DLR

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Automated Driving Applications and Technologies for Intelligent Vehicles

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

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Technical Workshop

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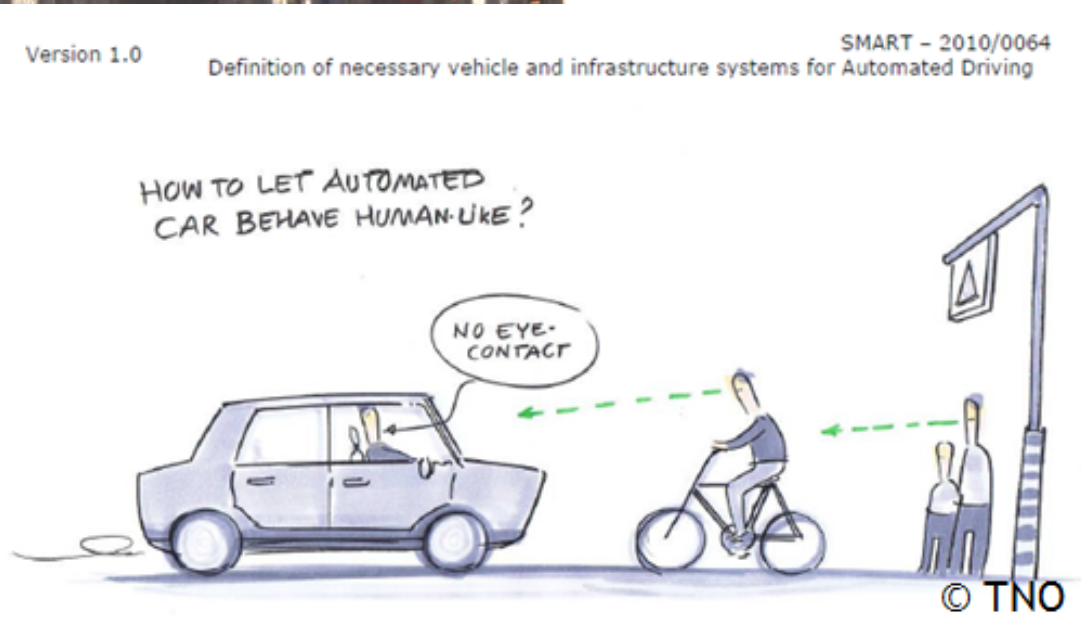
// Overview

- 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 enviroments 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

SAE level	Name	Narrative Definition	Execution of Steering and Acceleration/ Deceleration	*Monitoring* of Driving Environment	Fallback Performance of *Dynamic Driving Task*	System Capability *(Driving Modes)*
***Human driver* monitors the driving environment**						
0	**No Automation**	the full-time performance by the *human driver* of all aspects of the *dynamic driving task*, even when enhanced by warning or intervention systems	Human driver	Human driver	Human driver	n/a
1	**Driver Assistance**	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*	Human driver and system	Human driver	Human driver	Some driving modes
2	**Partial Automation**	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*	**System**	Human driver	Human driver	Some driving modes
***Automated driving system* ("system") monitors the driving environment**						
3	**Conditional Automation**	the *driving mode*-specific performance by an *automated driving system* of all aspects of the dynamic driving task with the expectation that the *human driver* will respond appropriately to a *request to intervene*	System	**System**	Human driver	Some driving modes
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5	**Full Automation**	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*	System	System	System	**All driving modes**

