



# **NHTSA Driver Distraction Expert Working Group Meetings**

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**Summary & Proceedings**  
September 28 & October 11, 2000  
Washington, DC

**Submitted by**  
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## EXECUTIVE SUMMARY

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### EXECUTIVE SUMMARY

A series of expert working group meetings, sponsored by the National Highway Traffic Safety Administration (NHTSA), were convened to address concerns associated with the explosive growth of in-vehicle technologies (e.g., cell-phones, navigation systems, wireless Internet, information & entertainment systems, night vision systems, etc.) and the potential for driver distraction. These meetings represent one of several NHTSA-sponsored activities related to the safety impacts associated with in-vehicle technologies. The purpose of these meetings was not to reach consensus among participants, but rather to solicit a broad range of views and perspectives relating to distraction and to identify needed research to support and advance the development of comprehensive research programs to address the driver distraction problem. The goal was to identify basic issues and existing research needs within each of the following five areas:

- (1) Understanding the Nature and Extent of the Driver Distraction Problem
- (2) Understanding the Human Cognitive Process as it Relates to Driving, Distraction and Safety.
- (3) Human Factors Guidelines to Aid in Equipment Design
- (4) Integrated Approaches to Reduce Distraction from In-Vehicle Devices
- (5) Ways to Effect Social Change Regarding the Use of Distracting Devices While Driving

Five individual expert working groups were convened; these were structured around each of the five topic areas listed above. Each group was comprised of between 10-15 participants and included representation from a wide range of industries and safety related organizations, including automobile manufacturers and system suppliers, academia, research firms, enforcement agencies, and individuals associated with various industry trade associations and highway safety organizations. Over 50 invited experts took part. In all, nearly 100 research topics and issues and over 20 research problem statements were identified. A number of common themes and observations emerged from the working group meetings. These include the following points and findings:

- Many forms of distraction exist. Experts generally recognize that distraction is a broad and encompassing phenomenon and is not limited to in-vehicle technologies – distraction can assume a variety of forms and result from a wide range of sources. Although NHTSA's focus on technology-related problems is warranted, other non-technological forms of distraction should not be ignored and may serve as a useful basis for comparison as well as provide insights to better understand the problem. An organizational scheme or taxonomy is needed to define and organize different distractions.
- Very little is known about the magnitude and characteristics of the distraction problem. Our understanding about how drivers use in-vehicle technologies and the context in which drivers use these devices is limited. Naturalistic studies using data recorders capable of capturing pre-crash scenarios and controlled epidemiological studies are needed to better understand usage and circumstances surrounding crashes caused by distraction. Data can be used to focus on key behaviors and risk factors, educate drivers on the safe use of technologies, develop countermeasures, and guide device design, among other activities.
- Objective, standardized methods and metrics need to be developed. At present there is no common basis for determining when an activity represents a distraction. Standardized methods and techniques are needed so that distraction can be objectively measured and impacts on safety assessed. Criteria and thresholds for defining "distractions" must be developed; these definitions should be tied to safety and enable the relative risks of the devices to be identified.

## EXECUTIVE SUMMARY

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- Current research does not fully address the issue of cognitive distraction. As a community, we need to develop tools and methods to quantify this type of distraction. Drivers need to understand that some technologies and activities may impose significant demands on their attention and may not be safe to use while driving – keeping their eyes on the road and hands on the wheel may not be enough.
- Safety benefits of in-vehicle devices and systems should be considered when thinking about restricting or limiting their use.
- Individual differences appear to play a significant role in the distraction problem. Different groups may react differently to in-vehicle technologies and drivers may have different distraction potentials; these may also change with the particular driving circumstances.

## OVERVIEW & BACKGROUND

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### OVERVIEW & BACKGROUND

The National Highway Traffic Safety Administration (NHTSA) recently sponsored two public events that focused on the safety problems caused by driver distraction from using advanced technology in-vehicle devices that receive, transmit, or display various types of information (e.g., cell phones, navigation systems, and wireless Internet). One event was an Internet Forum (held July 5 – August 11, 2000) which was a virtual conference on the web to understand the risks from distraction associated with the explosive growth of in-car electronics. The Internet Forum provided an opportunity for technical experts and the public (both in the U.S. and internationally) to download research papers, ask questions, and share experiences regarding the use of in-vehicle devices (cell-phones, navigation systems, wireless Internet, information & entertainment systems, night vision systems, etc.). In all, the site received over 25,000 hits with over 9,500 unique users and 2,500 registered guests. The site remains available as an information repository and can be accessed at NHTSA's web site ([www.nrd.nhtsa.dot.gov/driver-distraction/Welcome.htm](http://www.nrd.nhtsa.dot.gov/driver-distraction/Welcome.htm)). The other event was a public meeting held in Washington, DC on July 18, 2000, in which representatives of industry, government, safety groups, and concerned citizens discussed their views on approaches to understanding and addressing the safety concerns brought about by the growing use of in-vehicle technologies.

As a follow up to these two events, NHTSA contracted with Westat (with assistance from ITS America) to organize several working group meetings of technical experts in an effort to identify research initiatives that could help advance our understanding of the driver distraction safety problem and possible solutions.

### MEETING PURPOSE

Working groups addressed the need to minimize negative safety impacts associated with potentially distracting in-vehicle devices by identifying short and long-term research needs to support possible activities and interventions geared towards mitigating distraction impacts (e.g., device designs, technology aids, educational campaigns, laws, training, etc.). Five independent expert working groups were convened; these were organized around the following key topic areas:

1. Understanding the Nature and Extent of the Driver Distraction Problem
2. Understanding the Human Cognitive Process as it Relates to Driving, Distraction and Safety.
3. Human Factors Guidelines to Aid in Equipment Design
4. Integrated Approaches to Reduce Distraction from In-Vehicle Devices
5. Ways to Effect Social Change Regarding the Use of Distracting Devices While Driving

Research topics and problem statements within each of the five topic areas were identified.

### INVITED EXPERTS AND PARTICIPANTS

The individual working groups were comprised of recognized experts and representatives from industry, academia, research firms, enforcement agencies, and highway safety organizations; in all, over 50 invited experts participated. Working group meetings were held individually with some groups meeting on September 28, 2000 and others on October 11, 2000. Each group was led by a moderator and assigned a recorder. Invited experts and participants are listed in Table 1 for each of the five expert working groups.

**OVERVIEW & BACKGROUND**

**Table 1. Expert Working Group Participants**

<b>WORKING GROUP #1: UNDERSTANDING THE NATURE AND EXTENT OF THE DRIVER DISTRACTION PROBLEM (CONVENED 10/11/00)</b>	
Moderators: Recorder:	Joseph Carra (NHTSA) and Michael Goodman (NHTSA) Eddy Llaneras (Westat)
	<ol style="list-style-type: none"> <li>1. Fran Bents (Dynamic Sciences)</li> <li>2. Katherine Condello (Cellular Telecommunications Industry Association)</li> <li>3. Bud Dulaney (Prince William County Police Dept.)</li> <li>4. Ken Gish (Scientex)</li> <li>5. Ray Kiefer (General Motors)</li> <li>6. Anne McCartt (Preusser Research Group)</li> <li>7. Scott Osberg (AAA Foundation for Traffic Safety)</li> <li>8. David Shinar (Ben-Gurion University of the Negev)</li> <li>9. Jane Stutts (Univ. of North Carolina)</li> </ol>
	Federal DOT Participants: Wassim Najm (Volpe), Joseph Kaniathra (NHTSA), Gayle Dalrymple (NHTSA), Chip Chidester (NHTSA), Joe Tanning (NHTSA)
<b>WORKING GROUP #2: UNDERSTANDING THE HUMAN COGNITIVE PROCESS AS IT RELATES TO DRIVING, DISTRACTION AND SAFETY (CONVENED 9/28/00)</b>	
Moderator: Recorder:	Tom Ranney (VRTC) Elizabeth Mazzae (NHTSA)
	<ol style="list-style-type: none"> <li>1. Linda Angell (General Motors)</li> <li>2. Dave Benedict (Toyota)</li> <li>3. Klaus-Josef Bengler (BMW)</li> <li>4. Tom Dingus (VA Tech)</li> <li>5. Jim Foley (Visteon)</li> <li>6. Valerie Gawron (Veridian)</li> <li>7. Paul Green (Univ. of Michigan Transportation Research Institute)</li> <li>8. John Lee (Univ. of Iowa)</li> <li>9. Ron Mourant (Northeastern Univ)</li> <li>10. Tom Sheridan (Massachusetts Institute of Technology)</li> <li>11. Louis Tijerina (Ford)</li> <li>12. Hiroshi Tsuda (Nissan)</li> <li>13. Barbara Wendling (Daimler-Chrysler)</li> </ol>
	Federal DOT Participants: Mary Stearns (Volpe), Mike Goodman (NHTSA), August Burgett (NHTSA), Joan Harris (NHTSA)
<b>WORKING GROUP #3: HUMAN FACTORS GUIDELINES TO AID IN EQUIPMENT DESIGN (CONVENED 9/28/00)</b>	
Moderator: Recorder:	Richard Hanowski (VA Tech) Eddy Llaneras (Westat)
	<ol style="list-style-type: none"> <li>1. Timothy L. Brown (National Advanced Driving Simulator)</li> <li>2. John Campbell (Battelle)</li> <li>3. Dave Cok (Siemens)</li> <li>4. Dave Curry (Delphi/Delco)</li> </ol>

## OVERVIEW & BACKGROUND

	<ol style="list-style-type: none"> <li>5. Hiroshi Nanba (Toyota)</li> <li>6. Kenji Niiya (Toyota)</li> <li>7. Ian Noy (Transport Canada)</li> <li>8. Joe Laviana (Motorola)</li> <li>9. Gary Rupp (Ford)</li> <li>10. Colleen Serafin (Visteon)</li> <li>11. Dave Weir (Dynamic Research)</li> </ol> <p>Federal DOT Participants: Riley Garrott (Vehicle Research &amp; Test Center, NHTSA), Mike Perel (NHTSA), Paul Rau (NHTSA)</p>
<b>WORKING GROUP #4: INTEGRATED APPROACHES TO REDUCE DISTRACTION FROM IN-VEHICLE DEVICES (CONVENED 9/28/00)</b>	
	<p>Moderator: Neil Lerner (Westat)  Recorder: Eric Traube (ITS America)</p> <ol style="list-style-type: none"> <li>1. Richard Grace (Carnegie Mellon Univ)</li> <li>2. Ralph Hitchcock (Honda)</li> <li>3. Ron Johnson (InfoMove)</li> <li>4. Ray Kiefer (General Motors)</li> <li>5. Judy Gardner (Motorola)</li> <li>6. Dan McGehee (Univ. of Iowa)</li> <li>7. Srinivas Raghavan (Qualcomm)</li> <li>8. Dan Selke (Mercedes Benz)</li> <li>9. Trent Victor (Volvo)</li> <li>10. Huan Yen (Delphi Delco)</li> </ol> <p>Federal DOT Participants: Tom Granda (FHWA), Joe Moyer (FHWA), David Smith (NHTSA)</p>
<b>WORKING GROUP #5: WAYS TO EFFECT SOCIAL CHANGE REGARDING THE USE OF DISTRACTING DEVICES WHILE DRIVING (CONVENED 10/11/00)</b>	
	<p>Moderators: Joan Harris (NHTSA)  Recorder: Linda Cosgrove (NHTSA)</p> <ol style="list-style-type: none"> <li>1. Linda Angell (General Motors)</li> <li>2. Jack Archer (National Committee on Uniform Traffic Laws and Ordinances)</li> <li>3. David Brinberg (VA. Tech.)</li> <li>4. Peggy England (Cellular Telecommunications Industry Association)</li> <li>5. Leo Fitzsimon (Nokia)</li> <li>6. Barbara Harsha (National Association of Governor's Highway Safety Reps)</li> <li>7. John Lacey (Mid-America Research)</li> <li>8. Peter Mitchell (Academy For Educational Development)</li> <li>9. Lynda Morrissey (Network of Employers for Traffic Safety)</li> <li>10. Marsha Scherr (ComCare Alliance)</li> <li>11. Dave Tollett (International Association of Chiefs of Police)</li> </ol> <p>Federal DOT Participants: Roger Kurrus (NHTSA), Richard Compton (NHTSA), Jim Nichols (NHTSA), Sgt. Karen Dewitt (NHTSA)</p>

## OVERVIEW & BACKGROUND

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### ORGANIZATION OF THIS REPORT

Proceedings are organized and presented individually for each expert working group in the sections that follow. Each section includes the following elements:

- Statement of the problem, current status, and challenges to be addressed by the group.
- Summary and highlights of key group discussions.
- List of candidate research topics and issues.
- Research problem statements, including supporting rationale for why the work is needed, objectives of the research, and general technical approaches.

### ACKNOWLEDGMENTS

We would like to thank all of the invited experts who participated in these working group meetings. The insights, research areas and problem statements shared by this community of experts will serve as a valuable resource in the formation of future program efforts within NHTSA. We also would like to acknowledge the considerable work and commitment provided by the meeting moderators and recorders: Joe Carra, Mike Goodman, Eddy Llaneras, Tom Ranney, Liz Mazzae, Rich Hanowski, Neil Lerner, Eric Traube, Joan Harris, and Linda Cosgrove.

**WORKING GROUP #1:  
UNDERSTANDING THE NATURE AND EXTENT  
OF THE DRIVER DISTRACTION PROBLEM**

## UNDERSTANDING THE NATURE AND EXTENT OF THE DRIVER DISTRACTION PROBLEM

### THE PROBLEM

Driver distraction is one of the most common causes of traffic crashes. Given the explosive growth of in-car electronics (cell-phones, navigation systems, wireless Internet, information & entertainment systems, night vision systems, etc.) and the growing concern with distraction and safety implications, it is vital that we understand the risks from distraction associated with such technologies. Although available evidence suggests that use of electronic devices while driving may increase the risk of a crash, the magnitude of these risks is uncertain. Information about the influence of cell phones in crashes, for example, is currently difficult to obtain. Most states lack the means to track how many crashes are caused or influenced by distraction resulting from in-vehicle technologies. A number of studies have concluded that insufficient data exist upon which to estimate the magnitude of safety related problems with the use of in-vehicle devices (particularly cell phones). More precise exposure data is needed and existing reporting and data collection systems need to be structured to allow relationships between device use and crashes to be determined. Due to limitations in crash data reporting, other techniques to assess the safety problem are needed. These may include using event data recorders, collecting data on critical incidents (close calls), or observational studies.

