



Human, what human?

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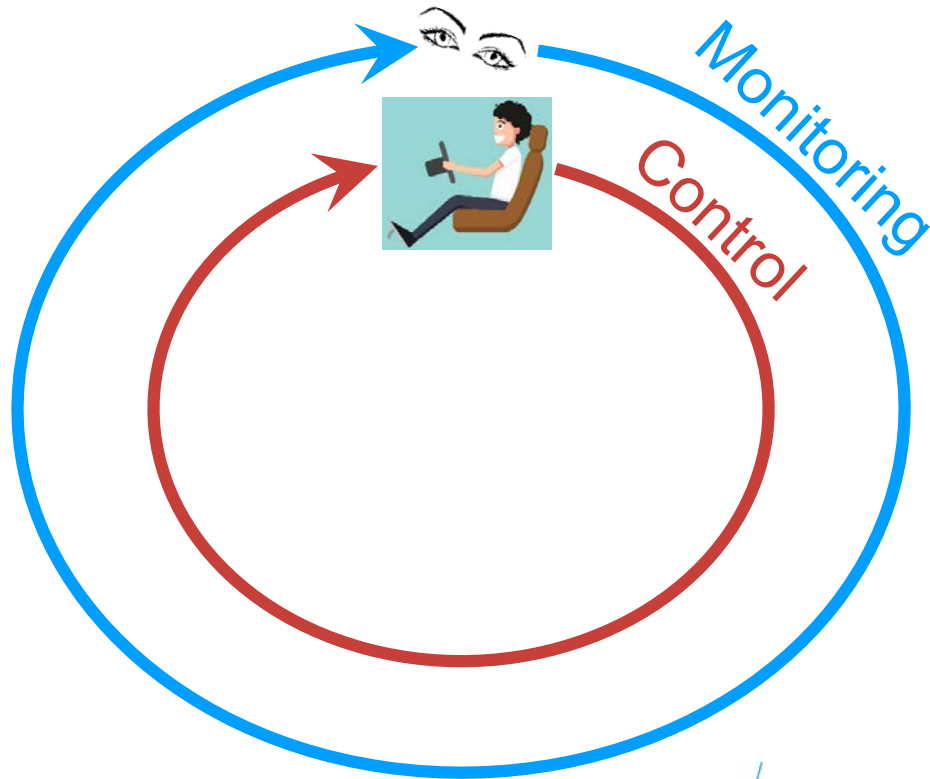


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The two loops



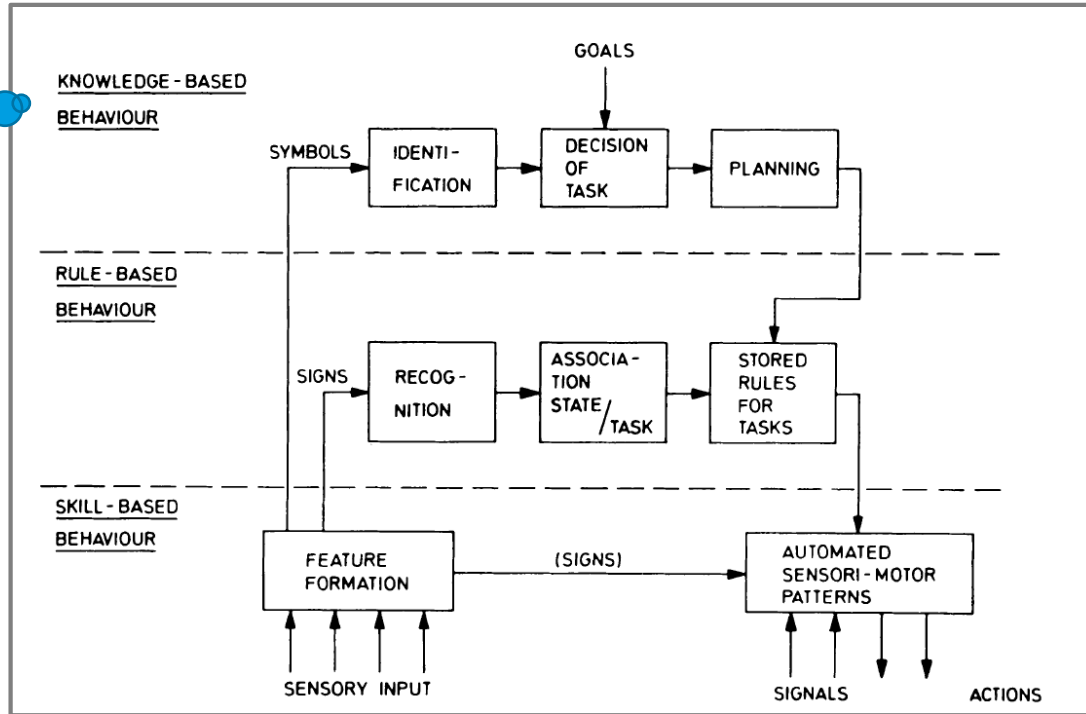
Automation of the dynamic driving task removes the inner loop

