UNIVERSITY OF TWENTE.

AIDA Centre for Applications of Integrated Driver Assistance

Human-centered challenges and contributions for the implementation of automated driving

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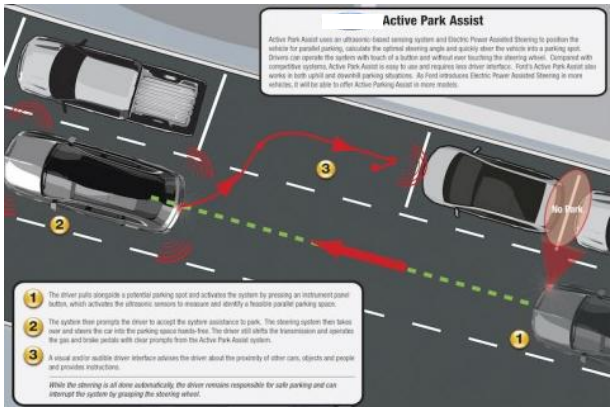
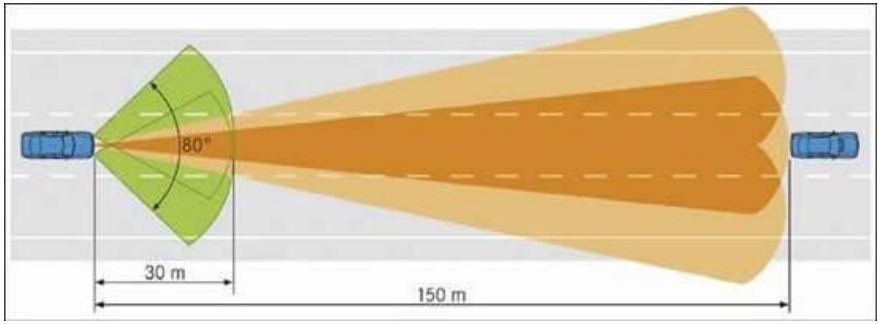
Background of research

Driver assistance (DA) today;

- focuses on **comfort** and **safety**;
- for **individual drivers**;
- is developed from a **technological** point of view [1].





Background of research

Other (potential) benefits [2],[3]:

- Active **safety**
- Reducing **mobility problems**

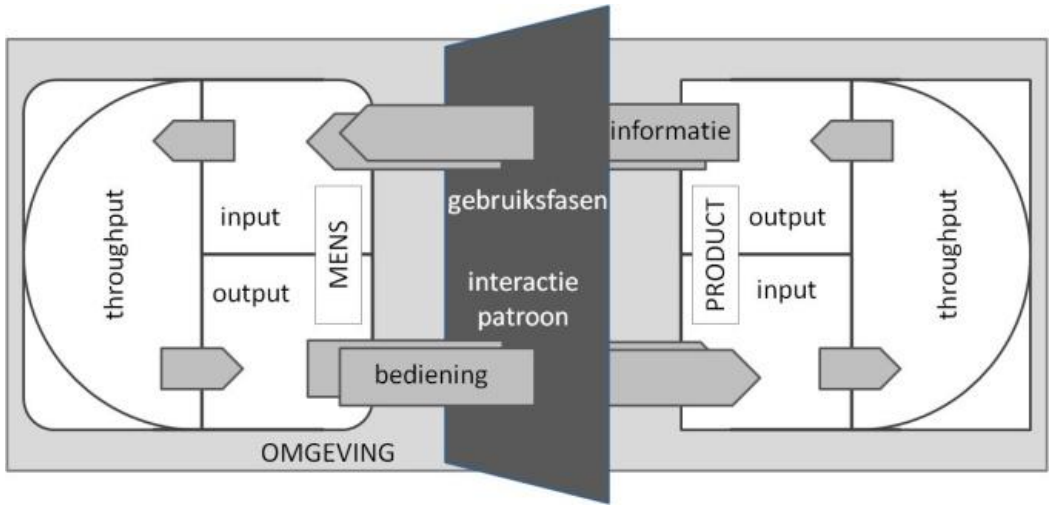
Advantages of automated driving:

- Faster reaction times
- Shorter following distances
- Increased performance (safety)

Background of research

State of Art for autonomous driving:

- Navigation
- Sensor technology (input)
- Decision making (throughput)
- Actuation (output)



Background of research

Q: Automation of *specific tasks* or *complete automation*?