### CURRENT STATUS

Driver distraction has been under study by NHTSA since the early 1990's. This work continues today and has explored methods to quantify driver workload, models to predict crash incidence as a function of workload, impact of wireless phone use while driving, route navigation system use and destination entry tasks, as well as the influence of individual driver differences. Current and planned research will study the distraction potential of various AutoPC interactions, naturalistic studies of wireless phone interfaces, and the safety benefits and tradeoffs associated with night vision systems. The AAA Foundation for Traffic Safety has also undertaken a study to examine the role of driver distraction in traffic crashes. The objective of this work, which is currently underway, is to identify the major sources of driver distraction that result in crashes and near crashes.

### CHALLENGES

A variety of challenges and outstanding questions related to this issue exist. A number of studies have called for improvements in data collection and reporting systems as well as efforts to understand how drivers interact with in-vehicle devices under naturalistic settings so that more precise exposure data can be collected. Other questions include:

- What can we learn about driver distraction from crash investigations, given that drivers may not be candid about their pre-crash actions or may not even recall pre-crash events due to the shock of the crash?

## Working Group #1: Understanding the Nature and Extent of the Driver Distraction Problem

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- If we had sensors that could electronically sense and record various driver behaviors and vehicle parameters for several seconds prior to a crash, what would we like to know?
- Is information about close calls associated with distraction useful for understanding the nature and extent of actual crash causal factors and circumstances? What is the most meaningful way to obtain such close call information?
- Is the preponderance of anecdotal and experimental evidence, the increasing complexity of in-vehicle technology and the projection of increasing availability and use of the technology in the near future enough of a basis for action without the availability of statistically meaningful crash data?
- Is it reasonable to believe, at least in the short term, that we could ever manage to get accurate and sufficient crash data on the role of cell phones/driver distraction/technology in precipitating crashes?
- Is there an epidemiological approach that could provide a better sense of the role of cell phones, technology, and distraction in causing crashes?
- How are changes in driver skills and abilities (ability to: rapidly 'filter out' irrelevant stimuli, divide attention and attention switching, hold information in working memory while carrying out other tasks, process and respond to information quickly, etc.) likely to interact with the use of in-vehicle devices and how can these effects be tracked? Are older drivers more susceptible to interference from distractors?
- Comparing crashes involving drivers use of in-vehicle technologies to other types of distractions: To what extent is it important to compare crash risks from drivers' use of various in-vehicle technologies to other distractions? How can such comparisons be most meaningful and helpful to our understanding of possible countermeasures? What comparisons are most meaningful (e.g., use of radios, talking to passengers)? How are these comparable risks helpful in identifying countermeasures for reducing crashes?

## GENERAL GROUP DISCUSSION

The following summarizes the group's discussions and key issues discussed during the morning.

### Highlights & Basic Points

#### *Suggestions to Improve the Data Collection Process*

- Need to determine what information is important to collect.
- Need to determine the context and how drivers are using these devices.
- Technology is providing the opportunity to capture some types of information. System Diagnostic Modules on vehicles, for example, can provide basic vehicle parameters. NHTSA currently using this information, requires owners permission to access information.
- The consumer also is a factor that will drive what information can be collected and how the information will be used. There are privacy issues that need to be considered.
- Link crash records with phone use records. A broad epidemiological study to collect this type of data is needed. Because of privacy issues, a court order is needed to obtain phone records. This approach may be needed since it is difficult to get valid data from drivers who may not admit use, especially post-crash.
- Crash investigation and police data collection forms should include a way to record the general category of "driver distracted," and not simply focus on cell phone; cell phones are just one of the many forms of distraction.
- Current estimates based on accident narratives suggest that driver distraction is currently very under-reported. Follow-up with accident involved driver and conduct interviews (under confidentiality).
- Data collection should to take into account: 1) the technology that comes equipped with the vehicle, and 2) devices that drivers bring with them into the vehicle. These may impact how we go about collecting and recording information.

#### *Clarify & Define Terminology*

- People have different definitions of what constitutes a distraction. There are many forms of distraction, including technology and non-technology based. Need a taxonomy to define and organize different distractions. NHTSA has defined 4 dimensions of distraction (cognitive, bio-mechanical, visual, auditory).
- Need to capture how compelling the distraction is.
- Need to understand the baseline level so that there is a common understanding.
- NHTSA's current focus is on technology-related problems; although the other forms may be useful basis for comparison.
- Need to look at a broad range of distractions to more fully understand the problem.
- Need to consider individual differences. Some drivers are more susceptible to distraction from any source (tuning radio, adjusting

## Working Group #1: Understanding the Nature and Extent of the Driver Distraction Problem

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seatbelt, etc.) so we need to fully understand the underlying problem and not just focus on technology related forms. Everyone makes a conscious decision to divert his or her attention from the primary task of driving.

- Baseline measures should incorporate non-technology related forms of distraction.
- Also need to assess the crash impact and magnitude of the problem. Is technology-related distraction more of a problem?
- Need to define thresholds. When does an activity become a distraction? Just because drivers are not engaged in the primary driving task and attending to a non-driving task does not necessarily mean they are "distracted." Need to gain an understanding of what people do when driving.
- Need to get measures that can generalize to safety.

### *Support Law Enforcement*

- Law enforcement is not currently well equipped to record or capture the many forms of distraction (and crashes caused by distraction). Short of video installed in cars, it is difficult to accurately gauge distraction-related crashes. Drivers tend to "shut down" when involved in accidents (due to liability) and do not offer "incriminating" information (such as being distracted).
- Witnesses are currently the best single source to determine if distraction was involved in a crash. Police do question witnesses.
- Some departments want traffic crashes to be handled quickly so they can deal with other crimes, some agencies don't motivate their troops and give them the training they need to do an efficient job on reporting accidents.

### *Specific Techniques & Approaches*

- Near crashes should also be mined as an information source – perhaps drivers would be more willing to offer information about these if a reporting mechanism existed.
- Use of law enforcement crashes as an information source. Many police departments use in-vehicle technologies. This population generally maintains detailed records.
- Rental car fleets can also serve as a data collection tool. Some have new technologies such as navigation systems. Need to be able to determine if device used at the time of the crash. Higher-speed crashes are easier to determine this.
- Simulators will allow us to isolate groups, and bring drivers to the point of a crash (impose demanding and overly taxing requirements).

### *Other General Observations & Comments*

- Expect to see an increase in collisions due to an inability of drivers to practice defensive driving. Drivers who would otherwise be paying attention may have a diminished capacity to respond to errors resulting from other drivers (distraction may not only impact an individuals driving performance, but their ability to respond to other drivers' mistakes as well).

### CANDIDATE RESEARCH TOPICS, IDEAS & NEEDS

Individuals were asked to identify their top three research priorities relating to understanding the nature and extent of the distraction problem. The following research issues were identified; these are grouped based on their perceived priority (note that items within a group are not necessarily prioritized, but are simply listed the order in which research topics were solicited from individuals).

#### First Round Research Topics/Ideas

1. Use commercial vehicle fleets to examine relationships between crashes and in-vehicle technology.
2. Research driver willingness to engage in potentially distracting tasks while driving. Investigate factors that influence (motivate) driver willingness to do something potentially distracting while driving, and the circumstances under which this occurs.
3. Conduct a prospective crash study using trained police officers to investigate crashes. Could take the form of a special NASS study with follow-up interviews with drivers involved in crash. Needed to supplement existing databases.
4. Conduct experiments focusing on new technologies. Use lab studies to supplement crash database and better understand problem posed by such devices.
5. Expand Electronic Data Recorder (EDR) data collection to include distraction elements/video. Incorporate additional data into EDR, including video of driver and forward view. Foster increased use of EDR, mandate use of systems, and facilitate access to data.
6. Observational studies of driving behavior. Need to equip vehicles with data recorders. Many police departments already using video technology in cars (at least forward looking cameras).
7. Understand baseline workload factors. How do these vary under different driving conditions (day/night, rain/snow, etc.). Need to quantify how workload varies under plain'old driving conditions and when driver is engaged in other tasks.
8. Study individual differences in distraction. Develop techniques to identify "distractible" individuals.
9. Simulator research using various demanding situations. Use simulators to simulate different crash scenarios; measure baselines and then using different loading tasks.
10. Equip rental cars with cameras. Provide an inducement to drivers (such as reduced rental rates) to rent vehicles and agree to be recorded. Provides opportunities to examine and compare driver performance and behavior with and without the presence of various in-vehicle devices (some cars are equipped with technologies, others not). Can be applied to other vehicle fleets and special groups. Using the police as a fleet, for example, avoids some of the logistical problems and issues.
11. Collect better information about the specific crash circumstances surrounding crashes caused by distraction.
12. Study police department vehicles, using data recorders & cameras.
13. More driver education on risks and how to use devices responsibly.

Second Round Research Topics/Ideas

14. Assess the relative severity of different distracting events (different situational events) and differences in driver age as well as driving experience.
15. Update NASS data elements. Review variables NASS is currently collecting and determine if additional data should be collected to support our understanding of distraction.
16. Expand the use of computerized crash investigation data entry. Make it easier for police officers to enter and recall information. Computerize system to facilitate tasks (such as using bar code readers)
17. Conduct random survey of population (general public) regarding how distracting they perceive cell phone use to be. Can be expanded to other in-vehicle technologies.
18. Develop a distraction "scale." Inventory and scale distraction associated with a range of tasks.
19. Examine risks vs. benefit of these systems.
20. Collect additional situational factors and driver status information (e.g., fatigue) as part of efforts.
21. Collect exposure data. Baseline exposure for various distractions, including when and who is doing it. Document frequency of use, types of tasks being performed, and the context (conditions of use).
22. Develop a taxonomy of driving situations and scenarios. Need agreement of what a standard driving situation consists of; information can be used for scenario development in simulators.
23. NHTSA to develop standardized training program for police officers to collect crash data

Third Round Research Topics/Ideas

24. Development of standardized research protocols to enable comparison among studies. Develop empirically derived taxonomy of distractions, developed by expert panel with sample of accident cases. Everyone uses the same categories. Use empirical information to drive development of categories.
25. Revise the Minimum Uniform Crash Criteria (MUCC) to better reflect distraction. Revisit standardized data collection forms. MUCC should reflect distraction (not just simply an "inattention" label). Revise standard set of questions, get buy-in from states to adopt agreed-upon terms.
26. Capture near-miss data. Can be a valuable information source for better understanding distraction (more prevalent than accidents, and drivers may be more willing to offer information).
27. Validate simulator studies.
28. Study whether in-vehicle devices can serve to counteract the monotony of driving. Need to explore how sustained periods of "just driving" impacts performance; perhaps use of in-vehicle devices stimulate driver performance.
29. More elaborate data is needed on non-technological distractions. Need to study the full scope of distraction, not just in-vehicle devices. Feeds into driver education. Inventory what these are and how they impact driving. Best to use naturalistic observational studies (drivers who do not know they are being watched).
30. Conduct International comparative studies looking at effectiveness of different policies.

Additional Ideas/Elaborations Generated During Open Discussion

- Conduct epidemiological study to match cell phone and crash records.
- Follow-up with drivers after crash
- Look at a broad range of distractions to help understand the impact of technology-based distractions.
- May get more people to talk about distraction associated with near misses than crashes.
- Document enforcement personnel distraction-relevant crashes.
- Rental fleet study
- Need a scale of driving demand – baseline.
- Need better crash data, more detail.
- Trip logs.
- Expand in-vehicle data recording, and ease of access to data.

### Consolidation of Research Topics/Ideas

Time constraints prevented the group from developing detailed research problem statements relating to each of the 29 suggested items. In order to focus and manage the task, items were grouped into sets of related topics. Five research categories were defined: (1) on-road, naturalistic studies, (2) crash data, (3) simulator and experimental studies, (4) definitions, taxonomies, and procedures, and (5) cross-cutting. Meeting participants were subsequently divided into subgroups based on the research categories in order to develop research problem statements. The following table indicates the relationship between the five high-level research categories and the 29 specific research topics listed above.

Research Categories	Specific Research Topic Number
(1) On-road, real-world, naturalistic, observational data collection. (includes survey approaches and trip logs)	1,6,10,12,16,20,25
(2) Crash data	3,5,11,14,15,22,24
(3) Experimental & Simulator Studies	4,7,9,13,26
(4) Definitions/Taxonomy/Procedures	17,21,23
(5) Cross-Cutting	2,8,19,27,28,29

Seven research problem statements, relating to the first four research categories, were developed. These are listed in the following section.

## RESEARCH PROBLEM STATEMENT

(Research Category 1)

**Title:** OBSERVATIONAL STUDY OF DEVICE DISTRACTION IN SPECIAL VEHICLE POPULATIONS

### Why this Research Needs to be Performed:

- There is no real-world data on drivers' propensity to engage in potentially distracting activities; factors affecting engagement in distracting activities; and how these impact driving performance.

### Key Objectives of the Research:

1. Establish baseline measure of driver exposure to events that may be distracting.
2. Provide input to the refinement of a distracting taxonomy.
3. Define methodology for collecting observational data on driver distraction.
4. Examine driver differences in response to potential distracting events.
5. To aid in developing measures of the severity to intensity of various distracting events.

### General Technical Approach:

- Use of special vehicle populations – rental cars, fleet vehicles, etc.
- Use of all available technologies (video, audio, accelerometer) to obtain real-world data of driver distraction (i.e., instrumented vehicle)

### Other Relevant Comments:

## RESEARCH PROBLEM STATEMENT

(Research Category 1)

**Title:** DRIVING DISTRACTIONS AS A CAUSE OF TRAFFIC CRASHES

### **Why this Research Needs to be Performed:**

- No research of its kind exists and this type of basic research is needed to understand the magnitude of the distraction problem in traffic safety.