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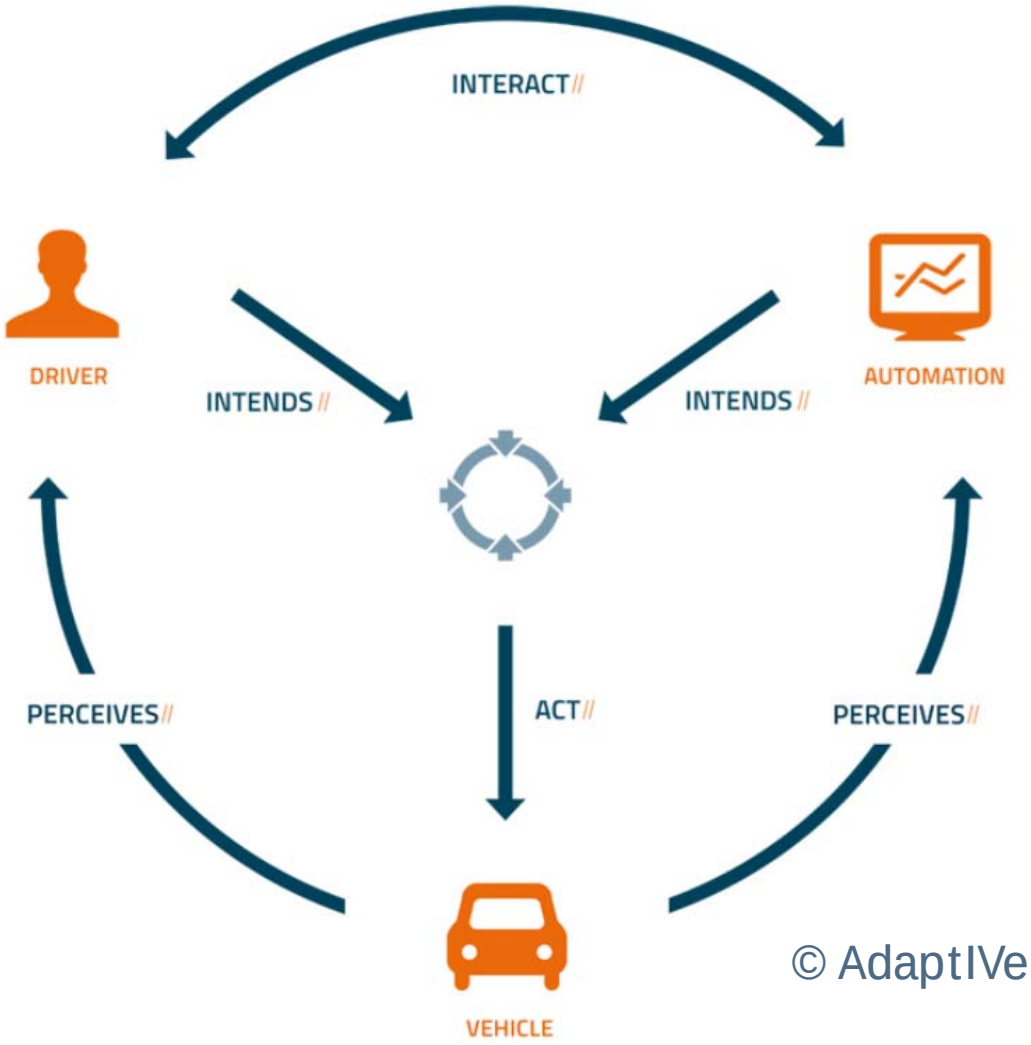
// Driver – vehicle interaction



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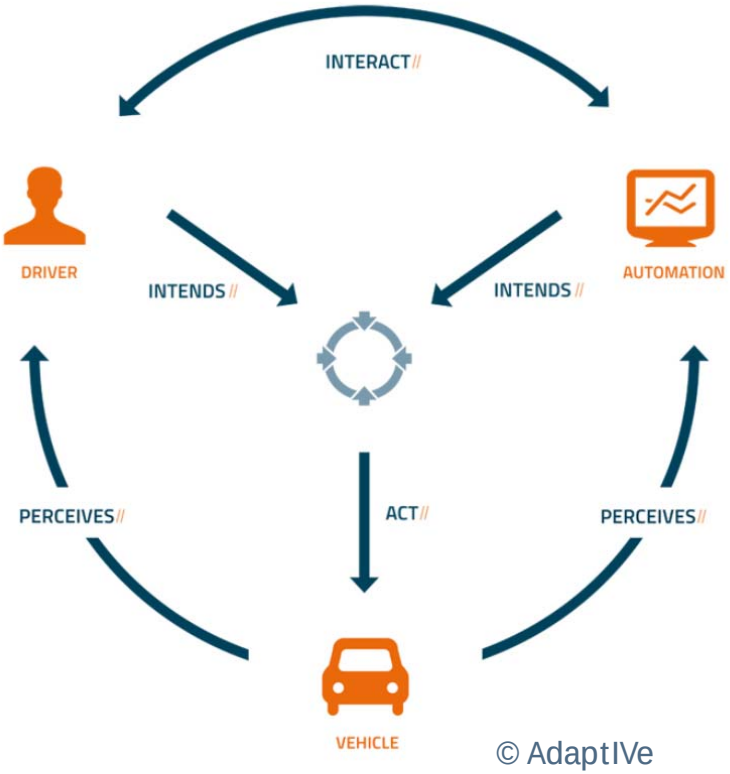
// Driver – vehicle interaction

