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CRASH WARNING SYSTEM INTERFACES: HUMAN FACTORS INSIGHTS AND LESSONS LEARNED

John L. Campbell

Battelle, Center for Human Performance & Safety

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Discussion Topics

- Project Summary
- Overview of Handbook Contents
- Current Status and Research Needs Relevant to:
  - Interface Characteristics of CWS Devices
  - Diverse Population of Drivers
  - Unintended Consequences
  - Integration of Multiple CWS Devices
  - Standardization of DVI Characteristics
- Conclusions

Project Summary
Specific Objectives

1. Develop a set of clear, relevant, and easy-to-use lessons learned that can be used to support the development of the Driver-Vehicle Interface (DVI) of near-term Collision Warning Systems (CWS):

   - building on the 1996 effort conducted by Comsis, determine the current state of human factors knowledge applicable to DVI development; i.e., controls, displays, message content & timing
   - to support the IVBSS program, develop guidelines for the integration of **forward collision** (headway warning), **lane change** (blind spot warning) and **road departure** warnings
   - identify additional research that is needed to fill existing gaps in the knowledge base
   - focus on passenger vehicles, but include information relevant to heavy trucks and buses

Project Summary
Industry Participation

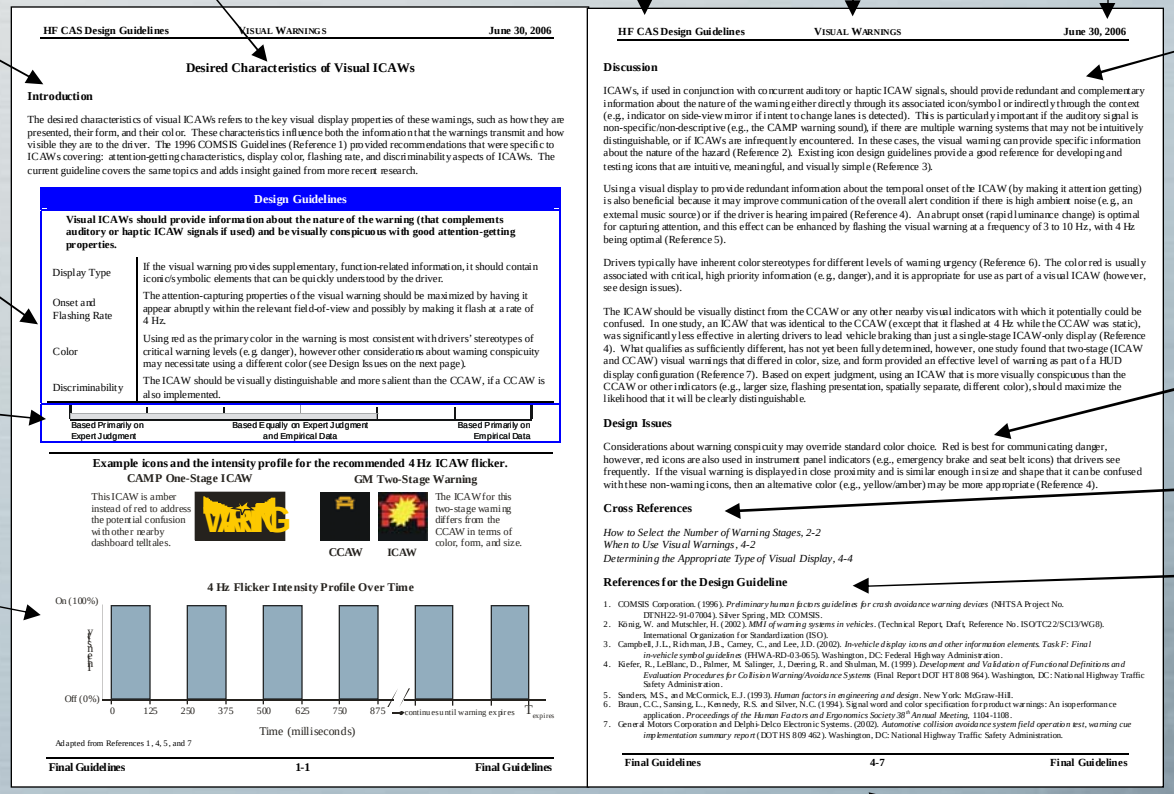
- Helped determine: relevant CWS technologies, key source documents and reports, desired content and format of the document, future research needs

