Increasing the LOA does not Decrease the HMI Challenge

SIP ADUS 2021

HF Breakout Workshop

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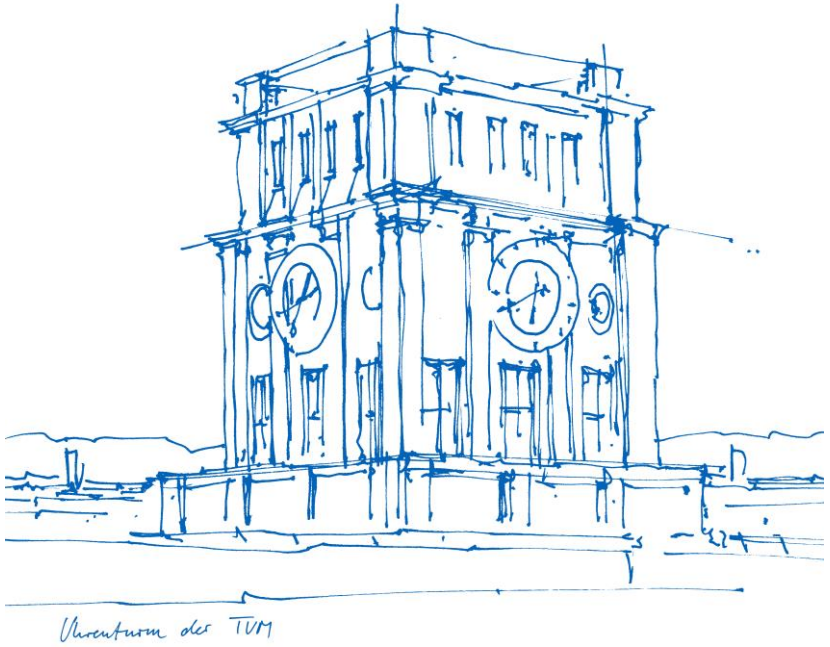
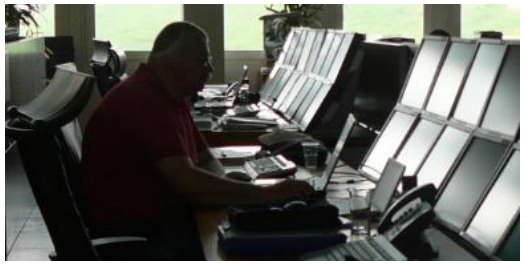
Chair of Ergonomics



Looking Back – Roadmaps und Levels

- With increasing LoA the human role is changing
- The promises on technical reliability are increasing
- In principle active guidance is replaced by monitoring and troubleshooting



Level 3 Research Questions

Simulation enabled

- Decision making in parallel
- Formulation of requirements
- Extrapolation of user behavior

Report on the Need for Research Round Table
on Automated Driving – Research Working Group

The questions listed in the following were formulated during the workshop of experts.
that as few changes as possible were made to the original contributions, less formal wo

Driver states and readiness to resume control

Assessment and development of technologies to measure driver availability
How can the performance/vigilance of the driver during automated driving be asses best bring him back to the control loop?
Define psychophysical limits to performance in the monitoring of partial automation
Can the driver maintain concentration during a longer automated trip?
Which requirements must be satisfied to permit the driver to resume control over the automated functions?
Can the driver handle the frequent change in "mode"? How can he be supported here?
Which driver states must be identified?
Examination of anxiety reactions
Situation awareness + system awareness of the driver/passengers

Designing the human-machine interface

Formulation of the design rules for the HMI
Development of arbitration concepts
Design of man/machine cooperation in high degrees of automation
Design of transitions in changing modes
Necessary feedback for high degrees of automation
Manufacturer-independent operating concepts/interactions
What do suitable HMIs look like?
Which HMI standards are necessary? (rented car scenario, rare use)
Which requirements must be satisfied for drivers to resume control of highly auto functions?
Can the driver handle the frequent change in "mode"? How can he be supported here?
Less reliability -> greater concentration; more reliability -> more acceptance
What do take-over strategies look like?
What is to be done to facilitate a driver take-over?
How can the driver be brought back to the control loop, e.g. at the limits of the sy -> Key word: transfer from vehicle to driver
Transfer from vehicle <-> driver; take-over from vehicle <-> driver

Non-driving activities

How/according to which rules do we permit non-driving activities?
Is an auxiliary activity good or bad?
How does a "driver" (auxiliary activity) behave if the vehicle performs an emergency stop?
What are the correlations between performing non-driving activities and possible impairments to the primary driving task (ability to take over the driving task at short notice) by the driver at automation level 3?

