes differed for a substantial proportion of candidates. The paper argues that inconsistent performance on the part of the candidate is likely to explain much of this apparent unreliability. Minor faults are recorded during the test but few candidates make the 16 of them necessary to fail. Self-reported accidents during the first six months of post-test driving were analysed together with driving test records for approximately 30,000 drivers. Statistical modelling suggested that people who pass the driving test having made large numbers of minor faults may be intrinsically less safe as drivers, but that they also tend to drive less overall, and less often at night. This reduces (and for men removes) the association between test faults and the actual number of accidents reported.

- (55) **Feasibility of Evaluating Design Ideas for Reducing Vehicular Entrapment at Railroad Crossings Using a Laboratory Experiment** One-Jang Jeng, Tirthankar Sengupta, Satya Valleplalli (New Jersey Institute of Technology — *USA*)

The number of accidents at railroad crossings is particularly high at places where streets run parallel to the railroad tracks. Existing grade crossings were investigated for potential problems and studied for design solutions. The present study reports progress of the first phase of a NJ DOT-sponsored project. A laboratory experiment was conducted to evaluate various design ideas before they are implemented in a second-phase field study. The laboratory study used images taken from actual scenes of railroad crossings in New Jersey instead of the graphical drawings commonly used in driving simulations. Possible design ideas were edited using image-processing software. Design ideas were then saved in different layers in order to generate design combinations that could be superimposed on the background images to create virtual railroad crossing scenes. Nighttime images were also made possible by retouching the digital daytime images. Preliminary results of the in-lab experiment are presented. Lessons learned from the current project indicate that the use of actual images with superimposed design ideas is a cost-effective approach to evaluating and redesigning display layouts.

- (56) **Modeling Driver Cognition** Delphine Delorme (University of California at Berkeley — *USA*)

Modeling driver cognition is a challenging but necessary endeavor in the effort to develop systems able to support drivers in their decisions and actions. This paper focuses on the design and implementation of the PADRIC (PATH DRIVER Cognitive) model, and on the module in charge of reproducing part of the perceptive processing of the model. The PADRIC model is integrated within a micro-simulation tool (SmartAHS) to support the development and assessment of driver assistance systems. For example, it has been used to generate simulations of visual distraction for highway-driving resulting in hard braking maneuvers. Future research will seek to include additional cognitive processes in order to increase the range of behaviors that can be simulated and to introduce new knowledge databases in order to apply the model to other traffic situations than highways.

- (57) **Acceleration Behavior of Drivers in a Platoon** Ghulam H. Bham, Rahim F. Benekohal (University of Illinois at Urbana-Champaign — USA), Outstanding Student Paper Award Winner

A new dual-regime acceleration model was developed to represent the acceleration behavior of drivers in a platoon of vehicles. Two sets of field data collected by aerial photographic techniques were used to assess the validity of the proposed and existing acceleration models. A single regime acceleration model failed to present the acceleration behavior of drivers. The field data indicated that at around 13 m/sec the acceleration rate drops. Thus, two different acceleration rates, higher acceleration rate at lower speeds and lower acceleration rate at higher speeds, were used to provide the best fit to the data. This provided realistic acceleration behavior of drivers in a platoon. The field data sets were collected about 10 years apart. The improvements in acceleration capability of a platoon of vehicles from two different time periods were determined. Improvements in performance of vehicles were quantified using the above mentioned field data. The method of quantification can also be used to predict and model the performance of vehicles currently in use. Inversely, current vehicles can be downgraded to represent vehicles of past years and thus make use of already collected data. Important uses of the dual regime model are in modeling the traffic flow behavior and designing roadway elements that depend on acceleration behavior of drivers.

- (58) **Evaluating the Presence of In-Vehicle Devices on Driver Performance: Methodological Issues** Christian Jerome, H.C. Neil Ganey, Patrick Commarford, Brian Oakley, Mustapha Mouloua, Peter A. Hancock (University of Central Florida — USA), Outstanding Student Paper Award Winner

A central concern of Intelligent Transportation Systems (ITS) is the effect of in-vehicle devices (e.g. cell phones, navigation systems, radios) on driver performance and safety. As diverse and innovative technologies are designed and implemented for in-vehicle use, questions regarding the presence and use of these devices assume progressively greater importance. Concern for the safety of advanced driver training and require us to develop and validate reliable and effective procedures for assessing such effects. This work examines a number of candidate procedures, in particular the evaluation of cognitive workload as a strategy by which such goals might be achieved.