### **Key Objectives of the Research:**

- To obtain an estimate of the percentage of crashes involved in different types of potentially distracting activities.
- Study the relative importance of different distracting events
- Validate police reported information in comparison to driver recollection (self-reports).

### **General Technical Approach:**

- Telephone survey of drivers involved in recent crashes.
- Comparison of police reports with driver (telephone) interviews/surveys.
- Comparison of data with CDS

### **Other Relevant Comments:**

- Low tech. approach should translate into a relative low cost project.

## RESEARCH PROBLEM STATEMENT

(Research Category 2)

**Title:** ENHANCE EXISTING CRASH DATA SYSTEMS

### **Why this Research Needs to be Performed:**

- Existing systems of records have not adequately captured driver distraction data. Data is needed to identify appropriate driving scenarios for experimentally addressing distraction issues.
- Need to measure the relationship between the advancements and availability of technological devices and crash occurrence.

### **Key Objectives of the Research:**

1. Develop better operational definitions for crash elements.
2. Quantification of driver distraction related crashes.
3. Identification of driver distraction scenarios.

### **General Technical Approach:**

1. Incorporate current taxonomies for driver distraction into police/NASS data forms.
2. Provide training/incentives for enhanced data collection.
3. Encourage the subpoena of cell phone records by police departments after serious crashes.

### **Other Relevant Comments:**

Certain police departments would be more likely to require enhanced data collection to support research.

## RESEARCH PROBLEM STATEMENT

(Research Category 2)

**Title:** EXPANDING EDR (ELECTRONIC DATA RECORDER) CAPABILITIES

### Why this Research Needs to be Performed:

- Limitation in crash investigations for addressing driver distraction problem.
- Need to more fully understand and identify key driver distraction scenarios for experimental purposes.
- Need to identify new emerging technologies which may be associated with driver distraction

### Key Objectives of the Research:

- Obtain more reliable pre-crash/crash driver distraction factors.
- Identification of key driver distraction scenarios to support empirical study.
- Quantification of driver distraction scenarios.

### General Technical Approach:

- Identify elements needed.
- Assess feasibility of getting desired elements.
- Develop standard set of elements (SAE, FMVSS)

### Other Relevant Comments:

## RESEARCH PROBLEM STATEMENT

(Research Category 3)

**Title:** STANDARDIZED TEST PROTOCOL AND SCENARIOS SUITABLE FOR  
CONDUCTING DRIVER DISTRACTION RESEARCH

### **Why this Research Needs to be Performed:**

- There are currently no standard driving situations that can be used to develop baseline measures of driver workload.
- Need to be able to compare (at least make reliable comparisons) among devices to be evaluated. Results should have implications for designs as well as safety.

### **Key Objectives of the Research:**

1. Develop standardized test protocol.
2. Develop standardized simulator scenarios.
3. Obtain baseline workload measures under a variety of environmental/traffic conditions.
4. Define a wide variety of potentially distracting tasks.

### **General Technical Approach:**

- Use crash data to identify key pre-crash factors.
- Use pre-crash factors to develop scenarios.
- Run wide range of subjects (age, impairments, etc).

### **Other Relevant Comments:**

- Need a taxonomy of driving situations.
- Simulator needed to present standardized situations.

## RESEARCH PROBLEM STATEMENT

(Research Category 3)

**Title:** FACTORS THAT CONTRIBUTE TO DRIVER WILLINGNESS TO ENGAGE IN POTENTIALLY DISTRACTING TASKS

### **Why this Research Needs to be Performed:**

- Distraction on the road is determined by the distraction potential of the in-vehicle task together with the willingness of the driver to engage in the in-vehicle task. We currently do not know what factors influence driver willingness to perform non-driving related tasks.

### **Key Objectives of the Research:**

- Develop a methodology to assess driver willingness to engage in other "non-driving" related tasks.
- Assess willingness of wide range of drivers under a variety of environmental/traffic conditions.

### **General Technical Approach:**

- Simulator study using different incentives. Varying incentives for in-vehicle task is necessary to assess willingness.

### **Other Relevant Comments:**

## RESEARCH PROBLEM STATEMENT

(Research Category 4)

**Title:** DEVELOPMENT OF A DRIVER DISTRACTION TAXONOMY

### **Why this Research Needs to be Performed:**

- Current data collection and reporting systems do not provide detailed and reliable estimates of exposure and accident causation factors associated with in-vehicle technologies. General "inattention" categories are typically used to characterize distraction-related crashes. Better data is needed to capture frequency of use/exposure data and crash causation attributable to in-vehicle distraction.
- Use of non-standardized terminology and definitions makes it difficult to compare crash databases. A common language is needed.

### **Key Objectives of the Research:**

- Create a common language with accepted and standardized definitions to allow comparison across studies and databases. Needed for classification of crashes. Emphasize crash factors associated with use of in-vehicle technologies.
- Obtain more detailed and reliable data by using standardized definitions and trained population of users (i.e., police officers and crash investigators).
- Expand upon existing work (e.g., Indiana Tri-Level study, workload dimensions, etc.) to enable concrete sources of distraction to be identified and linked to crash causation. Focus on in-vehicle devices.
- Increase the reliability of crash data sources. Establish the potential reliability of data sources.

### **General Technical Approach:**

1. Convene a panel of experts to establish a broadly representative and useful taxonomic scheme. The taxonomy to include accepted definitions for common terms. Prior to the meeting, the panel would review a sample of representative CDS crashes and literature on crash causation (including relevant models and taxonomies) At the meeting, the panel will define components of the taxonomy to include the following dimensions:
  - 1) Human information processing (workload) factors – visual, auditory, cognitive, and bio-mechanical.
  - 2) Source of distraction (e.g., internal to the vehicle and external to the vehicle).
  - 3) Driving context and individual difference factors.
  - 4) Available potential distractions. The presence of potentially distracting devices or elements should be noted and their contribution to the crash determined. Just because a device may be present does not necessarily mean it contributed to the crash.
2. Once a taxonomy and common language has been developed by the panel, test its reliability by conducting a reliability analysis using a new sample of CDS crashes. This activity can be performed independently following the panel meeting (i.e., cross validate using new sample

**Working Group #1: Understanding the Nature and Extent of the Driver Distraction Problem**

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- of cases disseminated to panel members following initial development of the taxonomy).  
Analyze individual differences in cross-validated set by computing inter-rater reliability
3. Reconvene the panel to resolve differences. Revise and modify the tool based on this exercise.
  4. Develop protocols and data collection forms for use by police officers and crash investigators.
  5. Train police officers and crash investigators on use of these tools and protocols.
  6. Collect data in the field over a reasonable time period using the newly developed forms and procedures (note: approximately 5,000 cases should be documented in the course of a single year).

**Other Relevant Comments**

**Working Group #1: Understanding the Nature and Extent of the Driver Distraction Problem**

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Working Group #2:  
Understanding the Human Cognitive Process as it Relates to Driving, Distraction, and Safety

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**WORKING GROUP #2:  
UNDERSTANDING THE HUMAN COGNITIVE PROCESS  
AS IT RELATES TO DRIVING, DISTRACTION, AND  
SAFETY**

## UNDERSTANDING THE HUMAN COGNITIVE PROCESS AS IT RELATES TO DRIVING AND DISTRACTION

### THE PROBLEM

Fundamental human cognitive processes of perception and attention are at the core of the driver distraction problem. To the extent we understand these processes, we can better predict and address problems of distraction. Drivers must continually allocate attention to competing tasks, both driving-related and non-driving. Most of the time, they do this quite well. In this sense, "driver distraction" represents a failure of normal cognitive processes that are occurring all the time. Potential distractors of many sorts are often present, but significant distraction does not always occur. Why do these "failures" occur? How do we recognize and define them, independent of crash outcomes? What elements of the cognitive task, system interface, individual driver, and driving environment lead to these problems? We need a much better understanding of how drivers handle competing tasks and intruding events while driving, and how this results in significant distraction from vehicle control tasks.

There is a range of cognitive aspects that relate to this issue. These include such things as attention allocation, information processing time, cognitive capture, willingness to engage, risk perception, driver search strategies, workload, task strategies (e.g., "chunking"), emotional/motivational factors, and others. These cognitive processes are an inherent factor that affect in-vehicle device demands and driving performance outcomes. The problem is in understanding them to the extent that we can make these linkages.

### CURRENT STATUS

One of the initial issues to deal with is that of measurement of parameters that cause distraction and their effects. What should be measured and how do we measure it? As reflected in a number of the papers collected in the internet forum, NHTSA, CAMP, Volvo, and others have been conducting work in this area. We have advanced our understanding of how to conceptualize and measure workload and distraction. However, there are still important limitations to current knowledge. Most of this measurement work deals with the potential for distraction outcome, rather than with underlying cognitive processes. There also is a lack of understanding of the linkages of these metrics to roadway safety outcomes. Many measures focus on vehicle control aspects or monitoring tasks, while crash data seem to highlight failures to detect unexpected events (e.g., lead vehicle stopping, traffic signals).

Current knowledge has also been advanced by studies of workload and distraction for specific devices or tasks, such as route navigation destination entry or cellular phone dialing. Current research and evaluation remains pretty much on a task-by-task basis. It is difficult to predict workload/distraction prior to developing a working prototype, and difficult to deal with combinations of devices and functions simultaneously present in the vehicle. We still lack a basis for more generic analysis, based on the collective perceptual and cognitive demands of devices and tasks. It is also unproven that such generic analyses will enable specific conclusions to be drawn regarding safe designs. Lacking a more detailed understanding of these relationships results in fairly crude evaluation techniques, such as the "15-second rule." There is no accepted

## Working Group #2:

### Understanding the Human Cognitive Process as it Relates to Driving, Distraction, and Safety

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taxonomy of in-vehicle tasks, based on cognitive or display attributes. An important step in this direction may be the work done by Virginia Tech on an IVIS (In-Vehicle Information System) demand tool. This prototype software package is intended to serve as a tool to support design trade-offs associated with in-vehicle devices and predict the degree of driver demand (or distraction) associated with a task. It uses simplified models of driver cognitive and perceptual processes. The model accepts user inputs features of the IVIS task and interface, and the model derives figures-of-merit for information demand. The assumptions, as well as the model output itself have not been validated. The means of categorizing mental activities (e.g., search, interpretation, computation, planning), the segmentation of task "demand", and the means of equating demand associated with differing types of resources also require further validation. The model also does not include some dimensions of distracting tasks that NHTSA and others have pointed to as important, such as whether or not events are driver initiated and paced, the urgency of the task and the willingness to engage, the potential for associated tasks or "incidents" (e.g., note taking, dropping phone), and so forth. However the framework of the model is such that it may be possible to add these features relatively easily if appropriate data could be identified.

### CHALLENGES

There are a variety of important outstanding questions that need to be addressed through future research. These can be categorized into three broad topics: (1) How do we properly measure distraction and its related cognitive processes?; (2) How do we come to understand and characterize the cognitive basis of driver distraction?; and (3) How can knowledge about these cognitive activities be applied to address the driver distraction problem? The following issues encompass the sorts of questions that must be addressed in order to facilitate the development a comprehensive research program.

#### Measurement of distraction and related cognitive processes

- How do we define and measure distraction, workload, and their relationship?
- Are there different types and degrees of distraction, and with what implications?
- What are the links between task features, cognitive activity, distraction, and crashes?

#### Understanding the cognitive bases of driver distraction

- How can we characterize tasks and devices in a way that relates to cognitive demand?
- How accurate are driver perceptions of hazard, self-awareness of workload, and self-regulation of attention? What drives the willingness to engage in a distracting task?
- How do drivers decompose tasks into discrete subtasks ("chunking") so that they can better share attention?
- What are the important individual differences among drivers in cognitive aspects?

#### Application of cognitive aspects to problem mitigation

- How can we summarize and integrate knowledge about cognitive aspects into useful predictive tools, design guidelines, regulations, and public information?
- What misperceptions and errors characterize the driver's understanding of attentional hazards, awareness of distraction, and ability to self-regulate? Are there practical means to improve this (e.g., though education, training, or feedback)?

### GENERAL GROUP DISCUSSION

The following summarizes the group's discussions and key issues discussed during the morning.

#### Highlights & Basic Points

- |                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|--------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Exposure</i>                      | <ul style="list-style-type: none"><li>▪ Need to determine if exposure will increase if devices are made easier to use. NHTSA is currently looking at this issue in the context of hands-free cell phones.</li><li>▪ Estimates of exposure can be used to predict crash risk.</li></ul>                                                                                                                                                                                                                                                                                                                            |
| <i>Cognitive Capture</i>             | <ul style="list-style-type: none"><li>▪ Need to agree on how to define and measure cognitive capture, as well as specify criteria for unsafe vs. safe levels.</li><li>• Cognitive capture has two aspects: immediacy and risk-taking.</li></ul>                                                                                                                                                                                                                                                                                                                                                                   |
| <i>Dynamics of Task Chunking</i>     | <ul style="list-style-type: none"><li>▪ How tasks are chunked is related to the device as well as the individuals approach and environmental conditions. It would be useful to determine how people tend to organize and group task elements – how they chunk.</li></ul>                                                                                                                                                                                                                                                                                                                                          |
| <i>Measuring Distraction</i>         | <ul style="list-style-type: none"><li>• Drivers will regulate the use of devices when they recognize the complexity of the driving situation, so it may be revealing to study situations leading up to a crash. What aspects invited the use of the technology?</li><li>▪ Studying distraction under “naturalistic” settings presents a number of challenges.</li><li>▪ Data recorders can and are being used to record pre-crash scenarios and driver and vehicle dynamics data. Need to have a sufficient number of these systems deployed in the field.</li><li>▪ Need a common set of measurements.</li></ul> |
| <i>Managing Distraction</i>          | <ul style="list-style-type: none"><li>• As a driver learns to use a system, they should become better able to manage distraction.</li><li>• Young or inexperienced drivers do not have experience with doing supervisory activities and may be more prone to distraction effects.</li><li>• Should not frame the issue in terms of what <i>is</i> or <i>is not</i> safe, but rather what is <i>safer</i>.</li></ul>                                                                                                                                                                                               |
| <i>Taxonomy of Driving Scenarios</i> | <ul style="list-style-type: none"><li>▪ Use standard scenarios to measure distraction and driving performance. Allows data to be compared among researchers and research organizations.</li><li>• Standard scenarios can have particular benefit for simulator applications. May be worthwhile to develop standard “distraction” scenarios for NADS.</li></ul>                                                                                                                                                                                                                                                    |

### CANDIDATE RESEARCH TOPICS, IDEAS & NEEDS

Individuals in the group identified the following research needs listed below. These are listed in no particular order and some overlap exists among items. Time constraints prevented the group from developing detailed research problem statements relating to each suggested item or groups of related items. The group used these as a basis for developing the attached research problem statements.