Desired use and avoidance of abuse

Does the driver keep to the task of monitoring the trip or abuse the support? (In the case of partial automation)
Use of the systems to their limits e.g. in cases of tiredness
User expectations on the system versus real function of the system

Test methods for HMI

Test methods for – driving experience; - acceptance; - usability
Which scenarios are to be used to validate controllability?
Which factors of automated driving affect the driving experience and acceptance?

Learning and training

Requirements placed on training for automated driving
Does the driver unlearn the ability to drive himself?
Which mental models does the driver create on system function? How can they be "shaped"?
Which steps of social acceptance and learning/previous experience of the user accompany the gradual introduction of automated driving functions (over years)?

Differences in people, influences on tasks

Professional versus private use and differences in tasks
What effects do differences in personality have, in particular: perception of locus of control?

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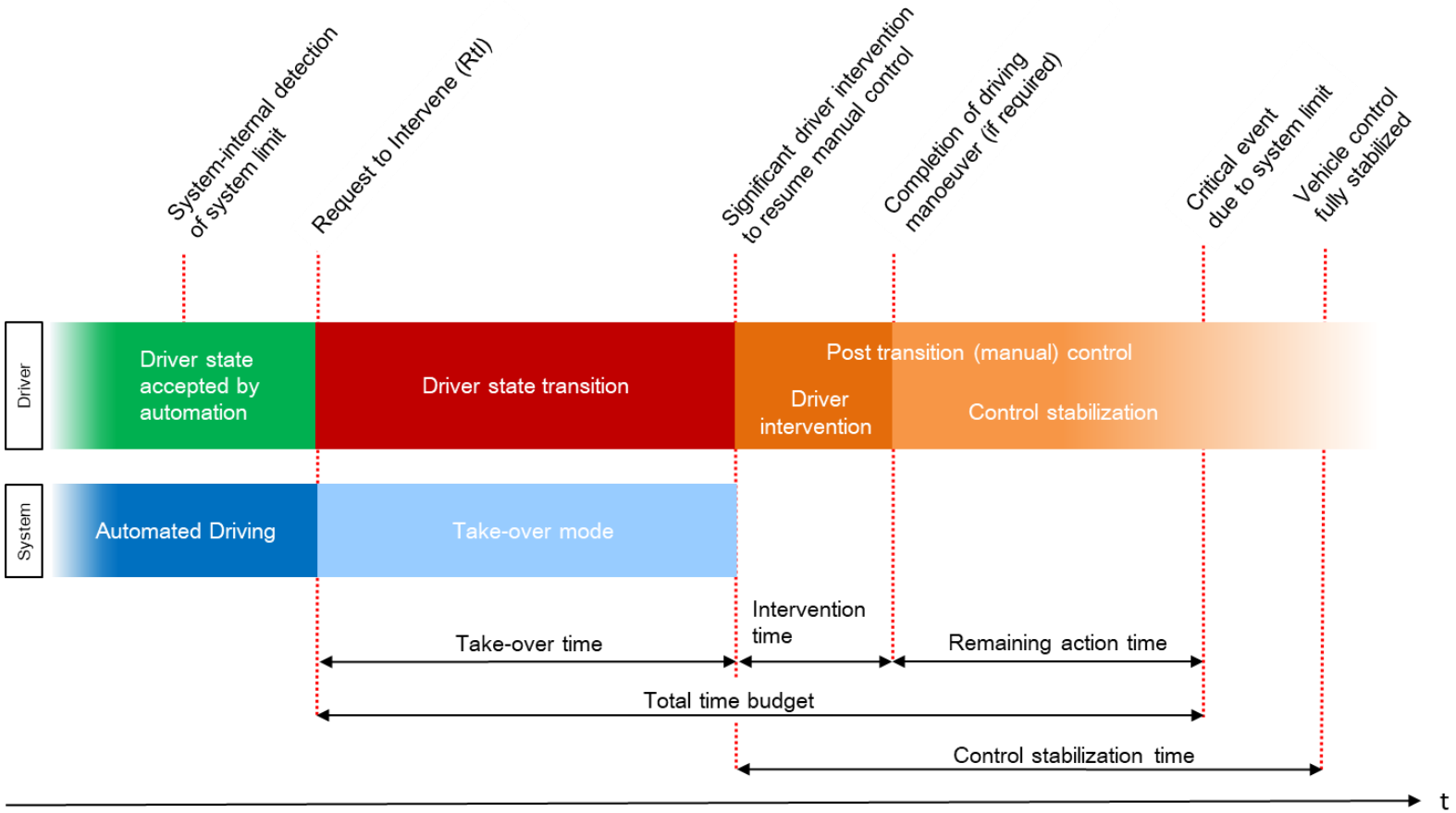
Transition Process and Model