- Klaus Bengler (BMW)
- Debby Bezzina (Visteon)
- Peter Burns (Transport Canada)
- John Hancock (Iteris)
- Steve Jahns (PACCAR)
- Jim Keller (Honda)
- Ray Kiefer (GM/CAMP)
- John Kovacich (Eaton)
- Tom Mattox (Eaton)
- Michael Nowak (Eaton)
- Dean Pomerleau (Cognex)
- Scott Pyles (Valeo)
- Jim Sayer (UMTRI)
- Dan Selke (M-B, USA)
- Colleen Serafin (Visteon)
- John Shutko (Ford)
- Alan Stevens (TRL)
- Tim Tiernan (Visteon)
- Louis Tijerina (Ford)
- Hiroshi Tsuda (Nissan NA)
- Meg Vais (Daimler Chrysler)
- Richard van der Horst (TNO)

Overview of Handbook Contents
Key Chapters

- General Guidelines for CWS Design
- Auditory Warnings
- Visual Warnings
- Haptic Warnings
- Controls for CWS Devices
- Forward Collision Warning Systems
- Lane Change Warning Systems
- Road Departure Warning Systems
- Application to Heavy Trucks and Buses
- Tutorials (CWS technologies, CWS operation, heavy trucks, integration)

Overview of Handbook Contents
Presentation Format



Introduction

Guideline Title

Abbreviated Handbook Title (*Both Pages*)

Abbreviated Chapter Title (*Both Pages*)

Revision Version (*Both Pages*)

Discussion

Design Guideline

Design Issues

Bar Scale Rating

Cross References

Figure, Table, or Graphic

References

Left-hand page

Page Numbers

Right-hand page

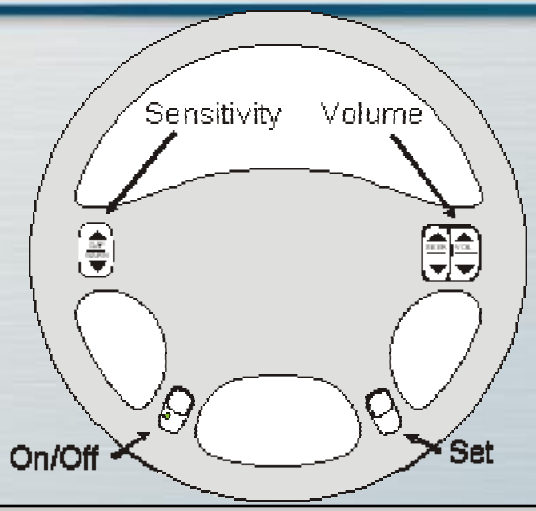
Overview of Handbook Contents

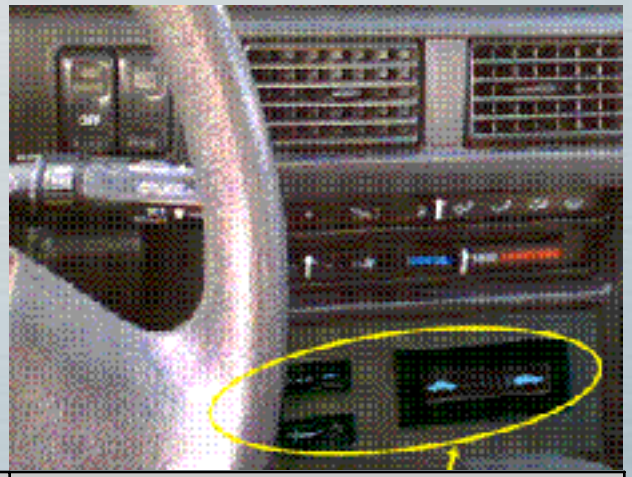
Example: *Determining the Appropriate Auditory Signal*

Ratings of auditory signals for collision warning functions.

