Engineering Safer Cars in a Fast Paced - Technology Rich - Increasingly Automated Environment

Bryan Reimer, Ph.D.
MIT AgeLab & New England University Transportation Center

NEMPA / MIT Technology Conference

May 29, 2014
The Future is Larger Screens
The Future is More Devices
The Future is More Information
The Future has More Older Drivers
and Expanding Automation
Automation Technologies are Going to Alter Driver Experience?

Vehicle Miles Traveled (VMT)
Vehicle Miles Driven (VMD)

Today
VMT = VMD

Tomorrow?
VMT ≠ VMD
The Challenge

For Safety Professionals, Regulators and Manufacturers

How to develop safe vehicles that provide drivers with enjoyable easy to access information while using automation and other safety technologies to help maximize driver focus on the road?

Achieving this goal will require a better understanding of how different forms of task load impact driver focus under different operating contexts.
Workload & Performance

Yerkes-Dodson Law

The relationship between performance and physiological or mental arousal

(Source: Coughlin, Reimer & Mehler, 2011)
Workload & Performance

More Information in the Vehicle Tends to Increase Workload

- Fatigue
- Inattention
- Optimal Range
- Active Distraction
- Overload

Workload / Stress

Performance
Workload & Performance

Automation Tends to Lower Workload

Workload / Stress

Performance

Fatigue

Inattention

Optimal Range

Active Distraction

Overload
The Benefits of ADAS

Autonomous Emergency Braking (AEB) – a key technology for enhancing older adult safety?

Projected benefits

Real-world benefits

IIHS Crash Avoidance Ratings 2014

IIHS, Status Report 2012
Cognitive Oriented Interfaces.....

... using voice and hands-free technology offer the promise of reducing the time a driver’s eyes are drawn away from the roadway and maximizing the time a driver’s hands are on the wheel, however
Developing a Comprehensive View of the “Modern” Driver Vehicle Interface

Limited objective research had been available on drivers’ interactions with production level voice interfaces under actual driving conditions. In 2011, the AgeLab initiated the first in a series of studies considering a range of DVI interactions in a Lincoln 2010 MKS.

- Studies focused on:
  - Assessing the demands associated with a voice interface
  - Considered the impact of structured vs. self-guided training
  - Evaluated an “experienced” user mode vs. the “default” mode
An Unexpected Effect

Total Eyes Off Road Time
“Expected and Unintended” Findings

• Voice recognition was better than expected with only 6 of 193 subjects being “dropped” for issues.

• The voice-command interface showed advantages over visual manual interaction on selected tasks.

• Also on the positive side, cognitive load for the voice-command tasks studied was generally lower than expected (based on self-report, physiology, driving performance).

• However, as shown earlier, visual demand for some voice-command tasks was higher than might be expected.

• Recent data validates the generalizability of findings across multiple vehicles as well as engagements with portable devices.
Google Glass vs. Samsung Galaxy

Brief description of a simulation study

• Compared performance of a full alphanumeric destination entry task using:
  › Google Glass
  › “Driver mode” voice interface of a Samsung Galaxy smartphone
  › Touch interface of a Samsung Galaxy smartphone

• A total of 24 participants were drawn from a college-age sample (mean age 25.0 years)
  › Native English speakers
  › Technologically experienced (considered as best case example of technology early adopters likely to use the Glass system)

The **Google Glass dialog structure** resulted in a **shorter interaction**. Both **voice-interfaces** have **lower workload** ratings than the smartphone touch interface.
Results Related to Distraction
Remote DRT approximates a brake light reaction task

The **DRT** reaction time shows **no statistical discrimination** between the two voice interface modes but the miss percentages are **different**, clear **advantages to voice over touch**.
Some Summary Observations

• The task structure of Google Glass does have selected advantages that should not be overlooked.

• Modern voice command interfaces are not “eyes free hands free ways of communicating with a vehicle”. While there are advantages of this mode of interaction they must be evaluated as multi-modal interfaces that draw upon visual, manual and cognitive resources.

• This argues that a holistic view of the demands placed upon the driver is needed when developing new technologies.

• New methods are needed to evaluate how the “benefits” and “costs” of ADAS and other automated vehicle technologies play together to ultimately impact driver safety.

• Moving forward we shift attention from distraction towards developing technologies that support driver focus in a context relevant way.
Questions