Marberger, C., Mielenz, H., Naujoks, F., Radlmayr, J., Bengler, K., & Wandtner, B. (2017). Understanding and Applying the Concept of "Driver Availability" in Automated Driving. In N. A. Stanton (Ed.), *Advances in Human Aspects of Transportation: Proceedings of the AHFE 2017 International Conference on Human Factors in Transportation*

Level 4 und Technical Surveillance

Motivators:

Remaining technical deficits

Allocation of clear responsibilities

What is the Level of Interaction?

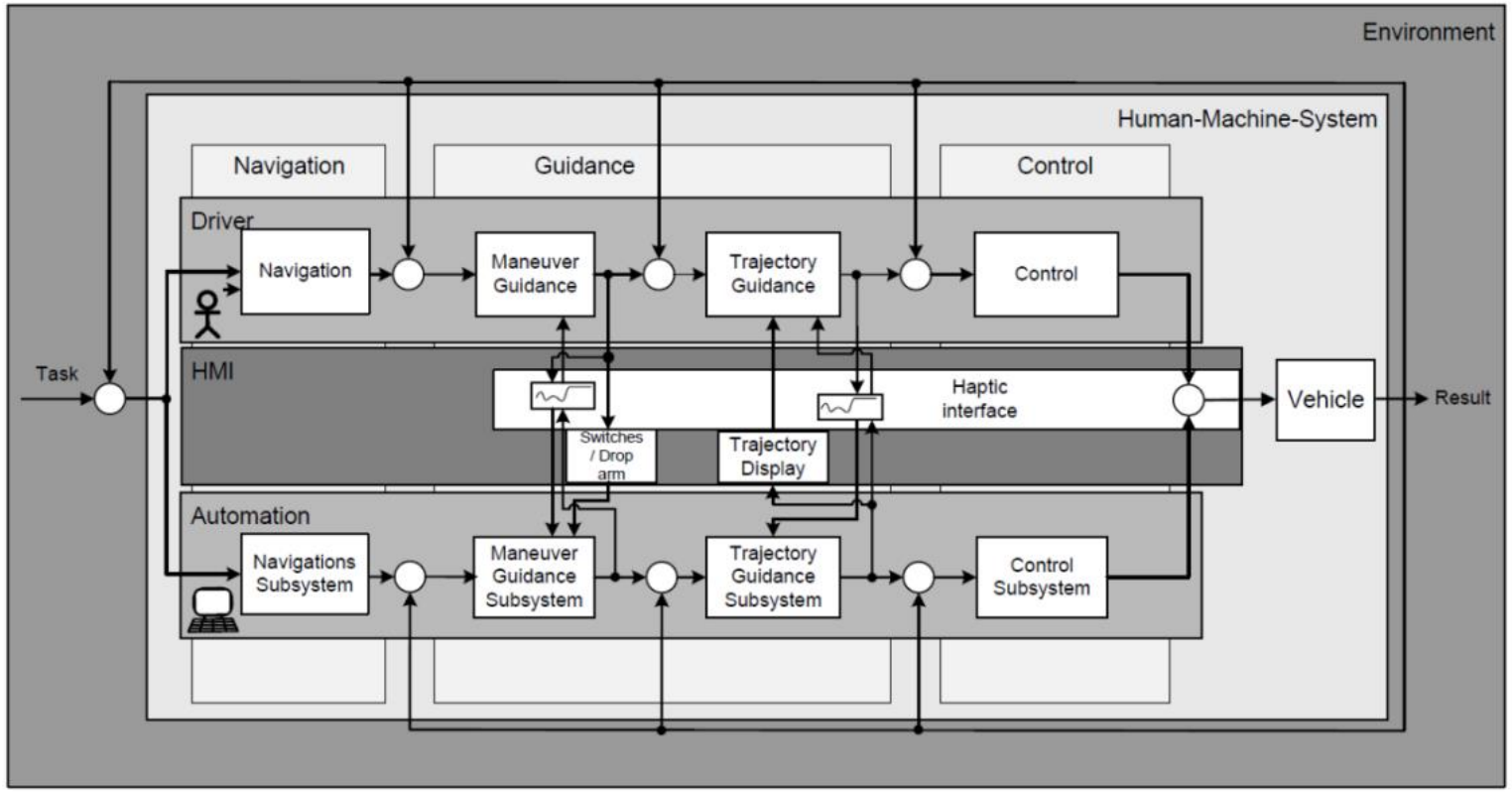
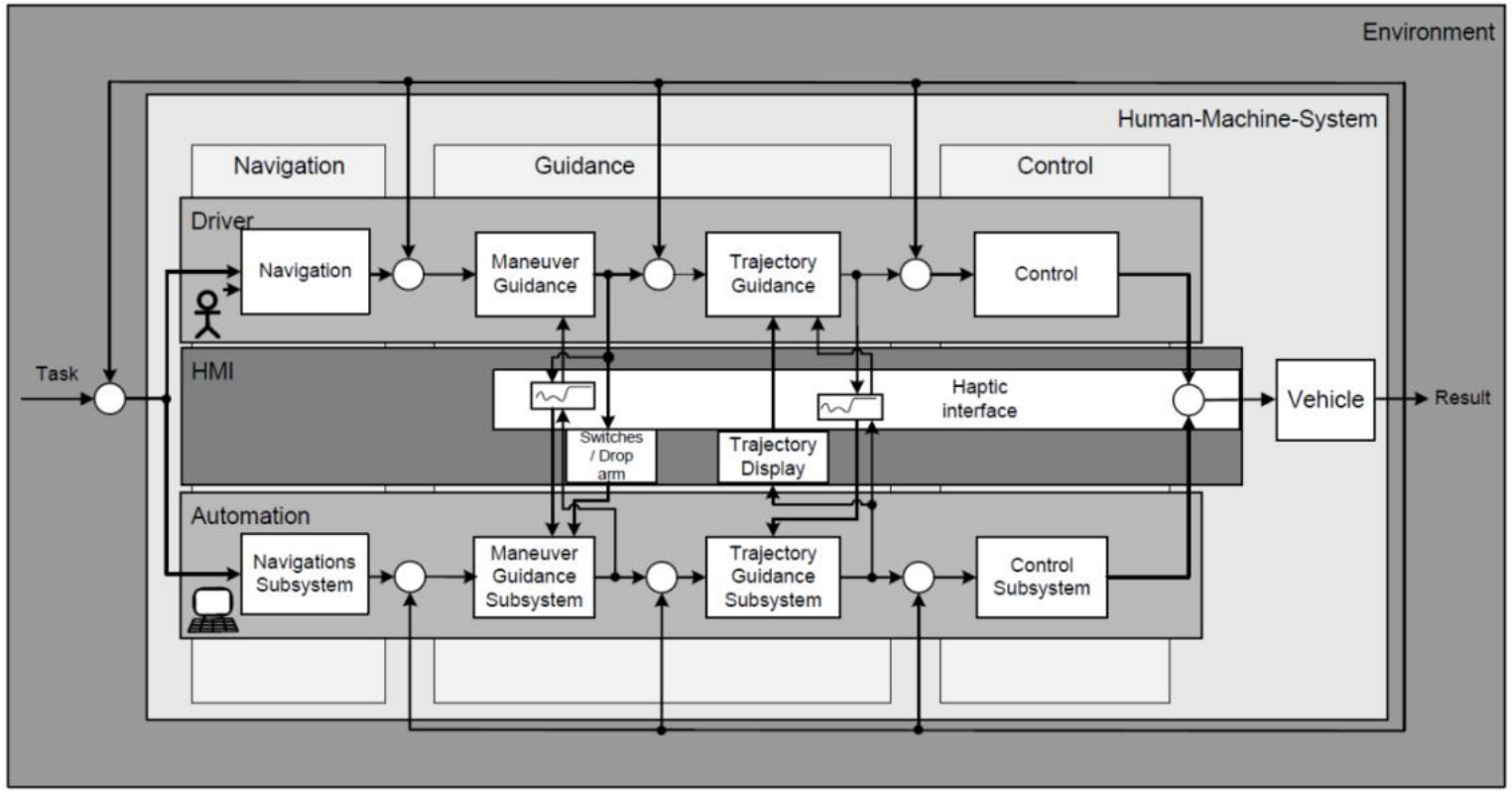