- (59) **Driver and Driving Assessment Issues Associated with the Application of a Secondary Task Technique: A Case Study** Michael P. Manser, Jacqueline Jenkins (Texas A & M University — USA)

This paper presents the results of an examination of driver assessment techniques applied to a case study investigating the relationship between conversation intensity while using a cell phone and driver performance. A secondary task technique was applied to study the influence of the intensity of conversation on the degradation of driving performance attributed to using a cellular telephone. Forty participants drove through simulated driving environments and engaged in cellular telephone conversations with the experimenter. After driving through each environment participants provided a rating of the workload experienced during the cellular telephone conversation during the drive. Accelerator input, speed, steering input, and lane position measurements were recorded while participants drove through particular sections of the simulated driving environments. Results of the study indicated the variation of steering input increased when the cellular telephone was used. Males generally drove faster, and females responded more quickly to a situation requiring a sudden braking or steering maneuver. Overall, the drivers perceived the workload to be greater when using a cellular telephone. However, the use of the case study to examine the driver assessment and secondary task techniques indicated there were several positive and negative attributes which need to be considered in future research where such techniques are to be applied. For example, an analysis of the performance measures revealed that changes in the horizontal alignment of the roadway created lasting perturbations in the data. In particular, increased variations in steering input and lane position were observed for a considerable distance and time after a participant exited a curved section of roadway. These perturbations subsequently interfered with the application of the secondary task.

- (60) **Evaluation of a Low-Cost, PC-Based Driving Simulator to Assess Persons with Cognitive Impairments Due to Brain Injury** Jerry Wachtel (The Veridian Group, Inc. — USA), William K. Durfee (University of Minnesota — USA), Theodore J. Rosenthal (Systems Technology, Inc. — USA), Elin Schold-Davis (Sister Kenny Institute — USA), Erica B. Stern (University of Minnesota — USA)

Brain injury due to accident or stroke frequently results in cognitive impairment, reducing an individual's ability to judge driving situations accurately. And such individuals may lose the metacognitive skills necessary to be aware of their own limitations. Typical on-road evaluations conducted by rehabilitation professionals are generally unable to assess the candidate's responses to real-world driving challenges because they are conducted under non-demanding conditions. Indeed, individuals with mild cognitive deficits may perform adequately on such tests but unsafely when driving challenges increase. In a project funded by the National Center for Medical Rehabilitation Research, National Institutes of Health, we sought to determine whether a low-cost, PC-based driving simulator could provide clinicians with information useful to their efforts to assess the safe ability to drive of individuals with cognitive impairments. We developed two driving scenarios and pilot-tested them on ten subjects—five with moderate impairments and five controls. Both the "simple" and "complex" scenarios matched the essential route characteristics of an existing on-road evaluation, but the "complex" scenario incorporated common but demanding driving challenges, including: cross-traffic failing to stop at a STOP sign; pedestrians crossing the driver's path; vehicles suddenly entering traffic from the shoulder; opposing traffic appearing from behind slower moving vehicles; slow lead vehicles causing

passing decisions; and oncoming traffic forcing gap acceptance decisions for left turns. Results from both discrete events and continuous performance data were encouraging. We evaluated four discrete events: run-off-road; crashes; failure to stop at STOP signs; and failure to execute directed turns. Whereas each of the brain-injured subjects committed at least one of these errors, none of the control subjects committed any. We collected continuous data for speed maintenance, speed deviation, and lane position, in both the simple and complex segments of the scenario, for two tangent and four horizontal curve sections. Generally, the non-impaired subjects improved their performance during the course of the 19-mile scenario, despite the fact that the complex events all occurred during the second half of the drive, whereas the impaired subjects' performance degraded during the complex segment of the run. The results will lead to an enhancement of simulator capabilities and a comprehensive clinical trial at multiple sites.

- (61) **Driver Advocate™ Tool** Chip Wood, Robert Leivian, Noel Massey, Jack Bieker, John Summers (Motorola Labs — USA)

Using scenario driven research, a Driver Advocate™ (DA) system has been designed to advise the driver about potentially unsafe situations based on information from environmental sensors. DA is an intelligent dynamic system that monitors, senses, prioritizes, personalizes, and sends alerts to the driver appropriate to the moment. This has the potential to sharply decrease driver distraction and inattention. To support the realization of DA, a DA Tool (DAT) has been developed to coordinate with a KQ (previously Hyperion) virtual driving simulator and allow the merging of the simulated driving performance, the environmental sensors, and the intelligent use of audio, visual, and tactile feedback to alert the driver to potential danger and unsafe driving behavior. DAT monitors the traffic, lane following, forward and side clearances, vehicle condition, cockpit distractions, Infotainment use, and the driver affective behavior. The DAT is designed to be highly configurable, flexible, and user friendly to facilitate creative freedom in designing usability and human factors experiments and rapid prototyping.