- (1) Define the types of distraction associated measures;
- (2) Explore the applicability of using the spotlight model of attention (intensity), breadth of attentional focus, what it's being directed at (i.e., conceptual/theoretical models)
- (3) Development of standard measures (surrogate safety measures) and criteria for evaluating cognitive demand of in-vehicle devices
- (4) Better understanding of drivers' compensation in different driving situations
- (5) Link between the driver's personality and driving situation/traffic
- (6) Understand the benefits/risks of multi-modality aspects of devices
- (7) Development of safety surrogates
- (8) Develop a consensus or taxonomy of accident/usage scenarios
- (9) Develop better distraction measurement techniques
- (10) Development of mathematical models embodying distraction potential
- (11) Explore driver training and re-licensing; when to stop driving (what age?); how can technology help?
- (12) Understanding types of distraction and how we measure it, then use to predict crash risk
- (13) Explore device training needs. Which devices need to have training support? How can we certify drivers?
- (14) Habituation, adaptation, automaticity.
- (15) Measure intensity of distraction, new devices are probably more intense than previous ones
- (16) Quantitative measurement of distraction potential, at initial product design stage (can't wait for naturalistic test with vehicles, correlation between simulator and vehicle testing results)
- (17) Quantitative measure of distraction (i.e., consensus, or decided upon method) which is made 'law' by an organization (e.g., NHTSA, SAE, ...). Good restrictions will promote good habits; easy to use may not mean safe to use.
- (18) Need a characterization of the cognitive processing requirements that determine the demand of concurrent tasks. Stages of processing and task content load on processing (Wickens' ideas applied to the driving situation is much less well defined.)
- (19) Developing a cost-benefit analysis for telematics services
- (20) How distraction impacts sensitivity and bias with regard to hazard (object/event) detection; bears upon risk taking of individuals
- (21) Having a model of human attention deployment system; it would be good to have model of how attention is switched between concurrent tasks (e.g., is the beam being split into 2, or is it turned off then turned on in another spot?) When does a secondary task that is very attention demanding begin to intrude on more automated primary driving tasks
- (22) What is the workload of normal driving situations; the baseline against which in-vehicle device as are judged as a function of road geometry, time of day, traffic, driver age, weather, and local driving style?

Working Group #2:

Understanding the Human Cognitive Process as it Relates to Driving, Distraction, and Safety

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- (23) How well do models of human performance (IDHSM, IVIS, SOAR, EPIC, IPME, etc.) predict performance with real in-vehicle devices?
- (24) Range of individual differences
- (25) Collection of naturalistic near-crash, pre-crash, and crash data to understand the real world scenarios associated with distraction-induced critical incidents (input to NADS standard scenario development effort)
- (26) Assess capability of broadening/narrowing ('spotlight' of) attention; willful attention sharing vs capture by things in the environment which grab you; cost of switching attention (does our system pose a penalty for switching? / interruptability)

## RESEARCH PROBLEM STATEMENT

**Title:** DEVELOPMENT OF A COMMONLY- ACCEPTED THEORETICAL FRAMEWORK OF DRIVER ATTENTION SUITABLE FOR ADDRESSING DRIVER DISTRACTION

### Why this Research Needs to be Performed:

- Currently there exists a multitude of overlapping, poorly defined terminology. This research is needed to:
  - Provide a common integrative framework to facilitate communication between researchers and Practitioners formulate hypotheses for empirical studies
  - Link in-vehicle system characteristics to cognitive

### Key Objectives of the Research:

- Develop conceptual/theoretical model (s) appropriate for addressing driver distractions
- Develop operational definition of lay concepts
- Develop and validate measurement tools

### General Technical Approach:

- Review basic psychological, human factors & Engineering (IEEE) literature to identify theoretical constructs relevant to attentional aspects of driving (and other relevant).
- Identify applicability of various theoretical/models to driver distraction. Models include:
  - Theory of signal detection
  - Multiple resource theory
  - intentional models

### Other Relevant Comments:

Framework must accommodate:

- Willful attentional Deployment vs. automatic capture
- Compensation Strategies-workload mgmt.
- Subjective importance and time urgency of task (motivation)
- Working memory burden
- Task continuity, chunking, interruptability
- Individual differences - habituation and automatically
- Characteristics of intentional spot light

## RESEARCH PROBLEM STATEMENT

**Title:** DEVELOPMENT OF STANDARD MEASURES AND CRITERIA FOR THE ASSESSMENT OF THE SUITABILITY OF IN-VEHICLE DEVICE USE WHILE DRIVING.

### Why this Research Needs to be Performed:

- Measures are required to guide product development across all phases of the product development process
- Understanding the meaningfulness, consistency and practicality of metrics, methods, and models ( $M^3$ ) is needed
- To begin to create an inward methodology to allow inter-comparability of HMI Assessments

### Key Objectives of the Research:

- To create a comprehensive and consistent methodology that supports each phase of the product development process.
- Define dimensions of assessment to be tracked throughout the development process ( e.g. interruptability/controllability, error robustness, visual demand, non visual cognitive demand
- To recommend a standard assessment "Tool Kit" for in-vehicle device assessment.

### General Technical Approach:

- Review and Characterize state of the art  $M^3$
- Develop Standard scenarios and tasks for evaluation of promising  $M^3$
- Use epidemiological, analytical, simulation, test tracking and on-road data gathering procedures to test and update  $M^3$
- Based on Results, recommend "Tool Kit" for various phases of product development process
- Establish criteria for accessibility of in-vehicle use while driving.

### RESEARCH PROBLEM STATEMENT

**Title:** INTERVENTIONS TO ENHANCE SAFETY WHILE USING IN-VEHICLE TECHNOLOGIES

**Why this Research Needs to be Performed:**

- Want to know the effectiveness of interventions

**Key Objectives of the Research:**

- Develop objective and quantitative methodology and criterion that is accepted by designers and policy makers.
- Develop objective driver certification
- Develop method for predicting when training is required to use in-vehicle technologies and recruitment training.
- Develop method for predicting effectiveness of enforcement techniques ( e.g., ticketing, differential insurance rates, money bonus for fleet drivers)
- Develop common interface for safety critical functions.

**General Technical Approach:**

- Must be objective, consistent, predictive of safety impact, and practical (e.g., enforceable)

**Other Relevant Comments:**

- Must be objective, consistent predictive of safety impact practical (e.g., enforceable)
- Should this be national or international how often should interventions be reviewed/revised? Should certification process begin in concept phase?

## RESEARCH PROBLEM STATEMENT

**Title:** WORKLOAD TAXONOMY OF DRIVING SITUATIONS OF NORMAL NON-CRASH, PRE-CRASH, AND CRASH DRIVING SITUATION SCENARIOS.

### **Why this Research Needs to be Performed:**

- Need a common database of literature to build upon. Common set of test conditions and comparison studies.
- Provides benchmarks for evaluating the safety of existing and new devices. Benchmarks reduce the cost and time required to assess new devices.

### **Key Objectives of the Research:**

- Generate detailed descriptions of distraction-related crash and non-crash scenarios. Collect enough information to build a driving scenario of each real world category. Road geometry, time of day, weather, traffic, road surface conditions, driver demographics (age, sex, experience), vehicle type and dynamics data.
- Generate a sample of driving situations based on NPTS and other sources. Collect a sample of driving performance data (speed, lane position, etc) plus workload measures identified by group as components. Develop equations to relate the driving situation (geometry) to performance metrics.

### **General Technical Approach:**

- Ultimate method should be left to the investigators
- General approach should use:
  - FARS and NASS, CDS (maybe GES). Inventory State data (Michigan, North Carolina, etc.) and pull selected cases that match selected categories)
  - Goodman's distraction data, NHTSA special crash investigators, other sources
  - Build simulation of conditions
  - Use case control approach
  - Interactions with local/State highway officials.

### **Other Relevant Comments:**

- Work should pay attention to replicability/repeatability issues.
- Important to characterize vocabulary within and between devices including longitudinal research

**WORKING GROUP #3:  
HUMAN FACTORS GUIDELINES TO AID IN  
EQUIPMENT DESIGN**

## HUMAN FACTORS GUIDELINES TO AID IN EQUIPMENT DESIGN

### THE PROBLEM

Driver distraction is a primary contributing factor in many crashes. As the number of Intelligent Transportation Systems and telematics devices increases, drivers may be inundated with information and warnings, potentially overloading rather than aiding them. Driver safety can also be jeopardized even without overload (i.e., drivers look away at the wrong time). The concern is that technology will find its way into vehicles with the potential for increasing distraction and lowering safety margins. In addition to OEM systems, we are now witnessing the introduction of after-market products developed by non-traditional suppliers of automotive electronic systems (including the AutoPC) into vehicles. The basic issue is how to design and implement these systems to assure safe vehicle operation (minimizing driver distraction) while satisfying the growing urge for navigation systems, wireless communication devices, on-board computers with Internet and e-mail access and other such in-vehicle devices. Poorly designed systems can exacerbate the contribution of distraction to crash causation. For example, activities not related to driving which involve in-vehicle systems with a significant visual component can overload drivers and elevate the risk of crashes. Although speech recognition and text-to-speech technology offer promising alternatives to visual-based interfaces, growing evidence suggest that these systems impose a cognitive load on drivers that can also impact driving performance. More research is needed to identify promising system designs, features, and technologies that minimize driver distraction.

Designers and engineers need accessible and usable guidelines for creating and evaluating interfaces that are compatible with safe driving. Guidance should be applicable during the early stages of design to prevent costly reengineering once a product is brought to market, and should be expressed in terms useful for product design engineers. The aim is to produce systems that are usable and safe by establishing rigorous design protocols to ensure that in-vehicle systems do not pose safety risks to drivers.

### CURRENT STATUS

Preliminary guidelines for the design of safe and usable driver information systems now exist, and more are under development both in the U.S. and internationally. The Society of Automotive Engineers, for example, has ongoing efforts to develop standards and guidelines for in-vehicle systems; much of this work is being performed by the ITS Division Safety and Human Factors Committee (see attachment for a list of SAE priority ITS human factors standards topics). An example is the SAE recommended practice J2364 Navigation and Route Guidance Function Accessibility While Driving (the so called "15-second rule"), which specifies the maximum time allowed for completing a navigation system task involving manual controls and visual displays when the task is performed statically. Other relevant work includes guidelines for Advanced Traveler Information Systems (Campbell, et al., 1998; Green et al., 1995) and human factors guidelines for crash avoidance warning devices (Lerner et al., 1996), among others. In Japan, the Japanese Automobile Manufacturers Association (JAMA) has been voluntarily advocating safety measures for the design and use of car navigation systems installed and sold by automobile manufacturers. All Japanese OEMs do not allow destination entry and other complex tasks in a moving vehicle, and the Ministry of Transport verifies compliance with these practices. Similarly,

the European Commission has sponsored the development of a "statement of principles" intended to limit the distraction potential of in-vehicle systems by identifying key MMI issues to be considered in the design and implementation of driver information and communication systems.

In a recent review of existing guidelines and standards content, Lerner (1998) characterized the current state of guidance as "disjointed, overly general, and incomplete." Various standards documents generally have quite different perspectives and ways of organizing the issues. More importantly, guidelines or principles tend to be written in very vague terms (rather than specifying a specific means of dealing with the issues), and offer no formal evaluation procedures. Future work needs to focus on the development of more detailed and prescriptive design guidance. Test protocols, tools, and criteria for evaluating the attentional resources required by IVIS designs are also emerging, and may be used to compare alternative designs and/or evaluate a system against benchmark safety criteria.

### CHALLENGES

The challenge is to ensure that safety is not compromised as new systems are introduced into the market. Possible issues to be addressed through research include:

- What research studies are needed to help identify recommendations for design characteristics of original equipment and aftermarket devices that minimize distraction? Is research best directed at defining safe design practices or developing test protocols to evaluate individual designs?
- What evaluation protocols can aid in safe equipment design?
- Can a simple test adequately address the global problem and how can tests be related to safety? What if a simple test that relates to safety cannot be found?
- Can the interactions be generalized into "types of activity" and have tests and protocols for each "type"?
- What technologies can be employed to develop less distracting devices (e.g., voice recognition, hands free operation, HUDs)?
- What designs and features (design solutions) have worked well? What problems have been observed?
- The establishment of maximum allowable task loads. How should these be quantified and what are the acceptable limits? Determinations of what should not be acceptable needs to be based on scientific criteria.
- Identification of effective and feasible approaches for evaluating the safety of a given in-vehicle system and determining the attention demand placed on drivers.
- Whether some form of systematic and centralized safety evaluations are needed to prevent dangerous systems from being introduced into the market.
- Behavioral adaptation issues
- Driver population characteristics (Design Driver)
- How to deal with OEM guidelines vs. after-market system guidelines
- Baselines – what is an appropriate baseline for comparison with use of distracting technologies.
- Do system descriptions need to include a measure of discretionary use?