► Focus on **partially automated driving**, because:

- accounts for system boundaries;
- personal liability of individual drivers;
- respects fun of driving and mastering a vehicle.

Background of research

- Existing research
  - EU SARTRE project
    Predefined “road trains”
  - Grand Cooperative Driving Challenge
    Data communication between arbitrary & different vehicles
  - Connected Cruise Control
    V2V + I2V data communication
  - interactIVe IP
    active intervention
- Increasing focus on human factors

Human Factors related problems for partially automation

Out-of-the-loop problems [4]

- Vigilance decrements (reduced alertness)
- Reduced awareness and anticipation of traffic situations
- Reduced manual and operational skills

Transition problems

- Unexpected transitions, due to diversity in traffic circumstances
- Mandatory to be able to take over full control at any moment

Specific solutions how to implement automation and how to overcome unwanted implications, **are not readily available**.

Challenges

(1) **Defining the appropriate levels** of automation;

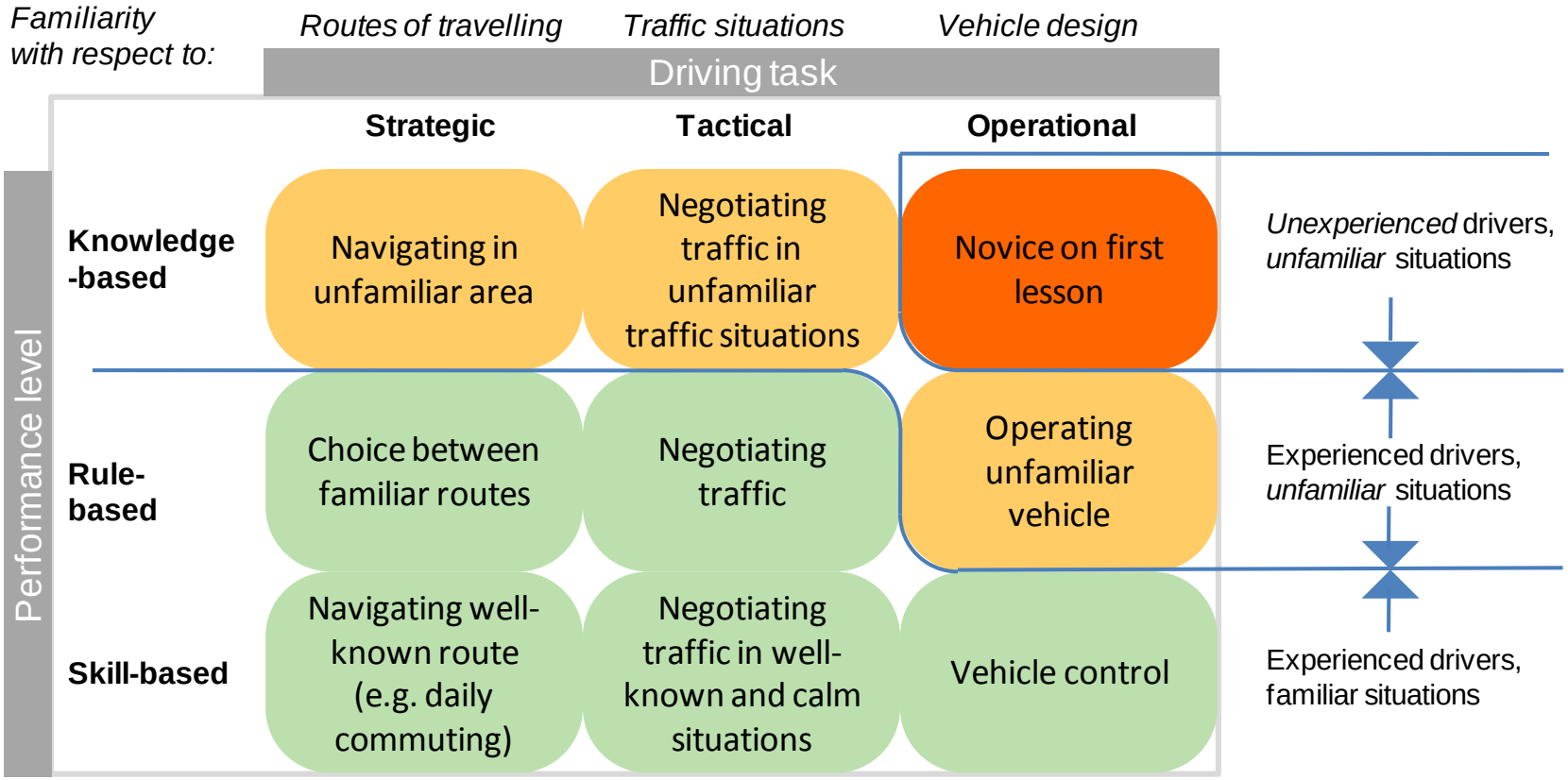
(2) **Developing appropriate transitions** between automated and manually driving (vice versa)