Which makes the Human Machine Interface (HMI) mission-critical



Skills, Rules, Knowledge in manual operation of a vehicle

Mental Models

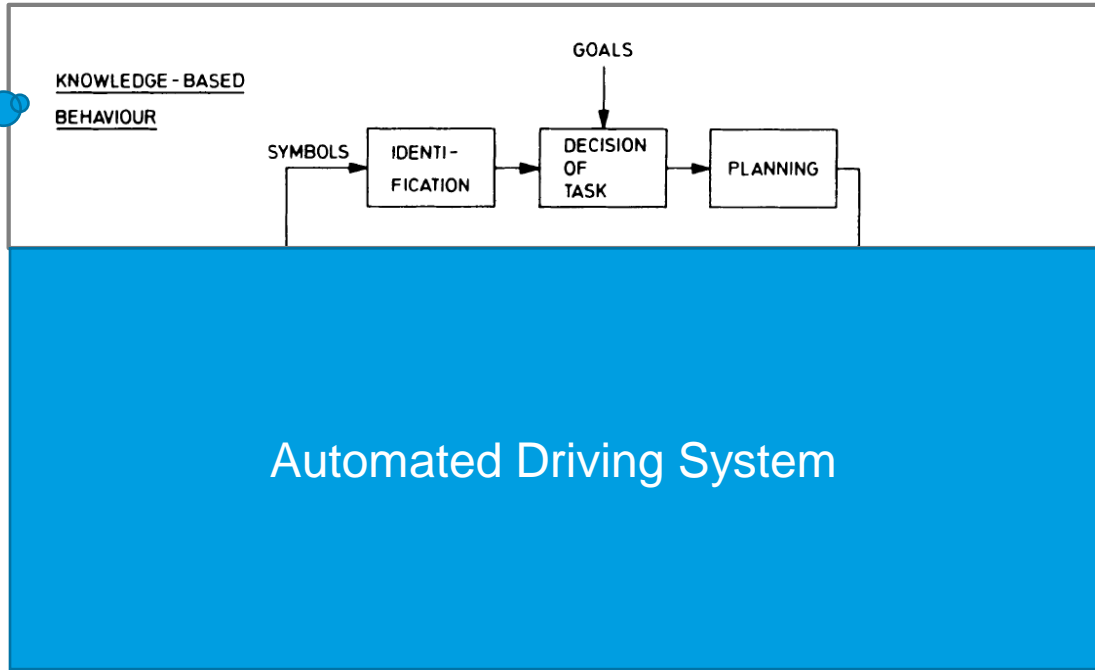


Workload ↓
Probability of error ↑

Source: Rasmussen (1983)