SAE S&HF COMMITTEE STANDARDIZATION TOPICS

1. Navigation Function Accessibility
2. Navigation System Man-Machine Interface Transactions
3. Human Factors for Adaptive Cruise Control Systems
4. ITS Message Priority
5. Visual Demand Protocol
6. Human Factors for Front Collision Warning (FCW) Systems
7. ITS System Integration & Dialogue Management
8. Guidelines for Auditory Displays
9. Legibility of Electronic Displays
10. Backup Warnings (low speed, rear obstacle detection)
11. Human Factors Guidelines for In-vehicle Cellular Phones
12. Human Factors Conventions for Mayday (Emergency Calling) Systems
13. Human Factors for Road and Lane Departure Warning Systems
14. Human Factors Guidelines for Lane-Change/ Merge Collision-Avoidance Systems
15. Usability and Consistency of Practice in Voice-Operated Systems Practice in Voice
16. Compatibility of Roadside Symbols and in-vehicle Icons
17. Human Factors Guidelines for IVIS for Older Drivers
18. Performance Specifications for Infrared Vision Enhancement Systems
19. ITS Highway Symbols
20. Standardization of ATIS Information Across Information Media
21. Heavy Vehicle Driver Alertness Detection and Warning System Specifications
22. Human Factors Guidelines for Design and Use of Head-Up Displays
23. Human Factors Guidelines for Automated Highway System (AHS) Emergency Events
24. Display and Control Guidelines for Automated Highway System (AHS)
25. Intersection Warning
26. Message Form and Content
Others Currently Under Consideration
27. ACC Stop & Go
28. Integration of Warnings
29. FCW/ACC Integration
30. Portable Devices (PDA's)
31. Guidelines for Haptic Displays (possibly integrated with item #8 above)

(adapted from Farber, 1997)

## GENERAL GROUP DISCUSSION

The following summarizes the group's discussions and key issues discussed during the morning.

### Highlights & Basic Points

#### *Need Yardstick to Measure Distraction*

- No standard and accepted metric for measuring distraction currently exists. Lacking this, it will be extremely difficult to quantify distraction.
- Need to develop a better perspective on what constitutes "normal" driving.
- Need baseline measures and the ability to assess how different systems stack up against each other and baseline tasks.

#### *Task Factors*

- The level of distraction may vary across different tasks. Need to understand what factors contribute to this, how best to organize and describe tasks, and establish benchmark tasks.
- Need to prioritize tasks based on their distraction potential. Devote efforts to high-risk tasks.

#### *Public Acceptance*

- What constitutes and "acceptable" level of distraction?
- What do drivers perceive to be an "acceptable" risk?
- What are current acceptable baseline tasks?

#### *Guideline Application & Process*

- Need to ensure that current guidelines are being applied to new system designs.
- By their very nature, guidelines do not take into account the specifics of every environment and context. Research feeding guidelines generally does not capture the full range of environments and implementation conditions.
- As a community we need to start by applying available "best practices" and knowledge gained through research and experience.
- Guidelines need to address foreseeable reasonable misuse.
- Guidelines (and standards) need to be sensitive to product differentiation needs.
- Guidelines should be made more accessible to system designers.

### CANDIDATE RESEARCH TOPICS, IDEAS & NEEDS

Individuals in the group identified the following research needs listed below. First and second round ideas, representing top priority research topic areas proposed by group members, are listed below. Items within the list are presented in no particular order and some overlap exists among items. Time constraints prevented the group from developing detailed research problem statements relating to each suggested item or groups of related items. The group used these as a basis for developing the attached research problem statements.

#### (First Round Suggestions)

1. Identify high level distraction devices and categories of devices (Input/Output types).
  - Evaluate methods and measures.
  - Tied to safety, new and improved risk benefit measures.
2. Develop baseline level driver tasks (both primary and in-vehicle) across various populations.
3. Objectively measure distraction in the vehicle while driving (quantification of distraction).
  - What is distraction and how can it be measured?
4. ITS task structural characteristics & effects on task chunking.
  - Nature of interaction varies, how do we characterize interaction and how easily does this interaction enable drivers to chunk information – control allocation of attention.
  - What are the important underlying task characteristics underlying chunking.
  - Product should be guidelines to help the designer chunk tasks. Guidelines for how to design systems so they are chunkable.
5. Develop guidelines for automated response (voice recognition) systems.
  - Menu structures and limits for voice systems.
  - Guidelines on system robustness, vocabulary, menu navigation.
  - Design characteristics of voice recognition systems.
6. Evaluation measures for cognitive interactions (cognitive distraction measures).
  - Scanning patterns
  - Identity measures - use to evaluate systems/tasks
  - Methodology for evaluating driving task
7. Develop guidelines for how to integrate devices. Prioritization of information.
8. Metrics for cognitive loading.
  - Establish yardstick and tick marks. Acceptable tasks in cars, where the cut-off point is.
9. Develop a metric for system approach evaluation, not just a single device but composite system (interaction amongst in-vehicle systems)
10. Guidelines for evaluation methodologies.
11. Integration guidelines.
12. Guidelines for assessing mental workload while executing ITS related tasks (cognitive load).
  - Establish how to measure mental workload (metrics).
  - Need method to measure driving environment load and in-vehicle task demands. Need adaptive measure.

Working Group #3: Human Factors Guidelines to Aid in Equipment Design

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(Second Round Suggestions)

13. Development of test procedures for aftermarket devices.
14. Measuring situational awareness (the outcome of distraction). Guidelines and metrics for measuring situational awareness.
15. Linking distraction to safety.
16. Guidelines for collecting accident data. To enable safety correlations to be made about impacts of different systems.
17. Certification for systems. What are appropriate guidelines for such a test.

### Consolidation of Ideas

The group held discussions to clarify and combine proposed research topic areas outlined in the previous page. The following framework was used to organize and consolidate research topic areas; the 17 research topics were reduced to the following 9 unique items.

1. Guidelines directed at what tasks cause "too much" distraction
  - benchmarking
  - baseline
2. Evaluation methodology guideline development
  - "yardstick" evaluating tasks that are currently acceptable vs. new task
  - Where should criteria be?
3. Guidelines to objectively measure distraction and S.A.
  - Quantification of distraction including cog. Load distraction
4. Guidelines to help designers chunk tasks
  - ITS task structural characteristics and their effect on distraction
  - Tasks within a system
5. Guidelines for automated voice recognition Systems.
  - DOD Info
6. Guidelines to integrate systems
  - Multiple systems
  - Tasks across systems
  - Composite system evaluation
7. Guidelines for "system priority" adapt system characteristics under certain conditions
8. Guidelines for infrastructure improvements
  - Cost benefit risk analysis
9. Guidelines for improved data collection forms – ITS added to police report forms.

## RESEARCH PROBLEM STATEMENT

**Title:** GUIDELINES TO HELP DESIGNERS CHUNK TASKS

### **Why this Research Needs to be Performed:**

- The nature of the driving environment necessitates drivers to acquire information in short bursts or time periods. Drivers cannot afford to take their eyes off the road continuously for an extended period. Information should be presented in a manner that facilitates its acquisition over a series of brief glances.
- Drivers should have control over their allocation of attention and systems should be designed to support safe allocation strategies.

### **Key Objectives of the Research:**

- Minimize the impact of distraction
- Identify designs that facilitate chunking
- Describe how task properties influence chunking
- Operationally define chunking
- Simplify the task by breaking it down to manageable pieces

### **General Technical Approach:**

- Explore range of interfaces, text, graphics, auditory displays/controls.
- Scope should focus on visual and manual task interactions.
- Methodology should define appropriate tasks (i.e., ones with an observable start and end point as opposed to continuous tasks). Identify tasks that are potentially chunkable.
- Use task analysis to define tasks & subtasks (e.g., reading e-mail, destination entry)

### **Other Relevant Comments:**

- Need to define how big should a chunk be.
- Operationally defining chunking. Transport Canada examining how breaking up tasks into pieces compares to task performance for the entire task. The assumption is that if a task is chunkable, then chopping it up into pieces should not impose an overall cost.

## RESEARCH PROBLEM STATEMENT

**Title:** GUIDELINES FOR SYSTEM INTEGRATION.

### **Why this Research Needs to be Performed:**

- Support introduction of multiple in-vehicle systems (plug 'n' play)
- Minimize driver confusion, distraction, and errors resulting from multiple devices.
- Explore compensatory effects of other on-board systems; assess the entire system of devices not just individual elements. Need to consider how distraction effects imposed by some devices may potentially be largely compensated for by other driver assistance or collision warning/altering devices present in the vehicle. Potentially "unacceptable" systems may very well become acceptable if distraction effects are mitigated by other systems. The acceptability of a combination of devices (or the overall system) should be assessed. If overall system is found to be distracting or not in compliance with acceptable norms, then individual system components should be examined and modified as needed

### **Key Objectives of the Research:**

- Development of clear, relevant, and useful design guidelines for the integration of multiple in-vehicle devices. What should be integrated? How should they be integrated? Addresses both displays and controls.
- System-wide assessment procedures to evaluate performance for the entire system based on "safe" versus "unsafe" driving (and not just procedures to assess individual elements). Development of integrated system performance metrics.

### **General Technical Approach:**

1. Identify ITS Devices implementation scenarios, and driving scenarios.
2. Characterize scenarios with respect to our, information processing framework.
3. Prioritize information within and between scenarios.
4. Develop preliminary guidelines through review and integration of existing literature.
5. Test and evaluation of preliminary guidelines using mock-ups.
6. Develop final guidelines

### **Other Relevant Comments:**

## RESEARCH PROBLEM STATEMENT

**Title:** GUIDELINES FOR AUTOMATED VOICE RESPONSE SYSTEMS.

### **Why this Research Needs to be Performed:**

- Reduce visual demands associated with in-vehicle system interfaces
- Make interfaces more usable
- Make interface more naturalistic, minimize training requirements

### **Key Objectives of the Research:**

- Define appropriate maximum message length, based on message content (define length or chunk of audio response)
- If vocabulary is limited, develop a standardized set of message commands (ideally, based on natural language)
- Define menu depth and breath
- Specify error handling and recovery procedures (should be standardized)
- Establish consistency among systems for timing out
- Characterize important natural language aspects - speech inflections.
- Understand the types of errors and how to deal with them. Recovery from task interruptions (driver loses focus, or is distracted from the task to drive and then must re-acquire and understand where they are).
- Understand particular system-specific issues associated with automotive applications
- Define system feedback to the driver

### **General Technical Approach:**

- Review current voice interfaces (particularly web-based systems – speech works, MIT). literature and existing work, not limited to automotive applications
- Define test methodologies (wizard of oz, to mimic actual system), and applicable to low-cost simulators.
- Closed course testing with instrumented vehicle (measure eye glance, situational awareness – of both driving task and auditory task). Artificially introduce task interruptions.

### **Other Relevant Comments:**

## RESEARCH PROBLEM STATEMENT

**Title:** GUIDELINES TO OBJECTIVELY MEASURE DISTRACTION AND SITUATIONAL AWARENESS

### Why this Research Needs to be Performed:

- Multiple methods exist, need to define best ones (outline advantages/disadvantages).
- Need a common framework for quantifying demand
- Represents a basic building block, first step towards more advanced systems. Enable systems to adapt to driver loads/demands
- Allow comparisons among systems

### Key Objectives of the Research:

- Determine distraction over broad range of systems (produce measures useful for a broad range of devices or integrated systems)
- Family of measures appropriate for different stages of design. (validated, assess predictive value, establish correlation between early lab measures and fielded on-road performance with system)
- Detect the onset of a problem before it manifests itself in degraded driving performance (use situational awareness measures as advanced cue to problems)

### General Technical Approach:

- Review & document existing measures for assessing situational awareness.
- Link the measures to safety outcomes; see CAMP proposal.

### Other Relevant Comments:

## RESEARCH PROBLEM STATEMENT

**Title:** EVALUATION METHODOLOGY

**Why this Research Needs to be Performed:**

- Adequate evaluation systems do not exist upon which to assess safety/distraction impacts of in-vehicle devices and related activities.
- Assessment and evaluation are very important; need requirements (R&D; Standards; etc)

**Key Objectives of the Research:**

- Develop a standard evaluation methodology that specifies:
  - Procedures
  - Measures and metrics (driver and vehicle performance measures, ratings, visual allocation & eye glance, secondary workload measures, situational awareness, physiological measures, etc.)
  - Evaluation criteria (need a yardstick with benchmarks)
  - Sampling distributions (across various key dimensions: age, gender, experience, etc.)
- Development of a composite/global (overall) figure of merit

**General Technical Approach:**

- Literature review
- Define candidate standardized primary and secondary tasks.
- Employ full range of experimental methods
  - Laboratory (e.g., 15 second rule)
  - Driving simulators
  - On-The-Road and test track studies

**Other Relevant Comments:**

## RESEARCH PROBLEM STATEMENT

**Title:** BENCHMARKING EXERCISE

**Why this Research Needs to be Performed:**

- Need a method of assessing relative distraction potential among devices/activities. Puts new ITS and other potentially distracting technologies into perspective.
- Need to derive/establish baseline references (characterize performance with and without secondary task)

**Key Objectives of the Research:**

- Quantify the effect or impact of a variety of currently acceptable tasks and devices.
- Define the upper bound on impact of these devices

**General Technical Approach:**

- Define range of tasks
- Classification of tasks/devices with respect to current practice. May be accomplished via polls, accident data, direct observation.
- Experimental evaluation using standardized and/or accepted methodologies to measure distraction.
- Derive corresponding tentative boundaries of acceptability.
- Conduct a confirmation or "proof of concept" study to confirm impacts of device (relative impacts).

