Do we still need to consider Human Factors? - The challenges regarding human-vehicle interactions for automated vehicles
Overview

• How automation will change the human-vehicle interaction

• Do we still need to consider Human Factors?

• Challenges regarding the design of human-vehicle interaction for automated vehicles
  – Examples from EU projects AdaptIVe, HOLIDES, Citymobil2 and national projects

• Conclusions
Automated and connected driving - Changes in the role of the driver
Automated and connected driving - Changes in the interaction with other traffic participants
Do we still need to consider Human Factors?

YES - but why?

• Automated vehicles are to be implemented in mixed traffic environments where humans play a central role:
  – as drivers or passengers
  – as other road users (vehicle drivers or VRUs)
  – as operators
→ Automation does not remove the human - it changes the way humans interact with vehicles

• “[...] the irony that one is not by automating necessarily removing the difficulties, and also the possibility that resolving them will require even greater technological ingenuity than does classic automation.” (Bainbridge, 1983)
Do we still need to consider Human Factors?

Human Factors can help:
- to detect major effects of automated vehicles on human performance:
  - (short- & longterm) automation effects and implications for drivers
    - Driver workload, distraction, situation awareness
    - Trust, acceptance, fears, disuse and misuse
    - Performance and loss of skills
    - Differences in driver populations (e.g. age, intercultural aspects, experts - beginners - professional drivers)
  - (short- & longterm) automation effects and implications for other traffic participants
    - Trust, acceptance, fears
    - Information needs for safe interaction
Do we still need to consider Human Factors?

- Human Factors can help:
  - to improve the interaction design for human - vehicle interaction e.g.
    - Design of HMI and selection appropriate information and communication channels
    - Design of transitions of control
    - Selection of appropriate non-related driving tasks & definition of misuse
    - Design of automation behaviour
  - to design instruction strategies and trainings procedures
  - to define guidelines, rules and standards for HMI design
# Definition of the automation levels

<table>
<thead>
<tr>
<th>SAE level</th>
<th>Name</th>
<th>Narrative Definition</th>
<th>Execution of Steering and Acceleration/Deceleration</th>
<th>Monitoring of Driving Environment</th>
<th>Fallback Performance of Dynamic Driving Task</th>
<th>System Capability (Driving Modes)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>0</strong></td>
<td>No Automation</td>
<td>the full-time performance by the human driver of all aspects of the dynamic driving task, even when enhanced by warning or intervention systems</td>
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<td>r/a</td>
</tr>
<tr>
<td><strong>1</strong></td>
<td>Driver Assistance</td>
<td>the driving mode-specific execution by a driver assistance system of either steering or acceleration/deceleration using information about the driving environment and with the expectation that the human driver perform all remaining aspects of the dynamic driving task</td>
<td>Human driver and system</td>
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<td><strong>2</strong></td>
<td>Partial Automation</td>
<td>the driving mode-specific execution by one or more driver assistance systems of both steering and acceleration/deceleration using information about the driving environment and with the expectation that the human driver perform all remaining aspects of the dynamic driving task</td>
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<td><strong>3</strong></td>
<td>Conditional Automation</td>
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<td>System</td>
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<td>All driving modes</td>
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Driver - vehicle interaction
Driver - vehicle interaction

- Examples for relevant interaction design issues:
  - Transitions of control between different levels of automation
  - Design for reasonable usage and avoidance of misuse
  - Adaptation of automation behaviour on driver state and driving style/driver preference
Driver - vehicle interaction: Transitions of control

SAE level 0  SAE level 1  SAE level 3

SAE level 0  SAE level 1  SAE level 3

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Driver - vehicle interaction: Transition of control

- Risk of „control vacuum“ or „control surplus“

- Challenges for the interaction design:
  - Transitions need to be safe
  - Operation faults need to be avoided
  - Mode confusion should be avoided by presentation explicit information about available and activated automation level
Driver - vehicle interaction: Transition of control

- Experimental evaluation of HMI design variants for the instrument cluster at VTEC
Driver - vehicle interaction: Transition of control

- Concept for integrating information of diverse driver assistance systems and automation levels in a holistic concept at DLR
Design of reasonable usage/avoidance of misuse

- Challenges for the interaction design:
  - Take-over capability of the driver needs to be ensured, while allowing the driver to engage in non-driving related tasks
  - Misuse needs to be avoided
- Concept for integrating personal mobile devices in the overall vehicle system -> DLR project MOBIFAS

https://www.youtube.com/watch?v=f53zJV1Zh0Q
Design of reasonable usage/avoidance of misuse

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Adaptation of automation behaviour

- Challenges for the interaction design:
  - Ensure comfortable driving
  - Support the driver in an optimal way

- Concept for adapting the automation behaviour with respect to driver preference/driving style and driver status

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<th>Driver A: defensive</th>
<th>Driver B: offensive</th>
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<tr>
<td></td>
<td><img src="image1" alt="Diagram" /></td>
<td><img src="image2" alt="Diagram" /></td>
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<tr>
<th>Driver state</th>
<th>Driver C: attentive</th>
<th>Driver D: distracted</th>
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<td>the full-time performance by an automated driving system of all aspects of the dynamic driving task under all roadway and environmental conditions that can be managed by a human driver</td>
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Interaction with other traffic participants

- Automated vehicles are to be implemented in mixed traffic environments where humans play a central role as other road users
  - Drivers of other vehicles
  - Vulnerable Road Users (VRUs)
- Various forms of interaction between drivers of conventional vehicles and other traffic participants
  - Eye contact, hand signals, gestures
- Challenges for the interaction design:
  - Safe and intuitive interaction with other traffic participants
  - Implicit and explicit communication
  - Human-like behaviour?
Interaction with other traffic participants

- Focus groups, interviews, online survey by IST Leeds and DLR:
  - Which kind of behaviour and interaction do people expect from driverless vehicles in shared environments?

- 99% of the participants expect that vehicles behave according to traffic rules

- About 50% would like to have additional visual and acoustic information about
  - Direction of movement
  - Detection of objects in the near field
  - Planned/next actions of the vehicle
**Conclusions**

- Automation per se does not decrease Human Factors research needs
- The human stays a crucial part in the overall human - vehicle system
- Several Human Factors effects of automated vehicles have not been (fully) explored yet
- Vehicle automation will technically further develop - interaction design needs to keep pace
- Standardization of generic interaction concepts (not OEM specific HMI solutions) would help to significantly reduce critical interaction
Interested in further information? - References

**VRA project:** [http://vra-net.eu/](http://vra-net.eu/)

**AdaptIVE:** [https://www.adaptive-ip.eu/](https://www.adaptive-ip.eu/)


**MobiFAS:** [http://www.dlr.de/dlr/desktopdefault.aspx/tabid-10081/151_read-14305/#/gallery/20054](http://www.dlr.de/dlr-desktopdefault.aspx/tabid-10081/151_read-14305/#/gallery/20054) & [https://www.youtube.com/watch?v=f53zJV1Zh0Q](https://www.youtube.com/watch?v=f53zJV1Zh0Q)


**HOLIDES:** [http://www.holides.eu/](http://www.holides.eu/)


**CityMobil2:** [http://www.citymobil2.eu/en/](http://www.citymobil2.eu/en/)


- Merat, N. & Louw, T. (2015). Pedestrian and cyclists’ interactions with automated road transport systems in La Rochelle, France: Results from the CityMobil2 Project. *Proceedings of the Transportation Research Board Workshop,* Anna Arbor, USA.
Thank you.

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