Skills, Rules, Knowledge with automation of the driving task

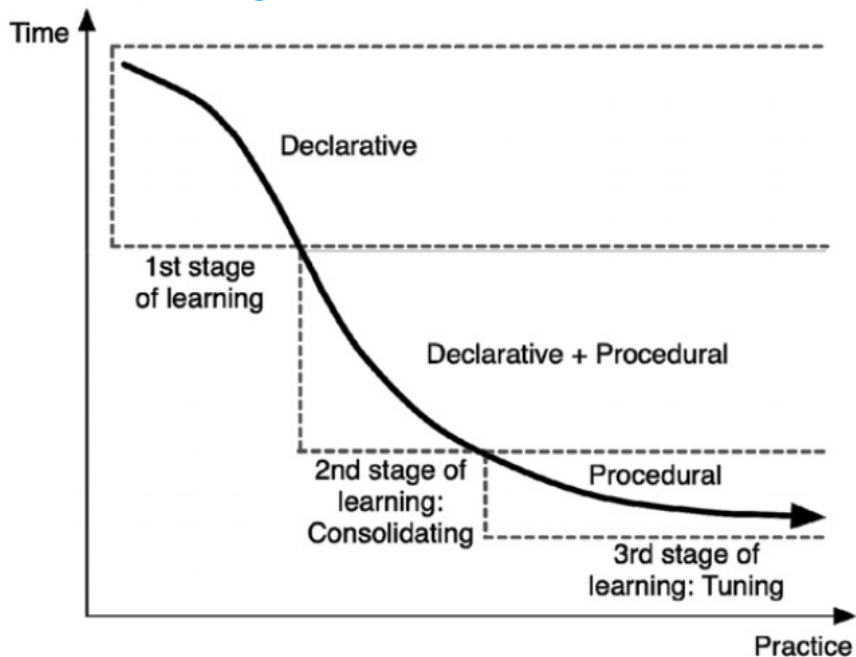
Mental Models



High workload

High probability of error

How can we improve performance at the Knowledge level: acquiring correct mental models



- We acquire procedural knowledge by practice
- But, of course, the functioning of the system(s) must be comprehensible by the user

Source: Kim et al. (2013)

Thus...

- Automation makes vehicle operation (the so-called Dynamic Driving Task) easier
- But makes higher-level understanding of the vehicle systems and the dynamic role of the human driver far more challenging
- So:
 - We need to reduce the variety of automated systems on a vehicle
 - We need to ensure that the human is able to understand the behaviour of the ADS
 - We need to assist the acquisition of correct mental models by means of **Commonality**

Information needs of the human

- What is the current level of automation of my vehicle?
- What is the capability (ODD) of the automated driving system (ADS) that I am enabling?
- What are my responsibilities?
- What else can I do?

“Commonality”



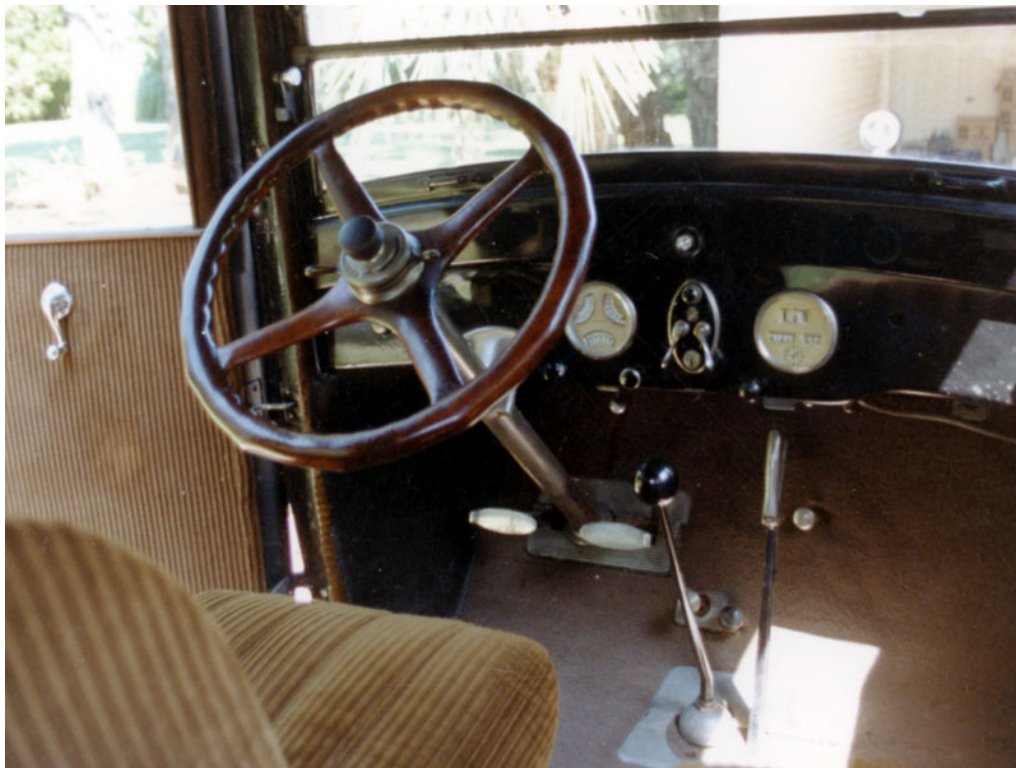
Annex on HMI states:

*For automated vehicles with a driver (levels 2, 3 and 4) there is the risk of human operator confusion if the designs of HMIs are substantially different across vehicle makes and models. Therefore the major information and interaction features of the HMI should be designed in a way that allows intuitive and easy accessible control of the vehicle functions and must have **a high level of commonality**...*

What is “commonality”?