- (62) **A HMD-Based Virtual Reality Driving Simulator** Ronald R. Mourant (Northeastern University — USA), Maria T. Schultheis (Kessler Medical Rehabilitation Research and Education Corporation — USA)

Recent advances in optics, HMD design, 3D graphics chips, and processes for personal computers have combined to make HMD-based virtual reality driving simulators available at low cost. A HMD with a resolution of 1,024 by 768 with a FOV of 50° diagonally is now available for about \$20,000. A graphics processor that can render large databases at fast frame rates costs only \$400. Personal computers can now support multiple processors that run over 1 Gigahertz. We discuss visual concerns with a HMD, choosing a HMD for a driving simulator, HMDs compared with fixed displays, consequences of improved frame rates, autonomous vehicles, and the use of a HMD based driving simulator for studying drivers who have cognitive impairments.

- (63) **Meta-Analysis of Crash Risk Factors Among Older Drivers: Application to a Model Program of Driver Screening** Karlene Ball, Virginia Wadley, Jerri Edwards, David Ball (University of Alabama at Birmingham — USA), Daniel Roenker (Western Kentucky University — USA)

In the absence of disease or impairment, there is no empirical evidence that subtle, age-related changes in sensory or cognitive function affect older drivers' abilities to safely operate a motor vehicle. However, impairments that do affect driving occur with a higher prevalence in the older population. This paper describes a meta-analysis of risk factors for automobile crash. Risks associated with compromises in visual acuity, contrast sensitivity, visual fields, useful field of view, and mental status are examined. Risks associated with medical conditions, medications, and physical limitations also are discussed. Results demonstrate that visual acuity and contrast sensitivity are only weakly associated with crash risk, while cognitive variables and mental status measures are moderately associated with crash risk. A specific measure of The Useful Field of View, UFOV®, is strongly associated with crash risk. These results suggest that driver evaluations aimed at detecting unsafe drivers can be significantly improved. Specifically, evaluations can be improved by including a broader assessment of visual function, an assessment of cognitive function including the UFOV®, an assessment of mental status, and an assessment of physical status. An evaluation incorporating these components might facilitate driver qualification or referral for appropriate intervention. A driver screening evaluation program incorporating these components is currently underway. With over 2,000 older adult participants, results from this model program indicate that cognitive function, rather than visual or physical function, is most strongly associated with mobility outcomes. Thus, interventions to maintain or improve cognitive function may also help to sustain mobility

- (64) **Effects of Speed of Visual Processing Training upon Non-Visual Attention in "At-Risk" Older Drivers** Nicole Skaar, Matthew Rizzo, Kirk Bateman, Steven Anderson (University of Iowa — USA)

Purpose: Reduction in a measure known as the Useful Field of View (UFOV) is a risk factor for car crash involvement in older drivers (Owsley et al, 1991; Ball et al, 1993). This measure depends on aspects of visual attention (divided attention [DA], selective attention [SA]) and speed of processing (Owsley et al, 1991; Ball et al., 1993). UFOV scores can be improved through speed of processing training (Ball, Beard, et al., 1988a,b), and this improvement may transfer to enhanced driving performance (Roenker et al, submitted). This preliminary analysis addresses the hypothesis that training of visual speed of processing can improve performance in attention-demanding tasks that