**Other Relevant Comments:**

**WORKING GROUP #4:  
INTEGRATED APPROACHES TO REDUCE  
DISTRACTION FROM IN-VEHICLE DEVICES**

INTEGRATED APPROACHES TO REDUCE DISTRACTION  
FROM IN-VEHICLE DEVICES

**THE PROBLEM**

According to U.S. Transportation Secretary Rodney Slater, "It is now important that we understand and minimize the risks from distraction associated with the explosive growth of in-car electronics." One approach to achieve this goal is through the integration of in-vehicle systems. Traditionally, systems have been developed in a piecemeal manner, but as the number of these devices increase it becomes vital to consider how these devices and functions will work together and to take steps to ensure compatibility and to minimize distraction. Interactive systems must blend information from safety and collision avoidance systems, advanced traveler information systems, and convenience and entertainment systems without overly complicating the basics of operating vehicles.

The basic issue is how to integrate multiple devices and systems to ease workload and distraction. Although the physical aspects of integrating hardware and communication architectures are important and a necessary prerequisite, our focus here is with the integration of information perceived directly by the driver (the man-machine interface). After-market products raise a host of problems for human factors integration since, by definition, they are added to a suite of other functions after that original suite has been designed. As these technologies are marketed to the public, there will also probably be a stronger consumer push to provide a broader and less predictable range of functions unrelated to driving. Automobile-platform PC's may provide an impetus for faster and more extensive implementation of functions - including safety-function integration with entertainment, information and personal communication. General problems related to integration appear to be widely recognized by researchers, designers, and regulators. These include information overload, message prioritization, visual attention demands, consistency of display and function, standardization of CAS warnings, etc. Nevertheless, available research and standards/guidance documents offer no specific solutions to these problems.

**CURRENT STATUS**

The U.S. Department of Transportation's Intelligent Vehicle Initiative (IVI) focuses on "accelerating the development, availability, and use of integrated systems that help drivers process information, make decisions, and operate more safely and effectively." Under the IVI program, DOT will seek to integrate intelligent systems into passenger vehicles, demonstrate system feasibility, and develop test procedures for systems and performance evaluation. Integration is expected to accelerate the introduction of intelligent systems, reduce manufacturing and consumer costs, improve marketability, and reduce distraction. Although a number of show vehicles exist that are "technology demonstrators" incorporating one or more advanced technology functions, none showcase a systematic approach to integrating multiple safety and telematics functions. In support of the IVI program, FHWA developed candidate configurations combining groups of basic and advanced safety and driver information functions in passenger cars, commercial trucks, and transit vehicles (Campbell et al, 1998). These configurations were used as a basis for defining a framework upon which to define specific human factors integration needs. These needs were also addressed at an IVI Human Factors Workshop conducted by FHWA, Battelle and ITS America (ITS America, 1997) which culminated in sets of research

Working Group #4:  
Integrated Approaches to Reduce Distraction from In-Vehicle Devices

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project statements; over 50% of the 48 research statements generated by 70 experts at the workshop dealt with the need to integrate and manage information presented to the driver. These included, among others, integration of driver models, understanding how various integrated system designs impact driver attention, prioritization and timing of messages, shared controls and the integration of dashboard elements, and understanding the multi-task requirements of how drivers perceive and process.

NHTSA also recently studied human factors integration needs of advanced in-vehicle safety and information systems in an effort to identify driver needs that system integration must address, supporting human factors data needed by system and vehicle designers, and unresolved research needs. Key issues related to integration identified by this work (Lerner et al., 1998) included:

- Information Load and Attention Demand (e.g., how to prevent information overload and distraction, concurrent messages, ability to sense and/or predict driving workload demands)
- Consistency and/or Optimization in Function (e.g., common warning envelopes, message timing)
- Message Prioritization
- Integrating Separate Products (e.g., plug & play interface aspects, when is integration needed, interaction of functions)

The report also indicates that although considerable research on individual functions or devices exists, there is only limited literature on the integration of multiple functions (the report includes bibliographic listings and reviews of relevant literature). Research gaps identified by Lerner (1998) are attached.

#### CHALLENGES

A number of avenues are available for human factors integration research leading to different activities and end products such as design guidelines, evaluation protocols, and models that quantify the potential safety effects on driver performance. Research is needed to develop empirically based guidelines to support system integration. A number of issues must be addressed, including the following:

- How can after-market devices be incorporated into on-board systems?
- Can a vehicle be made smart enough to predict vulnerability to a crash or tailor system responses to the capabilities and desires of each individual driver?
- If new capabilities are required for vehicles and devices, won't this approach only address the problem for people who can afford new cars?

## GENERAL GROUP DISCUSSION

The following summarizes the group's discussions and key issues discussed during the morning.

### Highlights & Basic Points

#### *How to Define & Measure Integration.*

- Need to define the basic parameters that influence "integration" and develop objective metrics and procedures for measuring integration. How do you go about measuring the current state of integration and its relationship to distraction?
- One approach is to define integration from the driver's perspective – a system is integrated once the driver perceives a single system rather than a collection of individual components and functions.
- Need to take a systems approach and look at all the dimensions of the entire system.
- Need to develop a human factors basis for accomplishing integration.

#### *Relevant Integration Aspects*

- Physical characteristics of the device. This influences how drivers interact with and uses the system. OEM's and suppliers can affect basic changes in the engineering of system HMI.
- Prioritization of signals. Prioritization schemes need to be established; these must be sensitive to the fact that message priority will vary under different conditions (factors influencing priority may also differ across countries.)
- The ability to predict or assess current driver workload (or distraction) levels would be invaluable and would feed into the development of adaptive systems that are able to manage and control information. Not currently possible.
- Infrastructure represents an important component for some advanced systems. Need to ensure consistency and compatibility of information presented by in-vehicle devices and the external environment. Issues of formatting, timing, and agreement, for example, must be addressed via integration. These aspects need to be reflected in integration.

#### *Aftermarket Influences*

- Need to consider the role of aftermarket devices and those brought into the vehicle. How can we exercise control over information presented to the driver under these circumstances. Blue-tooth technology may provide an avenue.

#### *Voice Based Interactions*

- Voice systems can be used to perform functions and limit visual demands. Need to better understand how to integrate multiple functions in a manner that is clear and understandable to the driver.

### CANDIDATE RESEARCH TOPICS, IDEAS & NEEDS

Individuals in the group identified the following research needs listed below. First round ideas, representing top priority research topic areas proposed by group members, are listed below. Items within the list are presented no particular order and some overlap exists among items. Time constraints prevented the group from developing detailed research problem statements relating to each suggested item or groups of related items. The group used these as a basis for developing the attached research problem statements.

1. Driver workload manager—sense and predict driver workload level; includes naturalistic data and eye movements.
2. Establishing priorities and heuristics for priority/dynamic algorithms (primarily for crash avoidance systems—which are adequate based on real-time information)—driver workload
3. Exploring setting up the vehicle as an information platform (add functionality but the driver sees it as an integrated whole)
4. Establish a set of recommended countermeasures for driver distraction
5. Pre-competitive research on the issues of reaction time and warnings—and possibly take a number of systems already developed (or with prototypes) and do longitudinal, naturalistic studies where drivers would be monitored before the system was put in their car, measured while using the system, and then measured after the system was in the car long enough to develop adaptive behaviors. (before/after/after time)
6. Develop a driver inattention monitor—define inattention, develop metrics, assess metrics, and automate measurement of that so you can put it in the vehicle. Taxonomy of types of driver inattention.
7. Defining inattention—more basic research (but a difficult thing to do)—feels that driver workload manager is more OEM focused—defining inattention and operationalize it. Apply to OEM, aftermarket in-vehicle devices and external information.
8. How can integrated systems be evaluated—what is the appropriate criteria and what is the redline for that criteria?
9. Standardization of signals (primarily crash avoidance) that request rapid braking or inputs by the driver.
10. Autonomous cruise control—not every system is similar—see how these systems work in the real world—how they interact with one another—will learn how drivers perceive this—field study of driver interactions
11. Define integrated multi-modal safety interaction model. Evaluate use of specific interaction methods for diverse tasks. Create a task taxonomy for integrated systems. Currently tasks definitions are piecemeal (e.g., navigation, radio, etc)
12. Cue Reliability - Questioning the benefits of alerting systems when the signals are difficult for the humans to perceive. If the driver is distracted it is difficult to perceive. The alerting systems have to be interactive with the state of the mind of the driver. Throwing more into the mix. False alarms and missed alarms. “Benefits of alerting systems where error is easy to perceive. When is a warning beneficial/not beneficial”.
13. Evaluation of driver interface in simulation
14. Guidelines for integrated systems.

### Consolidation of Ideas

The group held discussions to clarify and combine proposed research topic areas outlined in the previous page. The following framework was used to organize and consolidate research topic areas; the 14 research topics were subsumed under these three general categories.

1. **Scientific measurement of Driver Inattention (Consolidates items #1,6,7)**
  - Driver workload manager—sense and predict driver workload; includes naturalistic data and eye movement. Develop a driver inattention monitor—define inattention, develop metrics, assess metrics, and automate measurement of that so you can put it in the vehicle.
  - Defining inattention—more basic research (but a difficult thing to do)—feels that driver workload manager is more OEM focused—defining inattention and operationalize it. Apply to OEM, aftermarket in-vehicle devices and external information
  
2. **Safety Information Initiated by Device (Consolidates items # 2,5,10,4,12)**
  - Pre-competitive research on the issues of reaction time and warnings—and possibly take a number of systems already developed (or with prototypes) and do longitudinal, naturalistic studies where drivers would be monitored before the system was put in their car, measured while using the system, and then measured after the system was in the car long enough to develop adaptive behaviors. (before/after/after time)
  - Establishing priorities and heuristics for priority/dynamic algorithms (primarily for crash avoidance systems which are adapted based on real-time information)—driver workload.
  - Standardization of signals (primarily crash avoidance) that request rapid braking or inputs by the driver.
  - Establish a set of recommended countermeasures for driver distraction
  - Cue Reliability - Questioning the benefits of alerting systems when the signals are difficult for the humans to perceive. If the driver is distracted it is difficult to perceive. Alerting systems have to be interactive with the state of the mind of the driver!! Throwing more into the mix. False alarms and missed alarms. “Benefits of alerting systems where error is easy to perceive. When is a warning beneficial/not beneficial”.
  
3. **How to Achieve Integration: Implementation and Improvement of Information to Driver through HMI (consolidates items # 3,8,9,13,14)**
  - Exploring setting up the vehicle as an information platform (add functionality but the driver sees it as an integrated whole)
  - How can integrated systems be evaluated—what is the appropriate criteria and what is the redline for that criteria?
  - How to evaluate integrate system? Criterion and red line Field study of driver interaction
  - Consideration of cultural, language, physical limitations, individual differences

## RESEARCH PROBLEM STATEMENT

**Title:** DRIVER DISTRACTION /INATTENTION MONITOR AND SUPPORT SYSTEM.

**Why this Research Needs to be Performed:**

- Help address individual differences in driver attention capabilities
- Provides flexibility in addressing new systems
- Need more direct measures of driver inattention

**Key Objectives of the Research:**

- Integrate driver monitor information into an "intelligent/adaptive" interface
- Establish red-line criterion for unacceptable level of driver inattention
- Utilize all information available for altering inattention and collision warning criterion

**General Technical Approach:**

- Define inattention operationally
- Establish normal boundaries
- Develop metrics and measurement capability
  - Eye monitoring
  - Physiological measurements
  - Driver performance (speed, lane position, pedal activity, control activation)
  - Environment (road surface, time of day, vehicle position)
- Employ analytic, lab simulator, closed-course, and on road testing

**Other Relevant Comments:**

## RESEARCH PROBLEM STATEMENT

**Title:** EVALUATION OF INTEGRATED SYSTEM HMI

**Why this Research Needs to be Performed:**

**Key Objectives of the Research:**

- To determine how to measure successful HMI integration to minimize driver distraction
- Validate measures/metrics
- Identify impact of language, culture, physical, individual differences - What constitutes an integrated system to the user.

**General Technical Approach:**

- Taxonomy (task compilation/Task delay) errors, etc.
- Define interaction model ( feedback Modality)
- Review AMIC use cases to provide integration example.
- Determine how to provide affordance in interface design
- Determine metrics to verify driver can command given component and receive info. from desired component measures of driving performance/inattention
- Look in other areas for integration (aviation/FAA/ nuclear industry)

**Other Relevant Comments:**

- May be able to generate guidelines from output.
- Measurement protocol as product

## RESEARCH PROBLEM STATEMENT

**Title:** INTEGRATION, PRIORITIZATION AND USAGE OF SAFETY INFORMATION

**Why this Research Needs to be Performed:**

- To address integrated approaches to reduce driver distraction.
- Safety information needs to be collected.
- There is a need to fuse and prioritize data together and a need to understand how inform is to be utilized.
- To understand behavioral adaptation, false alarms and false misses.

**Key Objectives of the Research:**

- Decide what is possible to collect
- To develop and prioritize what algorithms are needed for crash avoidance systems and devices (e.g. adaptive systems)
- To see how information is being used
- Optimize the entire process for the greater safety
- To have a recommended set of standards for various signals to the driver that a crash is imminent (standardize crash warnings since they require a rapid response).
- Evaluate cost and benefits

**General Technical Approach:**

- Survey design and analysis
- Analysis and research
- Simulation ( e.g. Monte Carlo )
- Laboratory/Simulator work
- Build prototype of an integrated system

**Other Relevant Comments:**

- Details need to derive from earlier parts

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Working Group #5:  
Ways to Effect Social Change Regarding the Use of Distracting Devices While Driving

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**WORKING GROUP #5:  
WAYS TO EFFECT SOCIAL CHANGE REGARDING THE  
USE OF DISTRACTING DEVICES WHILE DRIVING**

## WAYS TO EFFECT SOCIAL CHANGE REGARDING THE USE OF DISTRACTING DEVICES WHILE DRIVING

### THE PROBLEM

Driver distraction is likely to increase with the introduction of new and sophisticated in-vehicle technologies. The public and drivers need to be made aware of the benefits and safety risks associated with the use of in-vehicle devices as well as any possible laws or regulations limiting or restricting the use of such technologies. Drivers also need to learn how to use in-vehicle technologies safely and responsibly without jeopardizing themselves and others. Education and public awareness campaigns are vital to alerting drivers of the potential for distraction, safety consequences of distraction and consequences of misuse, and the appropriate circumstances under which in-vehicle technologies should be used.