- 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



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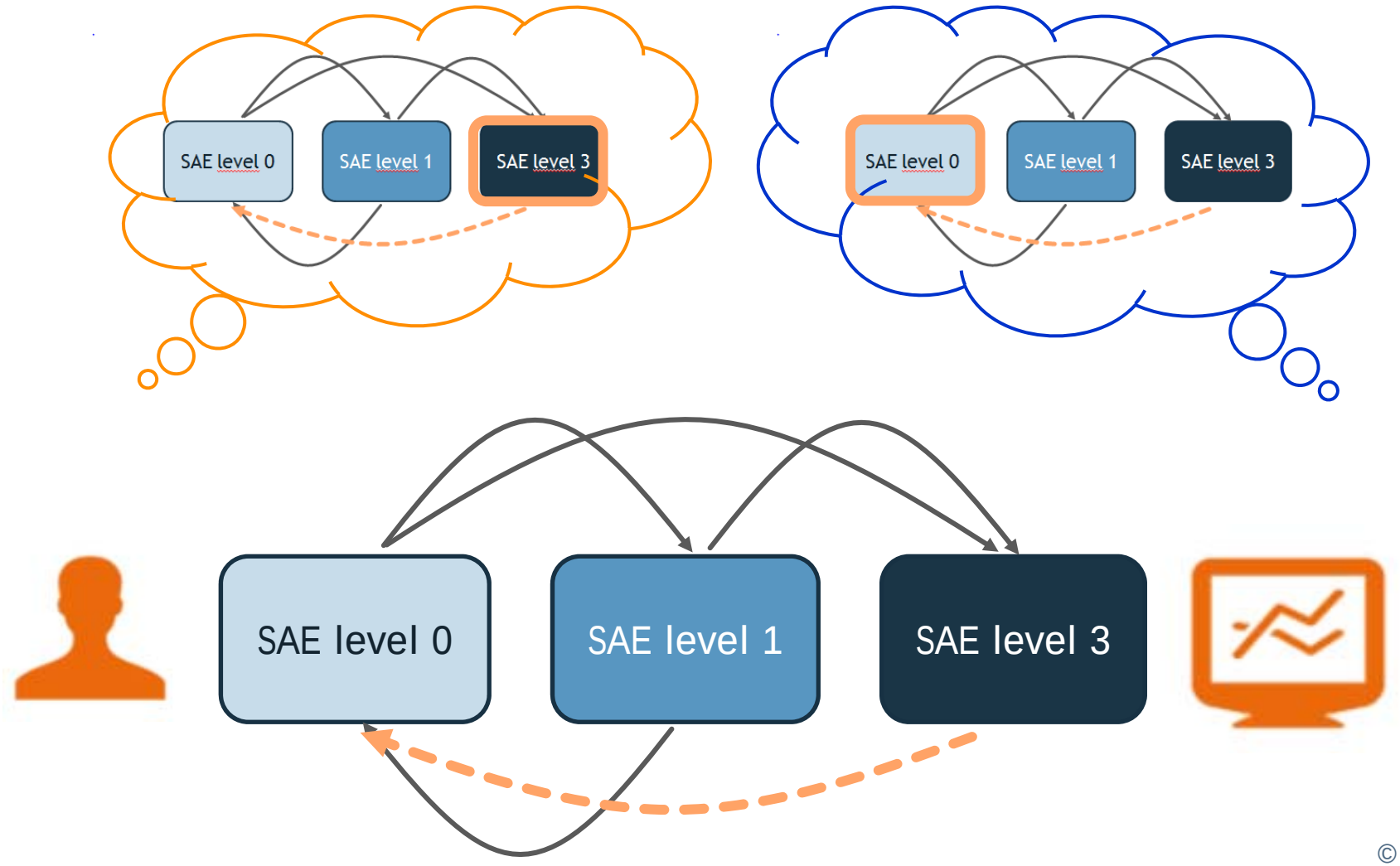
// Driver – vehicle interaction: Transitions of control



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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 presention 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

Manual

ACC

(Auto available)

Auto mode

Manual

(Auto available)

Auto mode

// Driver – vehicle interaction: Transition of control

- Concept for integrating information of divers 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