are processed outside the visual domain. **Methods:** Forty participants were enrolled in an ongoing study of at-risk older drivers based upon reduction in UFOV scores (measured using the Visual Attention Analyzer, 3000). Twenty-two participants ages 66-87 (mean age = 74.4; mean MMSE = 28.4; 65.4% male) were randomly assigned to a speed of visual processing training group and 18 participants ages 67-91 (mean age = 75.1; mean MMSE = 28.7; 52.6% male) were randomly assigned to a control group (who trained to use the Internet). Each group participated in 10 one-hour training sessions. All 40 participants also performed on a version of the Paced Auditory Serial Addition Task (Gronwall, 1977), which was administered before and after training. **Results:** After training, the speed of processing training group showed improvement in mean scores on all UFOV subtests (DA 66.18ms, SA 244.68ms [with identification of a foveal target] and 115.27ms [for a same/different foveal discrimination];  $P < 0.001$  Wilcoxon signed rank, all cases). The controls showed improvement only on the selective attention subtest (70ms  $p = 0.049$ ). On the PASAT, the speed of processing training group showed improvement in mean scores on the 2.4 second PASAT (8.6%,  $p = 0.01$ ). Results improved at the 2.0 second interval task, but this difference was not significant (4.4%,  $P = 0.11$ ) - possibly due to a floor effect at this difficult speed. The control group did not improve their PASAT scores significantly at either PASAT speed (3.0%,  $P = 0.51$  at 2.4 second and 3.8%;  $P = 0.22$  at 2.0 second intervals). **Conclusion:** Training of speed of visual processing improved performance on visual attention tasks as expected. We also found preliminary evidence of crossmodal transfer of these training effects leading to improvement on the PASAT, a task that commands both auditory attention and working memory. These preliminary findings suggest that speed of visual processing intervention may entrain attention resources at supramodal levels outside the visual modality. Improvement of attention in tasks outside the visual domain after training of visual speed of processing may be relevant to performance in tasks during driving such as multitasking, using a cell phone, and engaging in conversation with a passenger.

**(65) A Computational Model of Driver Decision Making at an Intersection Controlled by a Traffic Light** Terry Stanard, Robert J.B. Hutton (Klein Associates, Inc. — USA), Walter Warwick, Stacey McIlwaine, Patricia L. McDermott (Micro Analysis and Design — USA)

An important challenge associated with driving simulation development is the computational representation of agent behaviors. This paper describes the development of a preliminary autonomous agent behavior model (based on the Recognition-Primed Decision (RPD) model, and Hintzman's multiple-trace memory model) mimicking human decision making in approaching an intersection controlled by a traffic light. To populate the model, an initial Cognitive Task Analysis was conducted with six drivers to learn the important cues, expectancies, goals, and courses of action associated with traffic light approach. The agent model learns to associate environmental cues (such as traffic light color) with expectancies of upcoming events (like light color change) and appropriate courses of action (such as decelerating). At present, the model is currently being evaluated for its successful representation of the Recognition-Primed Decision Making process.

**(66) Investigating Drivers' Traffic Knowledge in Jordan** Wa'el Awad, Mohammad Rasoul S. Al-kharabsheh (Al-Balqa' Applied University — Jordan)

Jordan's fatality rate per registered vehicle is approximately 7.5 times larger than that of the United States (157.2 per 100,000 in Jordan vs 21.0 per 100,000 in the U.S.). This project addresses the traffic safety problem in Jordan by evaluating driver's knowledge of existing traffic laws and regulations. An experiment was conducted in which 55 subjects with current driver's licenses were administered a test composed of 25 questions selected from actual Jordanian driver's license exams. Statistical analyses were then conducted on the results. It was found that a shocking 96.4% of the drivers in this study failed to pass the simulated written driver's license exam, with professional drivers scoring worse than non-professional drivers. Based on the findings, recommendations are made regarding Jordanian public policy governing driver's licensing, including more frequent retesting of drivers, a higher standard of knowledge for traffic rules, and a nationwide program to assess the relationship between driver knowledge, driver behavior, and crash and fatality rates.

**(67) Socioeconomic Characteristics of Speeding Behavior** Kyungwoo Kang (Hanyang University — Korea)

Many studies on drivers' speeding behavior have been reported in the last decade. Most of the previous studies, however, have concentrated on the relationship between drivers' speeding behavior and road/vehicle characteristics, without considering other important factors such as personal characteristics and drivers' perception of the speed limit. This paper analyzes Korean drivers' speeding behavior by taking into account such factors as trip characteristics in addition to personal, vehicular, and attitudinal factors. Speeding behavior is measured by a categorical measure over the speed limit, and an ordered probit model is used to econometrically estimate the speeding behavior equation. Results indicated that i) male drivers with higher income tend to drive faster, and experienced drivers drive at higher speeds than others ii) vehicles with more horsepower and vehicles with safety features go slower than vehicles with less safety features iii) trip distance and frequent use of the road are important factors for speed selection behavior, and iv) perceived speed limit of the road and expectation of being caught for speeding are important factors for driving behavior.