### CURRENT STATUS

A number of industry and employer organizations (e.g., CTIA, General Motors, etc.) have developed and disseminated safety tips on how to use technologies safely and responsibly when driving. Some, such as the Network of Employers For Traffic Safety (NETS), have even launched distracted driver safety and training campaigns to help drivers recognize and manage distraction.

### CHALLENGES

- How do we develop and implement effective education, outreach, and enforcement programs? What approaches are likely to be effective? How can we best reach the greatest number of individuals in the target population?
- Given the nature of the issue and existing and often conflicting messages, what benefits can be expected from education/training on this issue - i.e., will education/training work and is it enough by itself to address the greater segment of the problem?
- What message is the appropriate message and should it be coupled with other non-technology based distractions or other highway safety issues (e.g., alcohol)?
- Since the media is an important source of information on this issue, should there be a special effort to educate the media?
- What data already exist about drivers' knowledge of the risks involved in using in-vehicle devices and other distractors?
- What types of individual differences are important to consider in developing programs to change driver behavior regarding use of distracting devices?
- What type of research data are needed by state legislatures, enforcers and judiciary in helping them to be effective in their decisions regarding maintaining public safety and use of distracting devices?
- How do we identify the most effective medium for conveying "safety tips"? What is the effectiveness of public service announcements, equipment warning labels, driver education materials, brochures, etc?

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Ways to Effect Social Change Regarding the Use of Distracting Devices While Driving**

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- **What types of information would be most effective in changing drivers' attitudes regarding unsafe behaviors and use of distracting devices? What are the differences in perceived versus actual risk?**
- **How can we evaluate the effectiveness of education programs?**
- **What factors influence public opinion regarding use of distracting devices while driving?**
- **What factors influence drivers willingness (or reluctance) to use in-vehicle technologies while the vehicle is in motion?**

## GENERAL GROUP DISCUSSION

The following summarizes the group's discussions and key issues discussed during the morning.

### Highlights & Basic Points

#### *Target Behaviors*

- What are the behaviors we might want to eliminate? Different behaviors lead to different levels of risk. It may be useful to think in terms of categories of risk.
- Need to establish a hierarchy of risk factors. Need to know the relative risks of various tasks before we can suggest modifying the behaviors. Once risky behaviors are identified, then we can understand the specific messages to disseminate (Need research to identify risky behaviors and target the message accordingly).
- Programs may prioritize and focus on behaviors that are high risk and also easily changed/modified.
- It would be helpful to know which series of behaviors we might want to change and which to encourage (which behaviors lead to safe use). For example, pulling off the road to make a call may introduce other risks.
- Need to define what proper use is safe relative to specific tasks and cognitive load, what behaviors lead to crashes, and which behaviors can we affect? Need a baseline.
- Distraction is not device specific - it is very broad. Cell phones are not the only distraction out there. Changing a CD can be very distracting too.

#### *Education*

- There may be public confusion over safe behaviors in using devices.
- Programs that change unsafe behaviors need to be developed. Some drivers don't see a difference between using these devices and the other distractions.
- It is important to find out the baseline level of knowledge the public has about risk, and find out what they believe they know. Knowledge gaps can be closed through education.
- What you think drives what you do, unrelated to what you know. Focus in on what people think.
- Promote the safe use of electronic devices as an alternative to bans.
- Educate drivers on traffic safety.
- Drivers need to understand that they are incurring risk at the cognitive level.
- Tell drivers to "keep your eyes on the road and hands on the wheel."

#### *Legislation & Enforcement*

- Need to draw a line between what is realistic and feasible to address, and what legislation would be likely to be passed. Every

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problem does not call for a legislative solution.

- Need to consider the inherent safety benefits of having these devices in vehicles when thinking about restricting or limiting their use.
- Consideration should be given to banning the use of cell phones by novice drivers, such as those authorized to drive by instructional permits and intermediate licenses. Following a conviction, drivers operating under authorization of a restricted license should not be allowed to operate cell phones while driving.
- One approach is to limit the behavior first, then address the audience.

*Knowledge Gaps*

- Current research does not fully address the issue of cognitive distraction, but suggests that cognitive distraction may be more risky. Is dialing a cell phone riskier than a one-minute conversation?
- Need to consolidate research about the kinds of distraction and build better research base in order to develop or implement programs.
- Need to understand why drivers are willing to take risks, even though they know about them. And what risk drivers are willing to accept? There are degrees of driving risk.
- Need data about the quality of driver decision making (driver's choices about when to use these technologies).

*Target Populations*

- Novice users are at higher risk already; the combination of driving inexperience and use of complex devices is likely to further increase risk.
- Different groups handle behaviors differently. Some populations (e.g., older drivers) may limit or self-regulate their use of these devices. We know older drivers often choose not to drive at night or inclement weather; they may also self-regulate in this area as well.
- Older drivers (over age 65) also represent the biggest purchasers of new, high-end cars; it may take these drivers longer to figure out how to use the devices. Is there evidence that older drivers are using the technology?

*General Observations  
& Comments*

- Technology is already ahead of people's current use. Devices with greater complexity are being introduced everyday. Use is widespread, although not all features are utilized.
- We should design the technology so it shapes driver behavior in a safe and responsible manner (it is easier to do this than to change people's behaviors after the fact).
- Interaction among devices used simultaneously is also a concern - at some point there will be an overload of information presented to the driver.
- Societal norms about proper use of electronic devices in vehicles while driving need to be established (as was done with alcohol use and driving).

### CANDIDATE RESEARCH TOPICS, IDEAS & NEEDS

Individuals were asked to identify their top three research priorities relating to understanding the nature and extent of the distraction problem. The following research issues were identified (note that items are not necessarily prioritized, but are simply listed the order in which research topics were solicited from individuals).

1. Need to establish baseline levels of distraction. Simulators might be useful for this purpose (allows researchers to structure the environment – events and high demand scenarios). Need to make distinctions regarding various tasks and individual differences (perhaps even categorize different distractions - eating, devices, interpersonal distractions).
2. Develop a measure that captures relative safety or risks of using devices.
3. Conduct research on cognitive load and driver capacity (examine individual differences, and differences across devices). Need to be able to assess cognitive load capacity of drivers (a pre-requisite before we can look at distraction). How much attention do you have to pay to driving, and can you accommodate short (e.g., 15-20 sec.) interruptions?
4. Identify specific behaviors most likely to put drivers at risk (looking down at dashboard vs looking up).
5. Measure extent distracted driving occurs.
6. More driver education on risks and how to use devices responsibly. Find out what device features increase safety and educate users on how to use these features.
7. Develop and evaluate strategies for creating effective messages. Which messages achieve behavioral change.
8. Determine how to deliver the message and how to reach the intended audience.
9. Evaluate a combination of behaviors and impacts on crash risk (need to be able to capture person/task/context).
10. Assess individual differences and capacity to multi-task. Can provide insights that could help drivers rate themselves in how they fall in distraction risk.
11. Determine what design features increase safety/reduce risks and launch education campaign about safety enhancing features of devices.
12. Compare drivers who engage in specific behaviors to those who do not. What accounts for these differences?
13. Examine design adaptations to minimize amount of time needed to operate device.
14. Evaluate external factors not controlled by the driver and relate to the controllable ones. Study how these influence attention, perception of risk, and driver decision to engage in potentially distracting activities or not.
15. Any research to be conducted should be executed as part of a cross-functional team that would include human factors researchers and social marketing/behavioral change researchers to examine driver distraction.
16. Explore what kind of measures would be useful to compare users and non-users.
17. Correlate crash data with presence of cell phones in use or other devices. Investigate if phone was in use at time of crash (need court approval to produce these records).
18. Evaluate the effectiveness of various policies across jurisdictions (or countries) which have passed restrictive legislation. (measure effectiveness in terms of crash reduction, or other objective safety measure) To what extent have such restrictions changed their behavior?

Working Group #5:  
Ways to Effect Social Change Regarding the Use of Distracting Devices While Driving

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Research problem statements addressing a subset of these ideas were generated by the group. These are presented in the following section. Of the three research problems listed, the first (evaluating the effectiveness of current regulations) was perceived to be the least important.

## RESEARCH PROBLEM STATEMENT

**Title:** EVALUATE THE EFFECTIVENESS OF CURRENT DISTRACTED DRIVING/CELL PHONE REGULATIONS

**Why this Research Needs to be Performed:**

- Many jurisdictions are considering legislation to restrict cell phone use and increasing distracted driving enforcement.
- Opportunities exist to assess the effectiveness of such interventions. We do not know if these are effective.
- The results of the study could be useful to jurisdictions considering such initiatives.

**Key Objectives of the Research:**

- Assess public awareness of initiatives and self reported changes in behavior.
- If possible, determine effects on crashes.

**General Technical Approach:**

- Conduct review to determine practices with other countries. Identify appropriate jurisdictions in US to conduct comparisons.
- Study regulations on increasing enforcement of existing laws, use comparison jurisdictions.
- Assess awareness of interventions, procurement practices, perceived risk. Conduct surveys of the general driving public about awareness of interventions and current practices. Report changes in behavior.
- Conduct appropriate crash analysis.

**Other Relevant Comments:**

- Examine the application of graduated licensing type elements and policies as they relate to use of in-vehicle technologies.

### RESEARCH PROBLEM STATEMENT

**Title:** IDENTIFY RISKY DRIVING BEHAVIORS AND THE RELATIVE SAFETY RISK ASSOCIATED WITH EACH.

**Why this research Needs to be performed:**

- The type of behavior and level of risk must be determine before changes can be made

**Key objectives of the Research:**

- Identify which behaviors cause the greatest safety risk to drivers.
- Determine how external factors effect engaging/not engaging in these behaviors.
- Determine what level of the population in engaging in such activities.
- Determine what segment of the population in engaging in such activities.
- Determine how changeable is the behavior.

**General Technical Approach**

- Types analysis
- Use simulator to measure reaction time; holding to correct speed, alignment, following traffic laws, tailgating, constant speed, etc.
- Correlate crash data with the use of technology (e.g. Canada U. of Toronto Study)

**Other relevant Comments:**

Considerations

- Kids with other passengers
- Different levels of conversations with passengers
- Changing CD changing radio station
- Unrestrained cargo (animals included)
- Cell phone dialing, hands free vs. hand held, long call vs. short call, heated conversation vs. normal chit chat.
- Navigation devices-viewing, programming, etc.
- Grooming (make-up, shaving)

### RESEARCH PROBLEM STATEMENT

**Title:** DEVELOP AND EVALUATE PERSUASION STRATEGIES FOR ACHIEVING KNOWLEDGE AND BEHAVIOR CHANGE (IN DIFFERENT TARGET AUDIENCES, INCLUDING: MESSAGES AND DELIVERY METHODS)

**Why this Research needs to be Performed:**

- To develop programs which will be effective in helping drivers manage distractions and avoid risk from in-vehicle distractions.

**Key objectives of the Research:**

(Using inputs from project 2 about risky behaviors to be changed )

1. Determine who (which group) exhibits those target risky behaviors
2. For each target audience, determine:
  - What they know and what they think they know
  - What beliefs they have
  - How they feel about each of the targeted behaviors
3. Generate alternative concepts for message content and delivery method for each target audience
4. Evaluate effectiveness ( changes in knowledge, attitude, behavior)
5. Propose "best" persuasion strategies for each audience
6. Examine how these proposed persuasion strategies fit into and build upon the larger safety messages on safety behaviors (buckle up, keep kids safe, don't drink and drive)

**General Technical Approach:**

- Surveys for objectives 1 and 2
- Focus Groups and analysis for objective 3
- Experiments for objective 4

**Other Relevant Comments:**

Need to define measures of effectiveness in changing behavior.

## SUMMARY & CONCLUSIONS

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### SUMMARY

Driver distraction has been under study by NHTSA since the early 1990's. This work continues today as have efforts to raise public awareness of potential safety implications associated with driver distraction while using advanced in-vehicle technologies. NHTSA recently sponsored two public events providing opportunities to share viewpoints, information, and recommendations regarding strategies to minimize potential adverse effects of driver distraction when using in-vehicle devices. One event was an Internet Forum (held July 5 – August 11, 2000) which was a virtual conference on the web to understand the risks from distraction associated with the explosive growth of in-car electronics. The second was a public meeting (held on July 18, 2000) at which representatives of the public, industry, government, and safety groups offered viewpoints regarding the roles of various entities in promoting best practices in the design of those devices and their use, approaches for evaluating the safety impacts of such systems, and outlined what new research and other safety initiatives are needed. Highlights and proceedings associated with these two events are documented in a separate report.

The work described here represented a follow-on to these two earlier events and provided an opportunity for invited researchers and technology developers to discuss key issues and generate recommendations for distraction-reducing strategies, data needs, and research methodologies. Five separate expert working groups were convened – each addressing a different topic area and charged with identifying short and long-term research needs to support activities and interventions geared towards mitigating the negative safety impacts associated with driver distraction induced by in-vehicle devices. The purpose of these meetings was not to reach consensus among participants, but rather to solicit a broad range of views and perspectives relating to distraction and to identify the range of research needed to address the driver distraction problem. In all, over 50 experts representing the automotive industry (OEM's and suppliers), academia and research firms, highway safety organizations, enforcement agencies, and industry trade associations participated and contributed to the development of 23 research problem statements in each of the five general areas outlined below.

#### Understanding the Nature and Extent of the Driver Distraction Problem

Although available evidence suggests that use of electronic devices while driving (e.g., cell phones) may increase the risk of a crash, the magnitude of these risks is uncertain. A number of studies have called for improvements in data collection and reporting systems as well as efforts to understand how drivers interact with in-vehicle devices under naturalistic setting so that more precise exposure data can be collected. Experts in this group examined limitations with existing crash data reporting systems and investigative techniques (e.g., event data recorders, critical incidents, observational studies) which can be used to better assess the safety problem and allow relationships between device use and crashes to be determined.

