Towards a AVST/Driver Partnership: 
Research and Implementation Implications

“If at first, the idea is not absurd, then there is no hope for it”
Einstein

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National Advanced Driving Simulator
Challenges and Opportunities with AVST

Challenges & Opportunities:

- Driving as Stimulus and Response
- Driving as Control with a Joint Cognitive System
- Driving as Multi-level Control
- Driving as Adaptation of a Diffuse Organism

Research & Implementation Implications

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Capitalizing on the Opportunities

- Holistic rather than piecemeal—theoretically tractable, but practically difficult
- Consider human-technology as unit of analysis
- Augment human rather than automate
- Address underlying crash mechanisms—
  - Speed and following distance
  - Inattention
  - Expectations
  - Culture
Collision Warnings: Directing attention and response

Cross-modal attention cueing—Stimulating one sense can direct attention in another sense
- Implication: Locate source of stimuli in similar spatial location
- Research issue: How does the internal “display” space of the vehicle map to the spatial location of roadway events?

- Multi-sensory integration—Several stimuli can sometimes be perceived as a unit with super-additive effects on speed of processing
  - Implication: Stimuli perceived separately can delay response
  - Research issue: What parameters govern multi-sensory integration with in-vehicle warnings to enhance response speed?
Failure of multi-modal sensory integration
Graded and Ambient Information: Supporting control and situation adaptation

- Graded information provides context for warning
- Ambient information provides preattentive background to guide situation adaptation
  - Implication: Continuous information can guide expectations and reduce reaction time to events
  - Implication: Use urgency mapping and annoyance tradeoff principles to grade alerts
  - Research issue: How to combine multiple auditory and haptic streams to form a coherent whole?
Internal Models: Designing for appropriate reliance

- Trust—part of the driver’s internal model of the AVST that influences reliance
  - Implications: Support appropriate trust by representing AVST Performance, Process, Purpose
  - Research issue: Does the benefit of reducing false alarms with a more complex AVST outweigh the increased difficulty in developing appropriate trust?
Interface design to calibrate trust

- Trustable systems may ease driver adaptation to differences between vehicles
Calibration of trust in technology

**Challenges & Opportunities**

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**Research & Implementation Implications**

**Mistrust:** Trust exceeds system capabilities, leading to misuse

**Calibrated trust:** Trust matches system capabilities, leading to appropriate use

**Distrust:** Trust falls short of system capabilities, leading to disuse

**Good resolution:** A range of system capability maps onto the same range of trust

**Poor resolution:** A large range of system capability maps onto a small range of trust

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**Trust**

**Automation capability**

- Calibrated trust: Trust matches system capabilities, leading to appropriate use
- Distrust: Trust falls short of system capabilities, leading to disuse
- Poor resolution: A large range of system capability maps onto a small range of trust
- Good resolution: A range of system capability maps onto the same range of trust
- Mistrust: Trust exceeds system capabilities, leading to misuse

- Calibration of trust in technology
- Automation capability
- Trust
Similar visual metaphor appears on side mirrors

- **Challenges & Opportunities**
- Driving as Stimulus and Response
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### Research & Implementation Implications

- Safe with Acceleration (use the gas pedal)
- Safe without Acceleration (no gas pedal required)
- Unsafe (No Lane Change)

Your Vehicle

Other Vehicle

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Challenges & Opportunities

Driving as Stimulus and Response

Driving as Control with a Joint Cognitive System

Driving as Multi-level Control

Driving as Adaptation of a Diffuse Organism

Research & Implementation Implications

Close Behind

Far Behind

LED Display

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# Traffic situation display

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<table>
<thead>
<tr>
<th>Challenges &amp; Opportunities</th>
<th>High traffic situation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Driving as Stimulus and Response</td>
<td>![Image of traffic situation display]</td>
</tr>
<tr>
<td>Driving as Control with a Joint Cognitive System</td>
<td></td>
</tr>
<tr>
<td>Driving as Multi-level Control</td>
<td></td>
</tr>
<tr>
<td>Driving as Adaptation of a Diffuse Organism</td>
<td></td>
</tr>
<tr>
<td>Research &amp; Implementation Implications</td>
<td></td>
</tr>
</tbody>
</table>
Driving across Multiple Timescales: Preparing and teaching the driver

- Operational, Tactical and Strategic Levels of Control—milliseconds to months matter
  - Implication: The short time-constant of operational control suggests AVST at this level needs representation at other levels to promote understanding
  - Research issue: To what degree is the influence of AVST confined to one level?
Information before and after an event provides context to collision warnings.

- **Trip demands**
- **Path demands**
- **Delay interaction**
- **Collision warning**
- **Discontinue interaction**
- **Situational feedback**
- **Trip report**
- **Safety review**

**Challenges & Opportunities**

**Driving as Stimulus and Response**

**Driving as Control with a Joint Cognitive System**

**Driving as Multi-level Control**

**Driving as Adaptation of a Diffuse Organism**

**Research & Implementation Implications**

**Proactive Feedforward control**

**Reactive Feedback control**
Traffic and Culture: AVST shapes the behavior of a diffuse organism

- Drivers/AVST are not isolated from others
  - Implication: AVST benefits may be most prominent in as they affect traffic and driving culture
  - Research issue: How does ASVT influence driving culture—perhaps the most powerful influence on traffic safety
Breakdowns in multi-driver compensatory processes

Challenges & Opportunities

Driving as Stimulus and Response
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Research & Implementation Implications

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You IDIOT! You were shaving and using your palm pilot instead of driving!

If you hadn't been sending a fax while playing with your GPS system, you MORON!
Towards a AVST/Driver Cyborg
Research and Implementation Implications

Conception of the driver AVST relationship drives:

- Interface design
- System architecture
- Standardization
- Benefits analysis

What would a collision avoidance system be like without a warning?

More information: http://www.engineering.uiowa.edu/~csl/

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Select references

- Moeckli, J., & Lee, J. D. (In press). The making of driving cultures. In *AAA Compendium on Driving Culture*.