Challenges

(1) Defining the appropriate levels of automation;

- What driving situations can be distinguished?
- What support types should be distinguished?
- How can the support types be allocated to driving situations?

What driving situations can be distinguished?



- combining hierarchical levels of the driving task (Michon) with performance levels (Rasmussen) [5],[6]

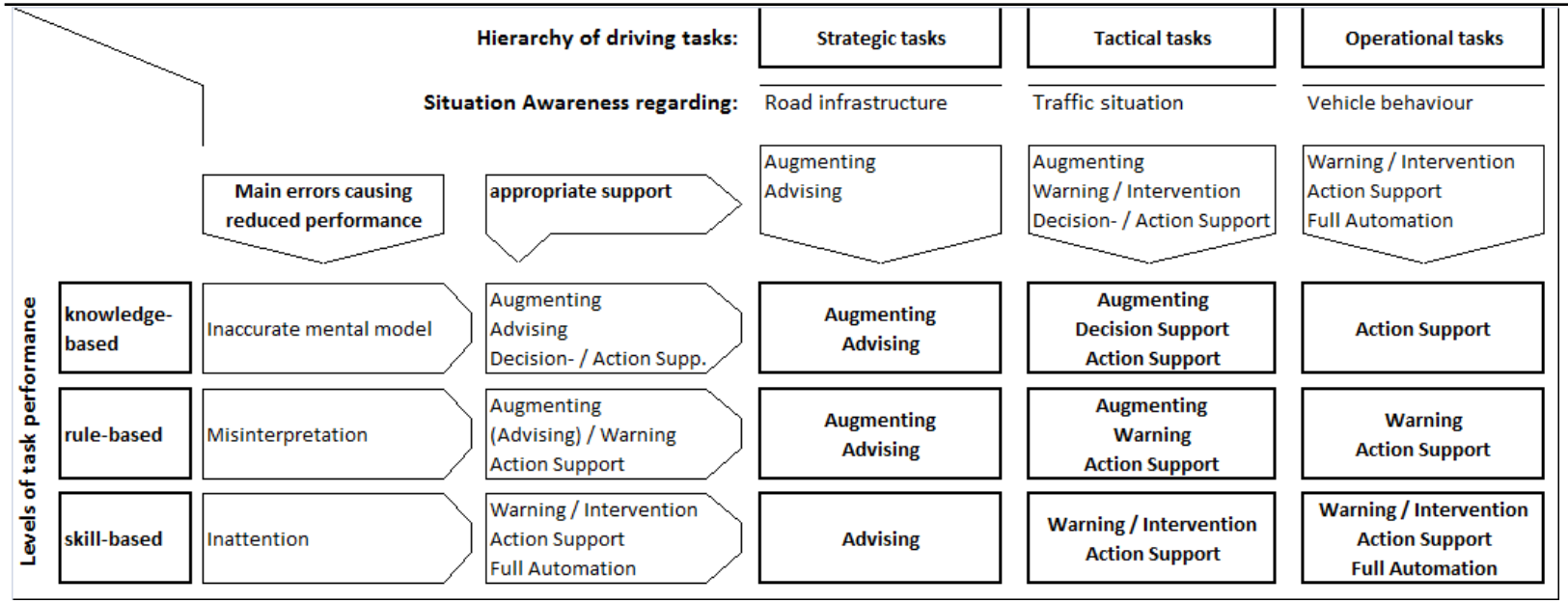
What support types should be distinguished?