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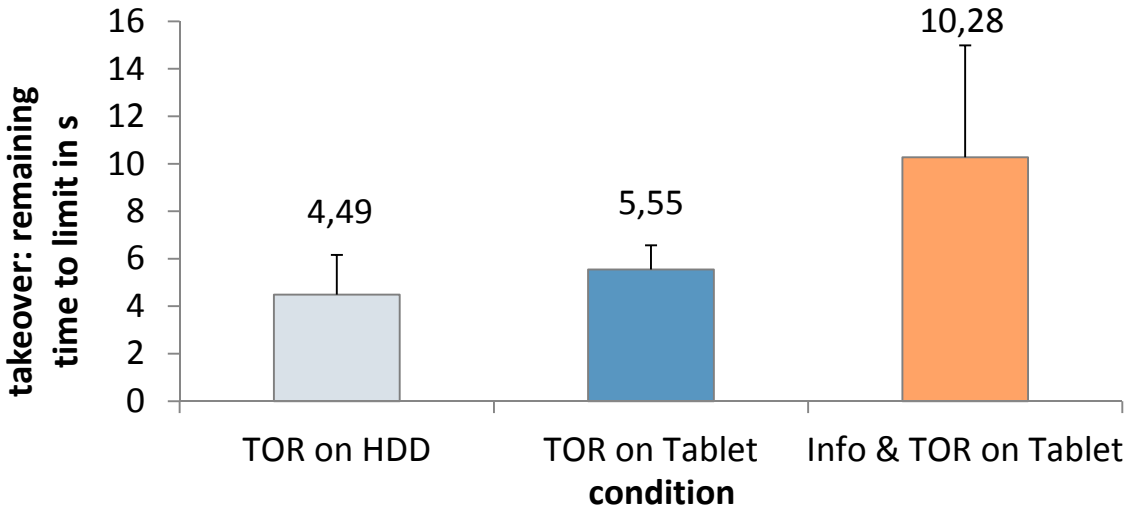
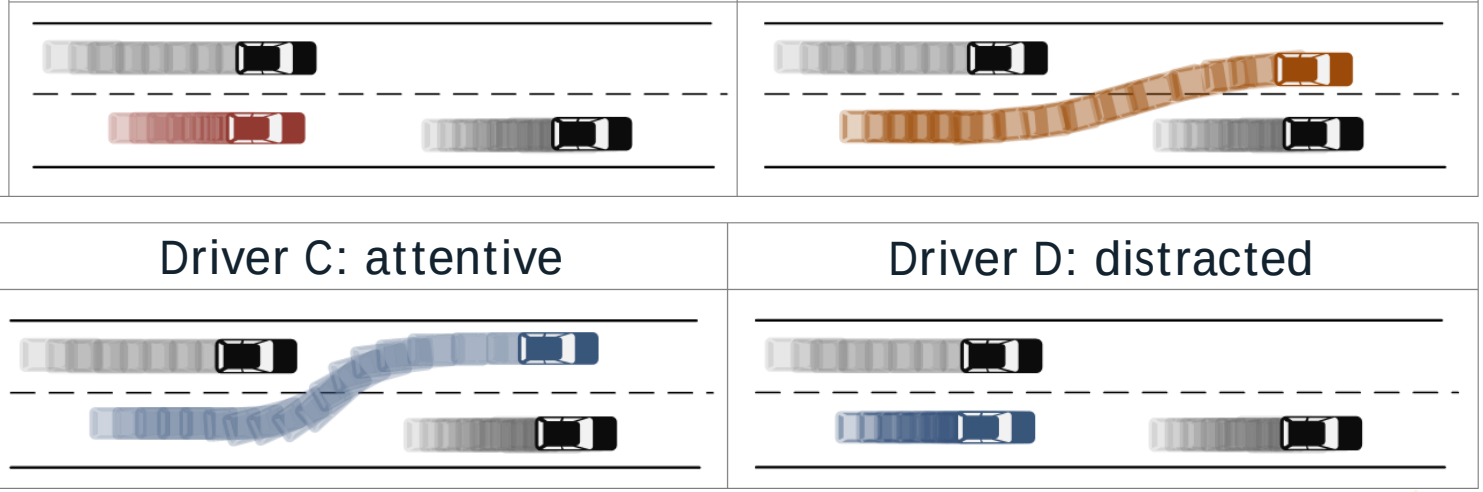


// Adaptation of automation behaviour

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

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

Driving style	Driver A: defensive	Driver B: offensive
Driver state	Driver C: attentive	Driver D: distracted