**(68) Driver Alertness Detection Research Using Capacitive Sensor Array** Philip W. Kithil (Advanced Safety Concepts, Inc. — *USA*)

The research project compared and analyzed physiological and performance data for 13 subjects driving a vehicle simulator. Each subject drove the simulator for morning, afternoon, and late night sessions. These sessions were intended to represent alertness conditions during an "awake" baseline period and the secondary and primary circadian sleep cycle periods. The sessions were approximately one hour, two hours, and two or three hours in length, respectively. With one exception, the subjects had experienced normal sleep the night before the test. Five men and eight women participated, ranging in age from 25 to 59. Physiological data included: real-time PERCLOS (percentage of slow-eye closure over one minute) using an infrared-reflective camera; head position coordinates using an overhead capacitive sensor array; and video of the right front of the subject's face. Performance data included: vehicle speed, lane departures, lane deviation, and steering/turn signal data. The research manager maintained logs of unusual circumstances such as departing the roadway, falling asleep at the wheel, excessive speeding, etc. Head position data was analyzed and compared to the videos. A multi-element algorithm was developed which captured patterns of head motion found to be characteristic of drowsiness. The algorithm output was compared to roadway departures noted in the research manager's logs of unusual events. The comparison showed a capability of advance detection of about 87% of driver roadway departures with a false positive rate of about 15%.

**(69) The Influence of Conversation, Low-Dose Alcohol and Driving Experience on the Peripheral Vision System** Peter Langer, M. Kopp, B. Holzner (University of Innsbruck — *Austria*), W. Magnet (Kuratrium fuer Verkehrssicherheit — *Austria*)

This study investigated whether legal everyday occurrences which take place while driving a motor vehicle and which require some attention, such as talking to a passenger or being under the influence of a low dose of alcohol (between 40 and 50 milliliters alcohol level), influence the scope of the driver's visual field. Alcohol in low doses does not damage a person's eyesight but reduces cognitive attention. Also investigated was whether the effect is related to driving experience. **Methods:** The peripheral vision reaction time of 60 persons was measured using the "Peripheral Vision Test" by Schuhfried. The test subjects were divided into three groups (n=20 each): Group 1 was asked to hold a conversation during the test; Group 2 took the test under the influence of a low dose of alcohol measured from the subject's breath using the "Alcotest 7410" (Dräger Sicherheitstechnik, Germany); Group 3 served as the control. Each group was divided into two subgroups, namely persons with average driving experience (more than 50.000 km) and persons having less driving experience (less than 5.000 km). All statistical analyses were performed on SPSS 8.1 for Windows. Differences between groups were tested for significance by means of analysis of variance and the non-parametric Mann-Whitney U Test. **Results:** Significant differences in the average reaction time were seen between the control and the conversation groups (0.76 vs. 1.20 seconds;  $p=0.01$ ) and also between the control and the alcohol groups (0.76 vs. 1.03 seconds;  $p=0.04$ ). This difference is enhanced when we look at the reaction times in the subgroups, divided into experienced and less-experienced drivers. The differences between the control group with experience and the conversation group with less experience is highly significant ( $p=0.003$ ), with the experimental group having faster reaction time, as is the difference between the control group with experience and the alcohol group with less experience ( $p=0.004$ ). The two alcohol subgroups also differ significantly from the control group with experience in terms of the average number of wrong reactions (0.8 vs. 1.8 ;  $p=0.029$  and 0.8 vs. 2.8;  $p= 0.002$ ). **Conclusions:** Holding a conversation with a passenger while driving a car reduces the peripheral vision field. The same effect can be observed in persons under the influence of a low dose of alcohol. The effect is enhanced when the person also has limited driving experience. The difference between a driver holding a conversation and an inebriated driver is that the inebriated driver not only has a longer reaction time but also shows more wrong reactions.

**(70) Human Factors in Highway-Rail Crossing Accidents: The Influence of Driver Decision Style** Mansour Rahimi, Najmedin Meshkati (University of Southern California — *USA*)

This paper explores the hypothesis that driver decision-making style influences highway-rail crossing accidents. To investigate this, we have designed an analysis of variance experiment with three independent variables: "driver decision style," "driver time pressure" and "intersection complexity." To simulate the driving conditions, we identified and videotaped a number of dangerous crossings in downtown Los Angeles. The tapes represented different environmental complexities and time pressures a driver experiences while crossing an intersection. The tapes were played back to the subject drivers. The subjects were classified according to their decision styles. Dependent measures were designed based on a driver's decision to cross the intersection. This paper presents the conceptual approach and the experimental design for this research.

