Human Factors Evaluation Considerations for Safety Enhancing Systems

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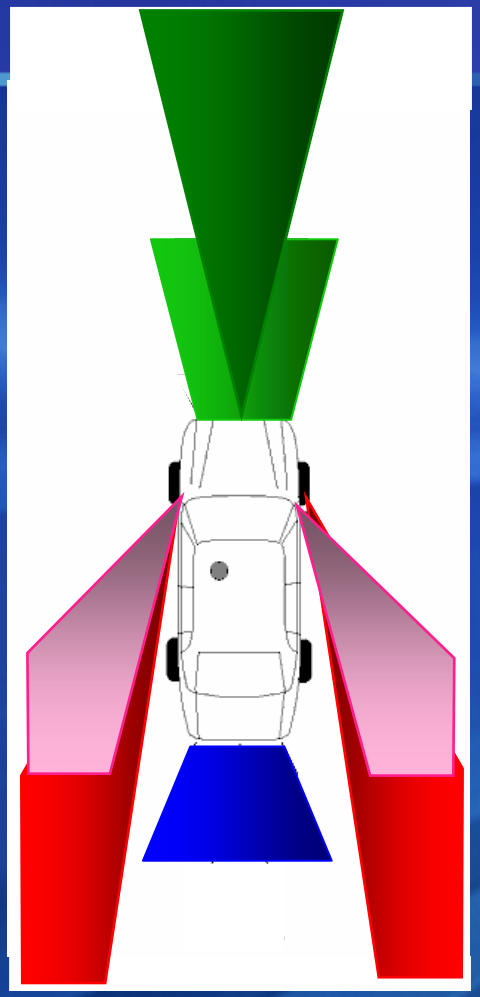
Adaptive Cruise Control
Collision Preparation

Forward Collision Alert
Auto Emergency Braking

Illustration of a Broad Range of Advanced Driver Assistance Systems with HMI Implications



Auto Lanekeeping

Lane Departure Warning

Side Blind Zone Alert

Lane Change Warning

Rear Video
Backup Warning
Auto Emergency Braking

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Human Factors Evaluation Considerations

- Establish a safety benefit
  - Direct
  - Indirect
  - Implied
- Evaluate & address potential unintended consequences, for example:
  - Does a driver with an ACC system engage in more in-cab distraction activities?
  - Does a driver with a Side Blind Zone Alert system stop using turn signals?
  - Does a driver with a Rear Video system stop looking behind when backing?
- Develop appropriate customer education materials
  - Inform driver in an effective manner of how to operate system, proper and improper usage, system limitations, and use cautionary information to mitigate any potential unintended consequences
  - Owner's manuals, quick reference guides, etc.

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Establishing a Safety Benefit

- Direct data
  - Safety benefits directly suggested based on crash database analyses *(e.g., Electronic Stability Control, Daytime Running Lamps)*
- Indirect data
  - Safety benefits indirectly suggested based on data gathered under well-controlled, realistic conditions where the experimentation is specifically designed to place drivers in "target" crash scenario(s) *(e.g., "Distract and Surprise" Methodology)*
- Implied data
  - Safety benefits implied based on "improved driving behavior" observed under less-controlled, realistic conditions where the experimentation is not specifically designed to place drivers in "target" crash scenario(s) *(e.g., A decrease in tailgating behavior with a ACC system observed during an in-traffic study)*

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Primary Research Methods & Challenges

- Safely create well-controlled, experimental crash scenarios to assess crash avoidance system effectiveness under realistic conditions

  → *Challenge: Creating safe, "realistic as possible" crash threats so that lay driver behavior can be observed*

- Understand effects of a system under less controlled, in-traffic, real-world driving
  - With versus without experimenter presence
  - "near crash" or "actual crash" events are rare
  - False alarm experiences vary substantially across drivers, which impacts both system effectiveness and driver acceptance

  → *Challenge: Making sense of large "uncontrolled" datasets, where "near crash" or "actual crash" events are still rare*

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Experimental Crash Scenario Studies

~ CAMP-US DOT Forward Collision Warning Projects ~

Last-Second Braking to a Surrogate Lead Vehicle

When do drivers start braking when they are instructed to wait until the last second to brake? How hard do they brake?

What levels of last-second braking are observed?

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Experimental Crash Scenario Studies

~ CAMP-US DOT Forward Collision Warning Projects ~

Video Still of Surprised Driver

“Distract and Surprise” Method

Passenger-side test driver with access to add-on brakes & steering wheel, and “bail out” alert

How does a driver respond to a lead vehicle braking unexpectedly when the experimenter distracts them, with and without FCA support?

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Experimental Crash Scenario Studies

~ CAMP-US DOT Forward Collision Warning Projects ~

"First Look" Method

How will a driver respond under "extreme distraction" conditions?

Will they brake or steer? How aggressive is their maneuver?