- From a human factors perspective, it could perhaps be defined in terms of its opposite: we don't have commonality when we need to form a new mental model of a system
- So commonality supports the user in his/her existing mental model of a system, when transferring to a new product
- At a more specific level, it means that the **high-level** features of the design are the same
- This still allows for distinctiveness (brand identity) in lower-level features

The Cadillac Type 53, 1916



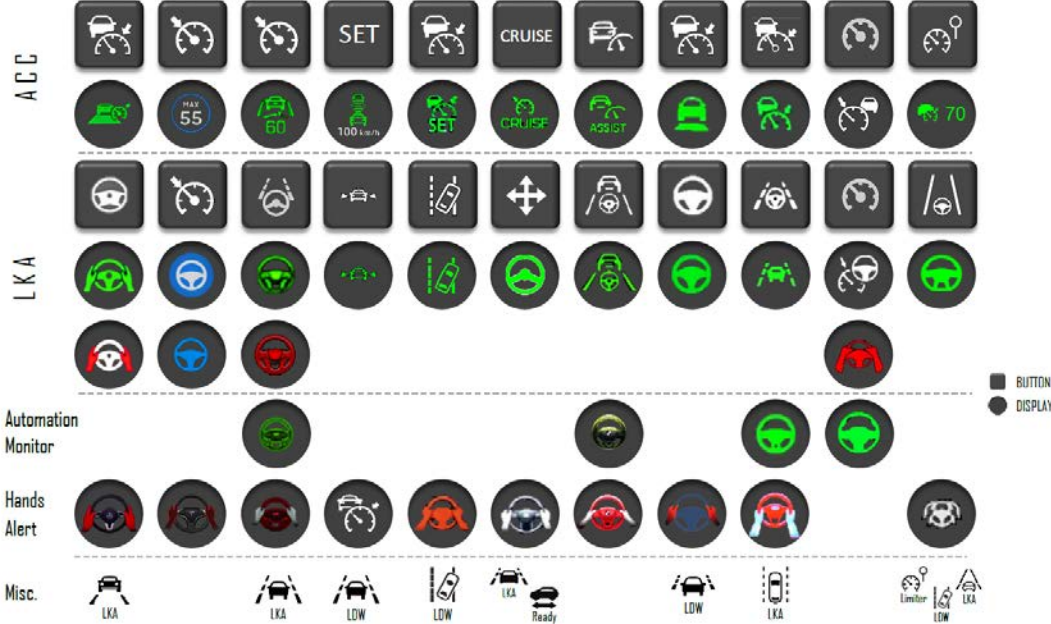
The vehicle that set the template for control layout and dashboard

1929 Skoda 422



- Brake pedal on the right
- Accelerator pedal in the middle
- Clutch pedal on the left

Symbols currently in use for systems providing Level 1 and Level 2 assistance



Each column represents a different manufacturer

Further requirements of HMI in automation (Carsten and Martens, 2019)

1. Provide required understanding of the AV capabilities and status (minimise mode errors)
2. Engender correct calibration of trust
3. Stimulate appropriate level of attention and intervention
4. Minimise automation surprises
5. Provide comfort to the human user, i.e. reduce uncertainty and stress
6. Be usable

What is the evidence from research studies on these issues?

- Not all that much — not many studies on ADS focus on higher-level HMI design
- Rather they are interested in a very specific aspect of the HMI, e.g. how many seconds before an upcoming transition-to-manual should drivers be warned
- Thus Blanco et al. (2015) in their report to NHTSA, *Human Factors Evaluation of Level 2 and Level 3 Automated Driving Concepts*, looked at:
 1. HMI for takeover request from L2 (i.e. assisted) driving
 2. HMI for takeover request from L3 driving
 3. How to prompt drivers to attend to the road when they are distracted
- All valuable, but should we not have a global concept first?

Conclusions

- Automation has the propensity to increase the demands on the comprehension of the human user
- The HMI plays the crucial role on communication between vehicle and human
- Commonality of HMI is essential



Thank you for your kind attention.

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