Functions	Example Message	Simple Tones	Earcons	Auditory Icons	Speech Messages
Informational (e.g., system status)	• Radar dirty • Sensor malfunction • Warning disabled	Poor	Poor	Poor	Fair
Cautionary Warning	• Headway gap too small • TTC too short • Closing rate too fast	Poor	Fair*	Fair*	Poor
Imminent Warning	• Collision imminent • Immediate action required	Good	Poor	Good	Fair

Overview of Handbook Contents
Example: *Design of CWS Controls*



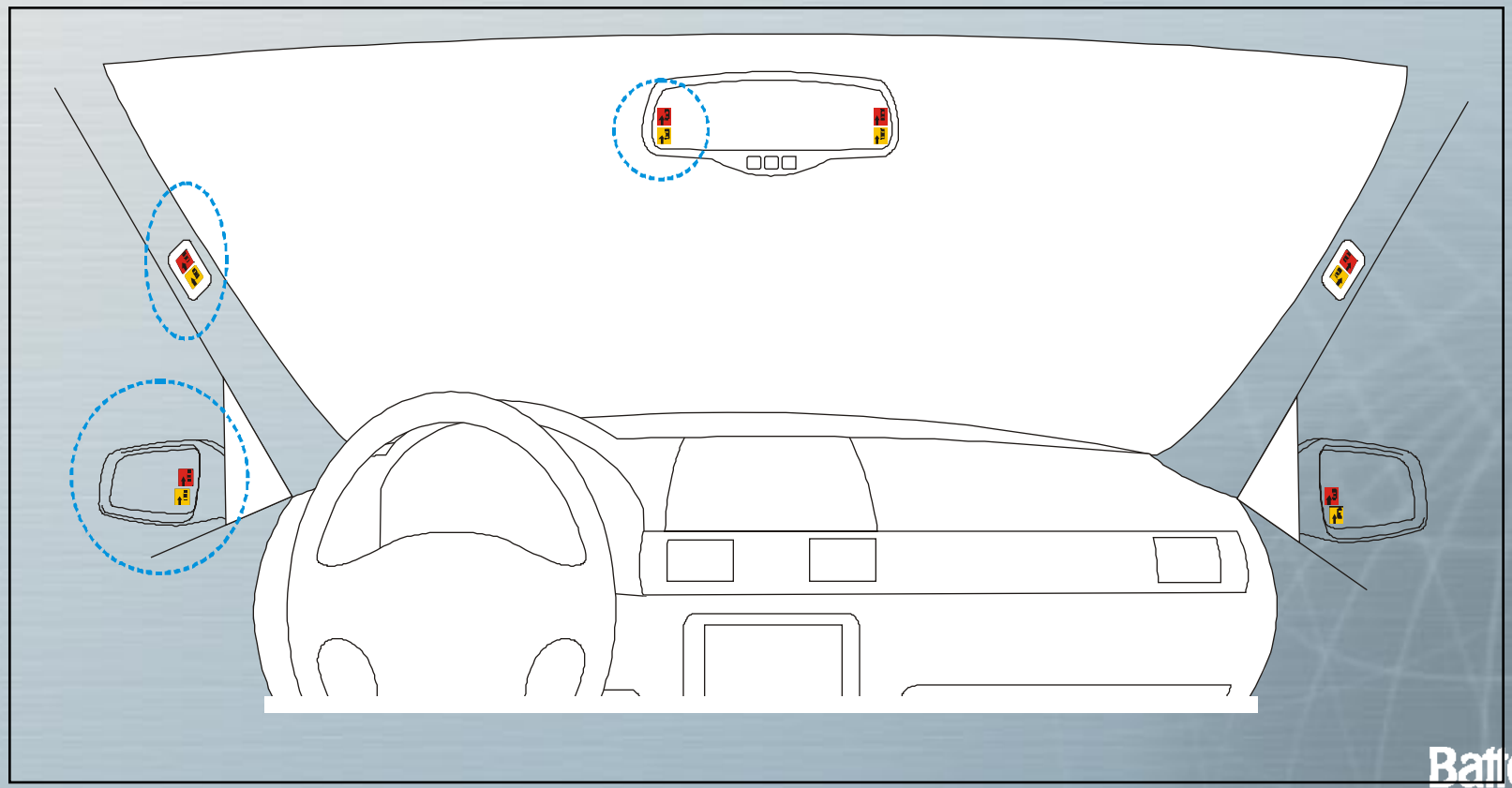


A. Well-designed Control Placement	B. Poorly-designed Control Placement
•Controls are aligned with forward view •Controls are within fingertip reach •Higher priority controls are on the outside (easier to manipulate) •Controls can be activated with both hands on the wheel •Controls are coded by location for easy identification Adapted from Reference 6	•Controls are not aligned with the forward view (driver must look away and down to see controls and display) •Placement requires increased glance time •Controls are partially obscured by steering wheel •Driver must reach to operate control •Controls are poorly or not labeled •Inappropriate control type for on/off switch

Overview of Handbook Contents
Example: *Design of Cautionary Collision Warnings for Lane Change Warning Systems*

Potential locations for LCW system visual displays.

The figure below shows potential display locations for CCW and ICW visual displays. Left-side display locations are circled by the blue dashed line.



Current Status and Research Needs
Interface Characteristics of CWS Devices

- Current Research:
  - Basic characteristics of visual (e.g., size, color, location) and auditory (e.g., intensity, sound type) warnings are well-understood, reflecting many years of human factors study, as well as more recent DOT-sponsored FOT experience.
  - Through recent efforts, robust designs of forward collision warnings are available
- Future Research Questions:
  - What are acceptable rates for false/nuisance alerts?
  - What are the required characteristics of haptic warnings?

Current Status and Research Needs

Diverse Population of Drivers

- Current Research:
  - Simple CWS DVI designs reflect basic perceptual and cognitive differences between older and younger drivers
  - There is generally high acceptance of the value and utility of CWS devices
- Future Research Questions:
  - What is the impact of impaired driving (e.g., alcohol, drugs, fatigue) on CWS DVI design?
  - Will a diverse driving population require a broad range of driver-selectable DVI features (e.g., timing, intensity, muting, message priorities)?

Current Status and Research Needs
Unintended Consequences

- Current Research:
  - Degraded levels of system performance (e.g., false alarms) decrease driver trust and decreased trust can lead to driver dissatisfaction, but trust can be regained over time.
- Future Research Questions:
  - In the long-term, do drivers change or neglect important safe-driving behaviors (e.g., speed choices, visual checks) because of the safety benefits provided by CWS devices?

Current Status and Research Needs
Integration of Multiple CWS Devices

- Current Research:
  - Key integration scenarios for a range of CWS devices have been identified
  - ISO heuristics for prioritizing in-vehicle messages have proven useful for CWS design
  - Successful “integration” will occur at the sensor, sensor processing, warning algorithm, and DVI levels
- Future Research Questions:
  - How should we address situations involving simultaneous hazards (e.g., relative timing and modalities, potential for masking, warning inhibition, driver response to >1 warning)?

Current Status and Research Needs
Standardization of DVI Characteristics

- Current Research:
  - Consistency across some key DVI design features of CWS devices will generally improve driver performance
  - Many basic features of CWS DVIs are already very similar
  - There is considerable variability across CWS devices in terms of their safety focus and their operation
- Future Research Questions:
  - What are the trade-offs between the benefits of standardization vs. product differentiation needs & future innovation?

Conclusions

- **The revised guidelines reflect the considerable body of DVI-relevant work conducted since 1996, as well as the solid foundation provided by the COMSIS guidelines.**
- **Key strengths of the guidelines are in areas such as visual & auditory warnings, controls, FCW devices, and technology overviews.**
- **Key weaknesses of the guidelines are in areas such as haptic warnings, roadway departure systems, and warnings integration.**
- **A number of research issues, many amenable to low-risk / low-cost efforts, have been identified.**