**(71) Fatigue Countermeasure Using Automatic Real-Time Video Processing of Eye Characteristics** Jeffrey B. Bishop (Future of Technology and Health, LC — *USA*), Isaac K. Evans (Evolutionary Heuristics — *USA*)

Fatigue is a large and growing problem for aviators and motor vehicle drivers. A fatigue countermeasure based on digital video processing of images of the subject's face has been developed. Digital video data of drivers was



collected in experiments in a driving simulator at University of Iowa. Algorithms were developed to automatically locate the head, eyes, and face features of the driver using wide field-of-view images. The exposed eye area is quantified using the final eye target location. Automatic processing of face features in a vehicle environment is a difficult task due to the complexity of the scene and the variable lighting conditions. The use of both static and dynamic processing in parallel and the use of symmetry has led to the development of innovative and useful algorithms for automatic face location and feature detection. The prototype system was effective in automatic feature location for all 13 subjects tested in driving simulator studies. The appearance of visible eye features is quantified and used to determine onset of potentially dangerous fatigue conditions. An alarm event is generated if the eyes remain closed longer than 1.5 seconds, or if sustained reduction in area of exposed eye features is detected (eyelid droop). Other studies in the literature have validated correlation of measures of pupil occlusion (such as PERCLOS) with operator performance lapse. The system is designed to work with an inexpensive digital video sensor mounted on the dashboard of a vehicle and runs on standard computing hardware.

**TECHNICAL SESSION 7**  
**Commercial Vehicle Operations**  
**Friday, August 17, 2001**  
**8:15 AM – 10:30 AM**

**(72) Design of a Guidebook for the Acquisition and Use of Driving Simulators for Training Transit Bus Operators** John F. Brock, Cynthia Jacobs, Richard Buchter (Milestone Group — USA)

The Transit Cooperative Research Program of the Transportation Research Board recently sponsored an 18-month research program to develop a set of Guidelines that transit agency trainers and managers could use to (1) determine if driving simulators could help meet training objectives and (2) if so, what kind of simulators to acquire. The end product of this research is a set of task-based criteria that lead to specific simulator characteristics. That is, one should purchase a training simulator based upon what tasks need to be trained. This paper reports on the limited available data on the effectiveness of driving simulators for training, the task clusters various technologies can train, and the decision aids developed for transit agencies that actually have applicability to any potential user of training simulation. The project included a literature review, visits to driving simulator users nationwide, a review of European simulator programs, and the collection of training data and accident data from both users and non-users of driving simulators. Instructors, students, course graduates, and managers were interviewed. The results of the research are presented and a simulator evaluation methodology is proposed.

**(73) Improving Safety for Drivers and Fleets: Historical and Innovative Approaches** Richard Grace (Carnegie Mellon University — USA)

A conference held at Carnegie Mellon University and sponsored by the 21<sup>st</sup> Century Driver and Truck Alliance and the Federal Motor Carrier Safety Administration (FMCA) addressed "Improving Safety for Drivers and Fleets". The conference brought together stakeholders within the trucking industry and safety experts from other industries to explore approaches to improve driver and fleet safety. The goal of the conference was to facilitate discussions among industry stakeholders as a first step in identifying and implementing effective safety processes that may help to meet FMCA's ambitious goal of 50% reduction in truck related fatalities by 2010. The first day of the conference provided three sessions related to trucking and industrial safety. The first session offers two views of historical safety initiatives to provide a foundation for understanding current industry safety practices. The second session focused on current efforts within government, the truck manufacturers and fleets. The third session provided a description of successful safety programs from other industries. The second day was a morning-long panel discussion to consider the approaches presented in Day One and to propose other independent or related approaches. The goals of the discussions were to identify practical safety steps that can be applied by fleets and drivers today and in the near future and to identify potential partnerships for implementing and testing new safety initiatives. The presentations from Day One and the panel discussion from Day Two will be summarized and discussed.

**(74) Re-Assessment of Driving Simulators for the Training, Testing and Licensing of Commercial Vehicle Drivers** John Pierowicz (Veridian Engineering — USA), Jerry Robin (Federal Motor Carrier Safety Administration — USA), Valerie J. Gawron (Veridian Engineering — USA)