Experimental Crash Scenario Studies

~ CAMP-US DOT Forward Collision Warning Projects ~

"First Look" Method

YOU ARE ABOUT TO CRASH

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Experimental Crash Scenario Studies

~ CAMP-US DOT Forward Collision Warning Projects ~

"First Look" Method

How will a driver respond under "extreme distraction" conditions?

Will they brake or steer? How aggressive is their maneuver

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Experimental Crash Scenario Studies

~ GM–Virginia Tech Transportation Institute ~

Surprise Trial Video Clip

"Distract and Surprise" Method

Would a driver detect or strike an object behind them when backing?

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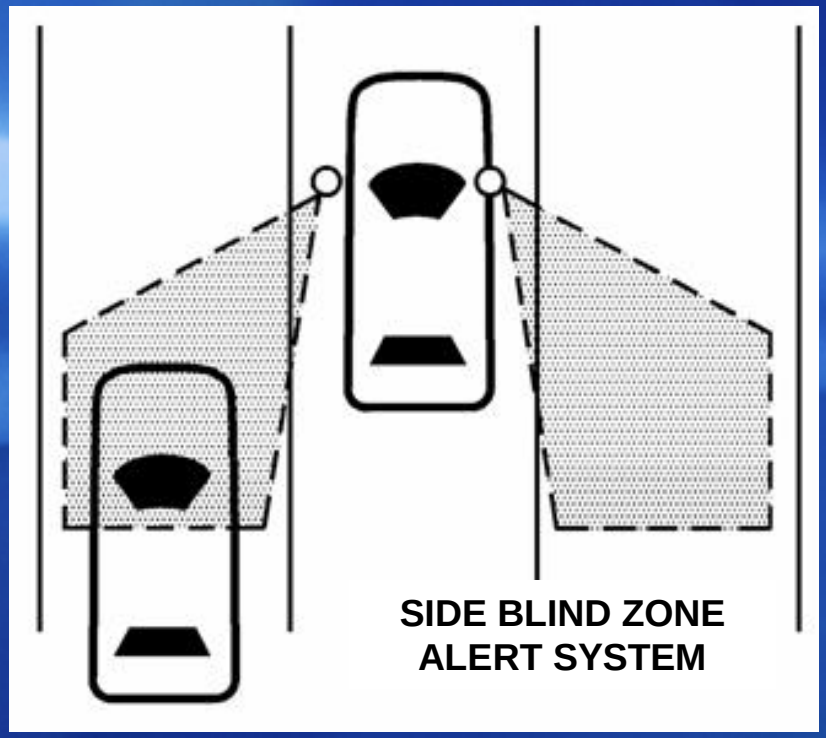
In-Traffic, Real-World Driving Studies

~ GM–Virginia Tech Transportation Institute ~



"In-Traffic" Method
(on-board experimenter)

Will the driver of a Side Blind Zone Alert System check their mirrors more before change lanes? Will turnaround behavior change? How about turn signal usage?

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In-Traffic, Real-World Driving Studies

~ GM-led Automotive Collision Avoidance System (ACAS) Field Operational Test (FOT) ~

"In-Traffic" Method
(ACC-FCA test vehicles used as personal vehicles for 4 weeks)

What were the effects of ACC & FCA on driver behavior and what are the potential safety implications of these effects ?
Were systems well-accepted?

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In-Traffic, Real-World Driving Studies

~ ACAS FOT ~

FCW System Alert Video Clip

An example of a useful FCA alert

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In-Traffic, Real-World Driving Studies

~ ACAS FOT ~

	Safety	Acceptance
Forward Collision Alert	- Some reduction in tailgating behavior - "Valuable" alerts identified - No broad "closing conflict" effect - Imminent alert rates varied widely from 0.08 to 4.34 per 100 miles across drivers - No unintended safety consequences	- Purchase interest lower than desired to due to frequency and nature of false alarms
Adaptive Cruise Control	- Substantial reduction in tailgating behavior - Increased lane dwelling - Perceived by drivers as having more safety value than FCA - No unintended safety consequences	- Purchase interest high

No rear-end crashes were observed in entire FOT; and none were predicted.

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Review of Human Factors Evaluation Considerations for Safety Enhancing Systems

- Establish a safety benefit
  - Direct
  - Indirect
  - Implied
- Evaluate & address potential unintended consequences
- Develop appropriate customer education materials
- Gather data to address the above under:
  - Well-controlled experimental crash threat conditions
  - Less controlled “in traffic” real-world driving conditions

Closing Thoughts

- Research needs in this emerging area should focus on developing common evaluation methodologies and techniques
- It is the OEM's role to integrate safety enhancing systems (including the HMI approach)
- Premature standards for these emerging systems could hinder system deployment
  - Discourages "healthy" OEM competition to develop effective and well-accepted safety enhancing systems
  - Even within an OEM, vehicle models will vary in the number of these systems on a given vehicle, as well as system combinations
  - Driver demographics considerations also play an important role

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