Discussions addressed suggestions for improving the data collection process, the need to define the various forms of distraction and develop measures and comparative baselines to assess the magnitude of the problem, and specific techniques and approaches for gathering needed data. Prospective crash studies, follow-up interviews with drivers involved in crashes, and expanding the capabilities and use of electronic data recorders were seen as potentially useful and appropriate research tools in studying the magnitude of safety impact caused by distraction. Over 30 research topic areas and seven research problem statements were identified and developed. A

## SUMMARY & CONCLUSIONS

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number of innovative suggestions and views were gathered, several are summarized below (Table 2 provides the titles for each of the specific research problem statements developed by the group).

- Information about close calls associated with distraction is believed to be potentially useful for understanding the nature and extent of actual crash factors. Not only are these types of events more prevalent than crashes, but drivers may be more willing to share information concerning near-crashes and critical incidents. Reporting systems in the aviation industry used to gather this type of information have proved extremely valuable. Similar reporting mechanisms should be implemented in this context; perhaps a web-based reporting system can serve this purpose.
- It is important to compare crash risk from drivers' use of various in-vehicle technologies to other forms of distractions. Examining a broad range of distractions will aid in our understanding of technology-based distraction.
- Studies should assess the relative severity of different distracting events and differences in driver age as well as driving experience.
- Better information about the specific circumstances (context) surrounding crashes caused by distraction is needed. Approaches for generating this type of information may include use of fleet vehicles, including police, commercial vehicle, and rental car agencies. Information generated should include exposure data for various distractions, documenting frequency of use, types of tasks being performed, and the conditions of use.

### Understanding the Human Cognitive Process as it Relates to Driving, Distraction and Safety

Drivers must continually allocate attention to competing tasks, both driving and non-driving. Potential distractors of many sorts are often present, but significant distraction does not always occur. Understanding how drivers handle competing tasks and intruding events (i.e., human cognitive processes of perception and attention) and how this results in significant distraction from vehicle control tasks is at the center of the distraction problem. Experts in this working group examined how cognitive aspects such as attention allocation, information processing time, cognitive capture, willingness to engage, risk perception, workload, and task strategies affect in-vehicle device demands and driving performance outcomes. Research topics and needs were sought to address the following areas: measurement (how to define and measure distraction), characterizing the underlying cognitive basis of driver distraction, and application of cognitive aspects to problem mitigation (how to apply this knowledge to predictive tools, design guidelines, regulations, and public information).

Four research problem statements and 26 topics were identified. Key discussion items and viewpoints are highlighted below (Table 2 lists the research problem statements developed by the group).

- A multitude of overlapping, poorly defined terminology exists to define "distraction." A common framework for operationalizing and measuring distraction is needed. Efforts need to emphasize the use of standard measures (safety surrogates) and criteria for evaluating cognitive demand.
- Little quantitative data exists to characterize workload levels associated with normal driving. Efforts should be launched to determine workload of normal driving situations, and better understand how drivers compensate under different driving situations. This work should include data collection under naturalistic settings and lead to the development of baselines against which in-vehicle devices are judged.

## SUMMARY & CONCLUSIONS

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- Use of standard scenarios to measure distraction and driving performance should be developed. These should be based on real-world near-crash and crash data and should be used to support simulation and modeling.

### Human Factors Guidelines to Aid in Equipment Design

As the number of Intelligent Transportation Systems and telematics devices increase, drivers may be inundated with information and warnings, potentially increasing distraction and lowering safety margins. The basic issue is how to design and implement these systems to assure safe vehicle operation (minimizing driver distraction) while satisfying the growing urge for navigation systems, wireless communication devices, on-board computers with Internet and e-mail access and other such in-vehicle devices. Designers and engineers need accessible and usable guidelines that are applicable during the early stages of design and expressed in usable terms understood by product engineers. Detailed and prescriptive guidance is needed as are protocols, tools, and criteria for evaluating systems designs. Experts in this group discussed and examined issues regarding the development of guidelines for the design of safe and usable in-vehicle telematics systems, including defining safe design practices, and test protocols to evaluate designs, and the use and effectiveness of technologies (Head-Up Displays, voice recognition, hands-free systems, etc.) in design. Six research problem statements and 17 topic areas were identified. Key discussion items, viewpoints, and suggestions are summarized below (Table 2 lists the research needs developed by this group).

- System designers and developers should apply available "best practices," guidelines and knowledge gained through research and experience. A mechanism is needed to ensure that current guidelines are being applied to new system designs. Guidelines need to address foreseeable reasonable misuse and be sensitive to product differentiation.
- No standard and accepted metric for measuring distraction currently exists. Developing a "yardstick" to measure distraction represents a fundamental task.
- Guidelines are needed to address voice recognition systems, system evaluations (including cognitive loading), system integration, workload assessment, measuring situational awareness, collecting and organizing crash data, assigning message priority, and for structuring tasks to be compatible with how drivers chunk tasks.

### Integrated Approaches to Reduce Distraction From In-Vehicle Devices

Traditionally, systems have been developed in a piecemeal manner, but as the number of these devices increase it becomes vital to consider how these devices and functions will work together and to take steps to ensure compatibility and to minimize distraction. Interactive systems must blend information from safety and collision avoidance systems, advanced traveler information systems, and convenience and entertainment systems without overly complicating the basics of operating vehicles. The basic issue is how to integrate multiple devices and systems to ease workload and distraction. After-market products raise a host of problems for human factors integration since, by definition, they are added to a suite of other functions after that original suite has been designed. Experts in this group examined the man-machine interface aspects of integrating information perceived directly by the driver. These issues included information overload, message prioritization, visual attention demands, consistency of display and function, and standardization of Collision Avoidance System warnings, among others.

## SUMMARY & CONCLUSIONS

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Fourteen specific topic ideas and three research problem statements were identified and developed. Proposed research topics were subsumed under three general categories related to the scientific measurement of driver inattention, safety information and signals provided to the driver, and how to achieve integration. A number of issues and perspectives were gathered regarding integration, and these are highlighted below (Table 2 lists the titles of the research problem statements developed by the group).

- Approaches for measuring and characterizing the current state of integration and its relationship to distraction are needed. A systems approach which examines all system dimensions should be adopted. Approaches should take into account: how the driver interacts with the system, prioritization of signals and messages, consistency and compatibility with external sources of information, and the physical aspects of the device interface (displays and controls).
- The role of aftermarket devices and those brought into the vehicle must also be considered as part of the driver-distraction problem. Blue-tooth technology may provide an avenue to exercise control over information presented to the driver under these circumstances. Bluetooth wireless technology is a defacto standard, as well as a specification for low-cost, short-range radio links between mobile PCs, wireless phones and other portable devices. It will enable users to connect a wide range of computing and telecommunications devices without the need to buy, carry or connect cables.
- Resources should be devoted to the conduct of pre-competitive research on issues related to reaction and warnings.
- Individual differences in driver attention can be addressed via development of a driver monitoring system capable of sensing and predicting driver workload. Such a capability can be used to define "inattention" as well as develop adaptable systems which manage driver workload.

### Ways to Effect Social Change Regarding the Use of Distracting Devices While Driving

The public and drivers need to be made aware of the benefits and safety risks associated with the use of in-vehicle devices as well as any possible laws or regulations limiting or restricting the use of such technologies. Drivers also need to learn how to use in-vehicle technologies safely and responsibly without jeopardizing themselves and others. Education and public awareness campaigns alerting drivers of the potential for distraction, safety consequences of distraction and consequences of misuse, and the appropriate circumstances under which in-vehicle technologies should be used are instrumental in helping drivers to recognize and manage distraction. This expert working group examined alternative approaches for effecting social change regarding the use of distracting devices while driving.

Discussions focused on a variety of issues, including the need to define and prioritize high risk target behaviors that can be the subject of educational campaigns, development of effective educational programs that change behavior, legislative efforts to limit or ban technology use when driving, and high risk user populations. Some suggested that behavioral change is best approached through device designs - effectively shaping safe and responsible use through limitations in functions or via good design practices. Creation of a cross-functional, multidisciplinary research team was suggested as a means to facilitate development and implementation of safe designs and oversee progress in the area. In all, eighteen research topics and three detailed research problem statements were developed. Table 2 lists the research problem statements developed by the group, and key topics, ideas and suggestions are summarized below.

## SUMMARY & CONCLUSIONS

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- The process of modifying driver behavior should start by first identifying the relative risks of various tasks. Once high-risk behaviors are identified, then messages geared towards behavioral change can be crafted and disseminated to defined user populations. Some behaviors may be the focus of change, others reinforcement.
- It is important to understand the baseline level of knowledge the public has about risk with using in-vehicle technologies and build upon these. Some individuals may have misconceptions about the safety of some devices or designs. It is also important to determine what technology features increase safety and educate users on how to use these features.
- In terms of legislation, consideration should be given to what is realistic and feasible to address and what is likely to be passed, as well as the safety benefits of access to these technologies. Efforts should examine the extent to which various policies have been shown to effect behavioral change.
- Not all messages will effect behavioral change. The need exists to develop and evaluate strategies for creating effective messages and delivery systems.

## SUMMARY & CONCLUSIONS

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**Table 2. Research Problem Statements**

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**EXPERT WORKING GROUP RESEARCH PROBLEM STATEMENTS:  
RESEARCH NEEDS ACROSS AREAS**

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**Understanding the Nature and Extent of the Driver Distraction Problem**

1. Observational study of device distraction in special vehicle populations
2. Driving distractions as a cause of traffic crashes
3. Enhance existing crash data systems
4. Expanding EDR (electronic data recorder) capabilities
5. Standardized test protocol and scenarios suitable for conducting driver distraction research
6. Factors that contribute to driver willingness to engage in potentially distracting tasks
7. Development of a driver distraction taxonomy

**Understanding the Human Cognitive Process as it Relates to Driving, Distraction and Safety**

8. Development of a commonly- accepted theoretical framework of driver attention suitable for addressing driver distraction
9. Development of standard measures and criteria for the assessment of the suitability of in-vehicle device use while driving.
10. Interventions to enhance safety while using in-vehicle technologies
11. Workload taxonomy of driving situations of normal non-crash, pre-crash, and crash driving situation scenarios.

**Human Factors Guidelines to Aid in Equipment Design**

12. Guidelines to help designers chunk tasks
13. Guidelines for system integration
14. Guidelines for automated voice response systems
15. Guidelines to objectively measure distraction and situational awareness
16. Evaluation methodology
17. Benchmarking exercise

**Integrated Approaches to Reduce Distraction from In-Vehicle Devices**

18. Driver distraction /inattention monitor and support system
19. Evaluation of integrated system HMI
20. Integration, prioritization and usage of safety information

**Ways to Effect Social Change Regarding the Use of Distracting Devices While Driving**

21. Evaluate the effectiveness of current distracted driving/cell phone regulations
  22. Identify risky driving behaviors and the relative safety risk associated with each.
  23. Develop and evaluate persuasion strategies for achieving knowledge and behavior change (in different target audiences, including: messages and delivery methods)
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## SUMMARY & CONCLUSIONS

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### CONCLUSIONS

Although five independent expert working groups were convened, each devoted to a separate topic area relating to distraction, a number of common themes emerged. These were captured in both the group discussions as well as in the research topics and problem statements generated by the groups. These include the following:

- Experts generally recognize that distraction is a broad and encompassing phenomenon and is not limited to in-vehicle technologies. Although NHTSA's focus on technology-related problems is warranted, other non-technological forms of distraction can serve as a useful basis for comparison as well as provide insights into the general problem.
- Very little is known about the magnitude of the distraction problem. Our understanding about how drivers use in-vehicle technologies and the context in which drivers use these devices is limited. Naturalistic studies using data recorders capable of capturing pre-crash scenarios and controlled epidemiological studies are needed to better understand usage and circumstances surrounding crashes caused by distraction. Data can be used to focus on key behaviors and risk factors, educate drivers on the safe use of technologies, develop countermeasures, and guide device design, among other activities.
- Additional work is needed to define and assess the relative risk of various distracting activities and devices. This need was identified by all of the groups, and dealt with the basic issue of defining distraction measures and criteria for evaluating demand. Many called for the conduct of naturalistic studies to define baseline demand associated with driving itself, and with the use of various in-vehicle technologies. Data characterizing exposure and context were sought. Use of event data recorders was also suggested by many participants.
- The idea of developing a taxonomy of driving situations (normal driving, pre-crash, and crash) surfaced repeatedly, and has application in a number of areas, including development of a common set of test conditions and benchmarks for evaluating the safety of existing and new devices.
- Use of near-miss data can serve to increase our understanding and since these events occur much more frequently than crashes themselves, data can be amassed relatively quickly.
- Individual difference factors were recognized as powerful influences over drivers' ability to multi-task and self-regulate behavior. This factor was also perceived to play a key role guiding driver risk perception and willingness to engage in secondary task interactions with in-vehicle technologies.
- At present there is no common basis for determining when an activity represents a distraction. Standardized methods and techniques are needed so that distraction can be objectively measured and impacts on safety assessed. Criteria and thresholds for defining "distractions" must be developed; these definitions should be tied to safety and enable the relative risks of the devices to be identified.

## MEETING AGENDA

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### Thursday (9/28/00) and Wednesday 10/11/00

- |                |                                                                               |
|----------------|-------------------------------------------------------------------------------|
| 8:30 - 9:00am  | Continental Breakfast                                                         |
| 9:00 - 9:15am  | Overview Agenda & Planned Activities, Self-Introductions                      |
| 9:15 - 9:30am  | Summary of Internet Forum & Public Meeting                                    |
| 9:30 - 11:30am | Charge to Working Groups & Group Discussion on Relevant Research & Key Issues |
| 11:30-12:30pm  | Lunch                                                                         |
| 12:30 - 2:30pm | Identify Candidate Work Items & Prepare Problem Research Statements           |
| 2:30 - 2:45pm  | Break                                                                         |
| 2:45 - 4:30    | Complete Problem Statements, Wrap-up & Summary                                |

Meeting Location: US DOT Headquarters  
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