Simulators have been successfully employed within the military sector and commercial airline industry for over 30 years. Simulation technology may supplement the training, testing, and licensing of commercial motor vehicle (CMV) drivers if its value can be sufficiently demonstrated. The Federal Motor Carrier Safety Administration is planning to conduct a simulation validation ("Sim Val") study in fiscal year 2002 (FY 2002) to do just that. In April 1996, FMCSA (then under the Federal Highway Administration) published a research report which discussed the availability and performance of truck driving simulators available at that time. The research indicated that the truck simulators were sufficiently mature to conduct a validation study. Thus the FMCSA developed and publish Sim Val Research Design (May 1999). Given breakthroughs in technology in recent years and to gain a better understand of

the functionalities of the truck simulator currently available, FMCSA is conducting a truck simulator reassessment. To help accomplish this work, FMCSA engaged Veridian Engineering. This paper describes the interim results of the reassessment of truck simulators to ascertain their performance and functionalities in support of the FMCSA SimVal Program. **NOTE:** This paper contains interim assessments of the simulators discussed. The interim assessments, made by Veridian Engineering and the Expert Team, were reviewed and approved by the respective vendors. Final assessments will be contained in the FMCSA final report.

**(75) Federal Motor Carrier Safety Administration's Research and Technology Initiatives to Enhance Commercial Driver Training, Licensing and Performance Management** Jerry Robin, Ronald Knipling (Federal Motor Carrier Safety Administration — *USA*)

This paper discusses several of the numerous commercial motor vehicle (CMV) driver training and safety performance enhancement initiatives being conducted by the Federal Motor Carrier Safety Administration (FMCSA), Office of Research & Technology (R&T). Programs discussed include the Truck Simulator Validation Study, the Pilot Test of Fatigue Management Technologies and the Intelligent Vehicle Initiative: Heavy Vehicle Platform – Generation Zero Operational Tests. The document will also serve to acquaint the reader with the mission of the FMCSA. Additionally, it provides an overview of the vast scope of research being conducted by the FMCSA R&T Office.

**(76) Value Assessment and Implementation Tradeoffs for Production-Heavy Truck Active Noise Control** Daniel J. Maguire (Cooper Advanced Technologies — *USA*)

Despite a long history, the implementation tradeoffs and value assessment criteria of active noise control (ANC) are not well established. With commercial heavy truck adaptive ANC controllers now available, there is a need for an understanding of the unique performance-to-cost ratio characteristics of these systems. Also, due to the specific spectral region that these systems are applicable to, studies of the physiological effects of broadband noise poorly represent the positive impact of ANC. This paper presents a collection of implementation tradeoff metrics unique to active noise control systems. In addition, evaluation issues and research are identified that will help to validate ANC benefits that are accepted, but insufficiently supported.

**TECHNICAL SESSION 9**  
**Infrastructure and In-Vehicle Systems**  
**Friday, August 17, 2001**  
**1:45 PM – 3:05 PM**

Manufacturers will continue to incorporate additional advanced technology in vehicles, year after year, for some time to come. But for all the sophisticated equipment that may reside in an autonomous vehicle, there are limitations to what can be expected from that "stand-alone" technology. For instance, take the case of a driver of an autonomous vehicle who is approaching an intersection and feels that he/she has the right-of way. That driver may have no way of knowing (due, for example, to buildings blocking the view) whether the cross-traffic is approaching on a collision course or not. In turn, the other driver also may be oblivious to the impending danger. Infrastructure technology can help alert both drivers that the possibility of a collision exists by providing through-the-windshield information and/or by communicating with in-vehicle technology. The objective of this session is to discuss, through a series of presentations, how infrastructure can increase roadway safety by enhancing the advanced technology that will reside in the vehicle. The first paper "Developments in Cooperative Intelligent Vehicle-Highway Systems and Human Factors Implications" discusses the advantages of cooperative systems with an international flavor. The author has aggregated information from a variety of countries on this topic. The next paper "Infrastructure Systems for Intersection Collision Avoidance" discusses the conceptual outline of potential infrastructure intersection collision avoidance system. The infrastructure concepts represent countermeasures for crossing path crashes at intersections. The third paper "Vehicle-Infrastructure Cooperative Systems for Intersection Collision Avoidance: Driver Assessment Challenges" describes driver behavior issues associated with the countermeasures presented in the preceding paper. Emphasis is placed on assessing driver performance and behavior with these countermeasures before the systems are fielded. Various assessment techniques are discussed in association with the advantages and disadvantages of each. The last paper, "Effects of Traffic Control Devices and Road Scenes on a Driver's Judgment of Curve Sharpness" will focus on implementation of an infrastructure system related to driver behavior.