	SUPPORT TYPES	FUNCTIONS				DESCRIPTION	EXAMPLES
		MON.	GEN.	SEL.	IMPL.		
1.	**Augmenting**	H/C	H	H	H	• Both human and machine monitor the present situation. The machine especially supports acquiring sensory information.	Night Vision
2.	**Advising**	H/C	H/C	H	H	• The machine supports by generating options, the human selects. The selected option might be another option than generated by the machine.	Attention Assist, Lane Change Assist
3.	**Warning**	H/C	C	C	H	• The machine temporarily generates *and* selects an option which, according to the machine, is mandatory to perform.	Lane Departure Warning, Frontal Collision Warning
4.	**Intervention**	H/C	C	C	C	• The machine temporarily generates, selects *and* executes an option which, according to the machine, is mandatory to perform.	
5.	**Action Support**	H	H	H	H/C	• The implementation part is being supported.	Powered Steering, Automated Gear Box
6.	**Decision Support**	H/C	H/C	H	H/C	• By combining Advising and Action Support, the human is being supported in terms of allowing full dedication to the selection-role.	

MON.= Monitoring task, GEN.= Generating options, SEL.= Selecting options, IMPL.= Implementation task
H=Human task performance, C=Computer task performance, H/C= combined Human - Computer task performance

- Support types derived from generic "Levels of Automation" [7]

Proposed *Assisted driver model* [8]



- 'Assisted driver model' recommends degrees of driving support depending on driving situation and experience.
- With regard to operation after failure, support in terms of partially automation of the implementation task is most recommendable.

Challenges

(1) Defining the appropriate levels of automation;

Conclusions on recommended levels of automation in relation to different driving situations:

- Operational tasks benefit most from physical implementation assistance, requiring some human involvement.
- Combinations of tactical and operational tasks performed at rule- or skill-based level benefit most from Action Support.
- Driving situations which are characterized by strategic tasks and/or dominated by option-generating are least appropriate for applying partially automation.

Challenges

(1) **Defining the appropriate levels** of automation;

(2) **Developing appropriate transitions** between automated and manually driving (vice versa)

Challenges

(2) Developing appropriate transitions between automated and manually driving (vice versa)

Based upon “Levels of Automation” [7]:

- Implementation support is likely to provide good operability for transition from higher to intermediate levels of automation.

➢ Remaining involved in the control-loop, preserving situational awareness

Based upon “Assisted Driver Model” [8]:

- Gain consistency in support types from one driving situation to another

Possible solutions …

- Force feedback in the pedals:
  - Continuous feedback in the brake and acceleration pedal to indicate system's adaptation in speed and distance
  - ➢ More active involvement in driving task and preservation of situational awareness
- Considering performance levels for secondary tasks
  - ➢ Deliberately direct driver's attention from secondary tasks towards the driving task
- Distributed responsibility, optimized for system and human performance
  - Example: automated parallel parking

Conclusions

- Human-centred challenges to define *when* and *how* to apply AD;
  - ➢ The Assisted Driver Model helps to answer in what circumstances and in which form automation is beneficial.
- Support in terms of joint human-computer interaction during the implementation is generally most recommendable;
  - ➢ Allowing better recovery.
- However, driver assistance will not necessarily make the driving task more comfortable;
  - Focus on driver acceptance;
  - Considering performance levels for secondary tasks
- Further research on appropriate interfaces for transitions necessary

Thank you

Further information:

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