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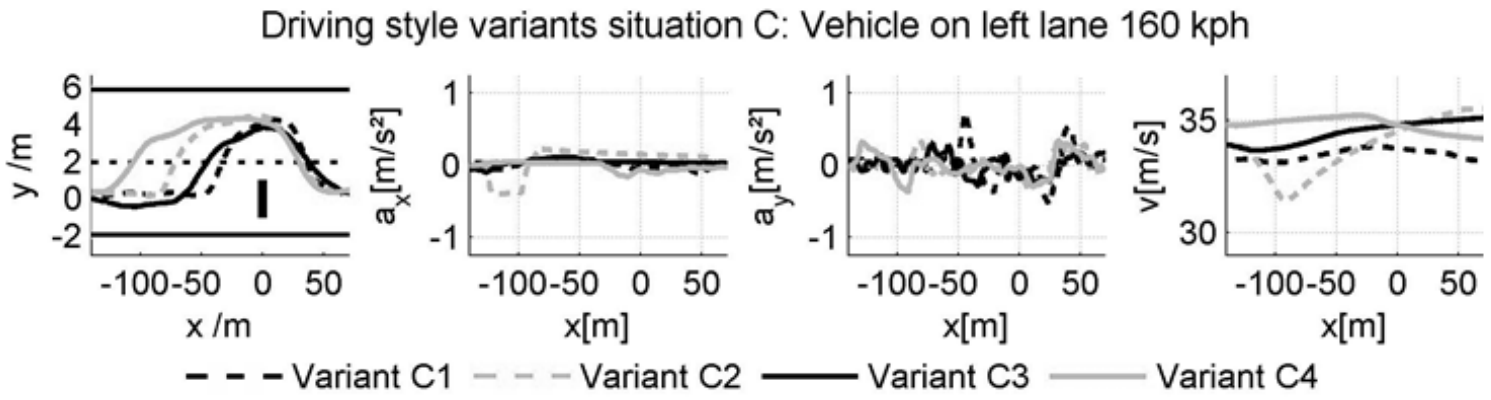

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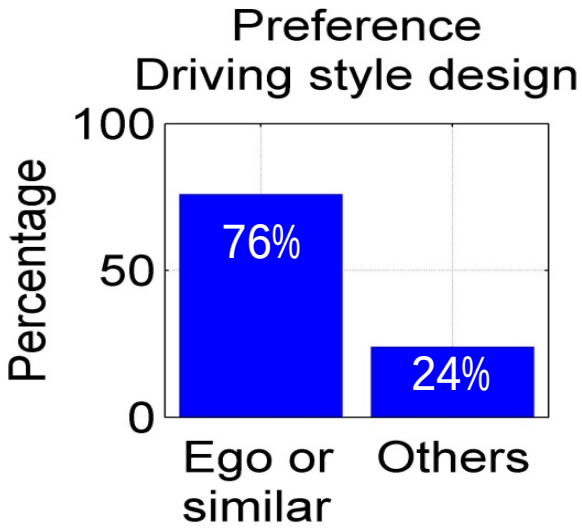

// Interaction with other traffic participants

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// Interaction with other traffic participants

- Automated vehicles are to be implemented in mixed traffic enviroments where humans plays a central rule 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?

Source: IDS concept car - Nissan

// 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

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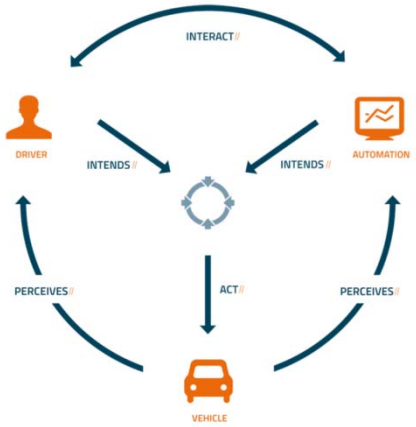
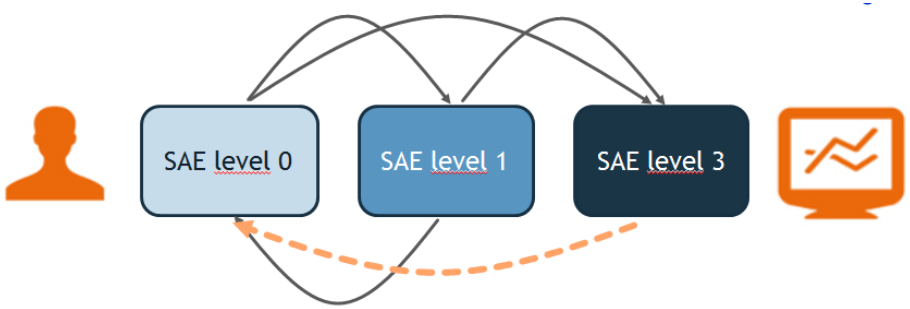
// Conclusions

- 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

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Thank you.

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Technical Workshop

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