**(77) Developments in Cooperative Intelligent Vehicle-Highway Systems and Human Factors Implications** (Richard Bishop, Richard Bishop Consulting — *USA*)

Cooperative vehicle-highway systems offer the potential to enhance the effectiveness of active vehicle safety systems which have entered the marketplace for light vehicles and heavy commercial vehicles. *Cooperative intelligent vehicle-highway systems (CIVHS)* offer an improved level of overall functionality. These systems are cooperative in that the vehicles can receive information from the roadway and respond appropriately, and vehicles can detect and report hazards to the roadway, for dissemination to other travelers. The systems are *intelligent* in that the ultimate response is determined by algorithms which weigh multiple parameters. This paper describes the

results of a study to collect information on the various forms of cooperative IVHS worldwide, and assess R&D activities, deployment issues, standards development, and government policies. An extensive set of parameters which may pass between the vehicle and its external environment are listed. Potential human factors implications are identified, resulting from the emergence of these driver assistance systems into the marketplace.

(78) **Infrastructure Systems for Intersection Collision Avoidance** Robert A. Ferlis (Federal Highway Administration — *USA*)

This paper will describe conceptual outlines of possible infrastructure intersection collision avoidance systems. The infrastructure concepts represent countermeasures for crossing path crashes at intersections. Crossing path crashes involve one vehicle cutting across the path of another, both initially traveling from either perpendicular or opposite directions, in such a way that they collide. Infrastructure-based intersection collision avoidance systems use roadside sensors, processors, and warning devices; roadside-vehicle communication devices; and traffic signals to provide driving assistance to motorists.

(79) **Vehicle-Infrastructure Cooperative Systems for Intersection Collision Avoidance: Driver Assessment Challenges** Vaughan Inman, Ted Shafer (Science Applications International Corporation (SAIC) — *USA*)

According to National Highway Traffic Safety Administration (NHTSA, 1998) data, there were 37,280 crashes that involved fatalities in 1997. Of these crashes, 8,571 were related to intersections. The fatal crashes at intersection were about evenly divided among non-controlled intersections, signal controlled intersections, and stop sign controlled intersection. In addition to fatal crashes, almost 1 million injury crashes occur at intersections annually, and there are about 1.7 million police reported crashes at intersection each year. Various programs have proposed alternative countermeasures to reduce the number of crashes and fatalities at intersections. Conventional countermeasures such as protected left turn signals are effective and fairly well understood. However, these countermeasures alone will not eliminate intersection crashes because they do not address factors such as willful and unintentional red-light and stop sign violations, gap acceptance problems associated with older drivers, and sight distance problems at intersections that may not warrant traffic signals. The Federal Highway Administration is pursuing infrastructure based ITS solutions to address crashes at intersections. Initially these solutions will not require changes to vehicles. It is anticipated that in the future, some of these solutions could be integrated into in-vehicle ITS systems to enable either in-vehicle warnings or automated crash avoidance systems. Four types of intersection-infrastructure systems are envisioned: (1) traffic signal violation warning, (2) stop sign violation warning, (3) traffic signal left turn assistances, and (4) stop sign movement assistance. Each of these systems is described briefly, and a preliminary list of the driver behavior issues associated with each is identified. The challenge for the design of these systems is similar to that for other areas of highway and vehicle design – how to assess driver performance and behavior with these systems before the systems are fielded. Various assessment techniques are discussed in association with the advantages and disadvantages of each. The FHWA human-centered research approach for intersection-infrastructure solutions is presented.

(80) **Effects of Traffic Control Devices and Road Scenes on a Driver's Judgment of Curve Sharpness** Kenta Suzuki, Takashi Uchida, Toru Hagiwara (Hokkaido University — *Japan*), Takahiro Ohmi, Roberto A. Tokunaga, Motoki Asano (Civil Engineering Research Institute, Hokkaido Development Bureau — *Japan*)

The effects of traffic control devices and road scene on a driver's judgment of curve sharpness were investigated by field experiments on a 12-km section of rural highway running through a hilly area in Hokkaido. The configurations of traffic control devices at 36 curves were obtained from the road maintenance database. The favorableness of the road scene was determined subjectively. Each of the six subjects drove a vehicle installed with instruments. The subject estimated the sharpness of the target curve before that curve and assessed the accuracy of that judgment subjectively after the target curve. Cluster analysis detected groupings of the 36 curves in terms of driver assessment of sharpness. The chevron sign and the curve radius had a strong positive effect in daytime and at night on judgment of the target curve. In addition, there were some dangerous curves where the subjects underestimated the sharpness before entering the curve. The chevron signs were verified as important cues in driver assessment of curve sharpness. Traffic control devices to provide information on curve depth should be installed to increase the accuracy of sharpness judgment.