Figure 10. Control flow diagram of an H-Mode system

Flemisch, Frank O.; Bengler, Klaus; Bubb, H.; Winner, H.; Bruder, R.: Towards cooperative guidance and control of highly automated vehicles: H-Mode and Conduct-by-Wire. Ergonomics **57** (3), 2014, 343--360

And how to Design the HMI



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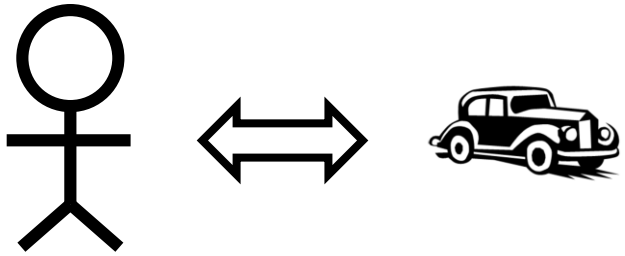
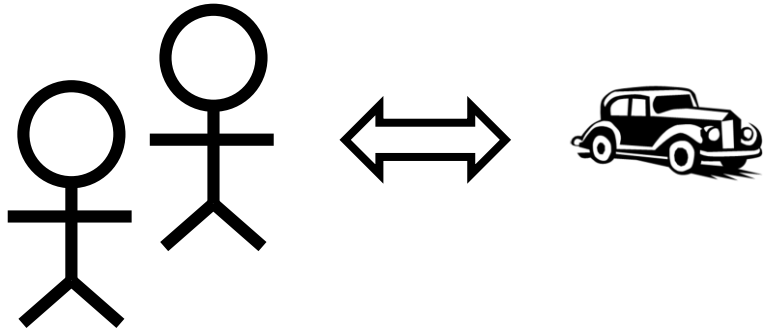
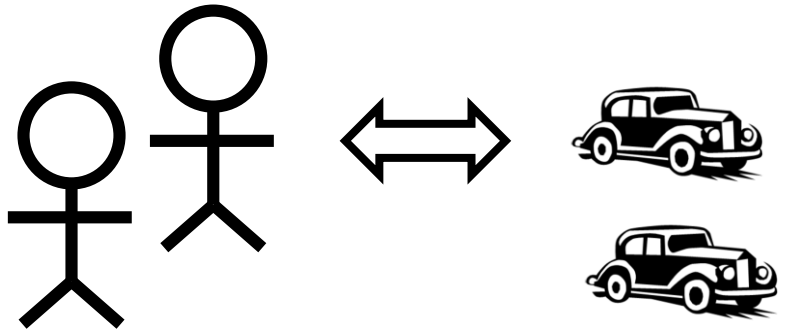
Defining the Working Situation







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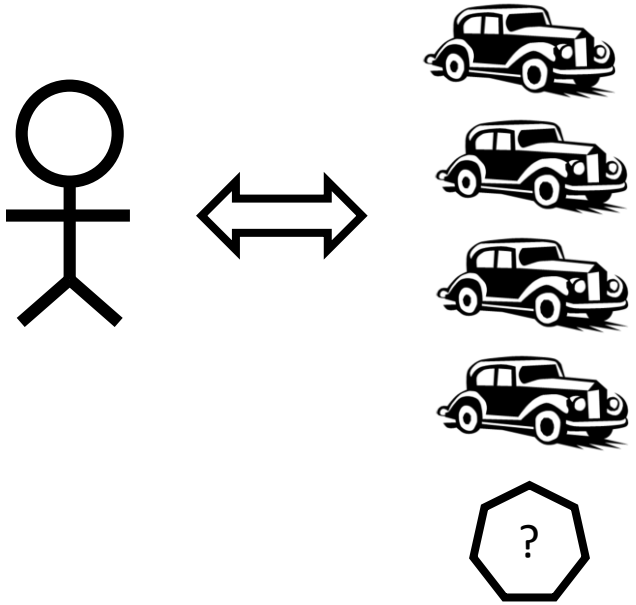

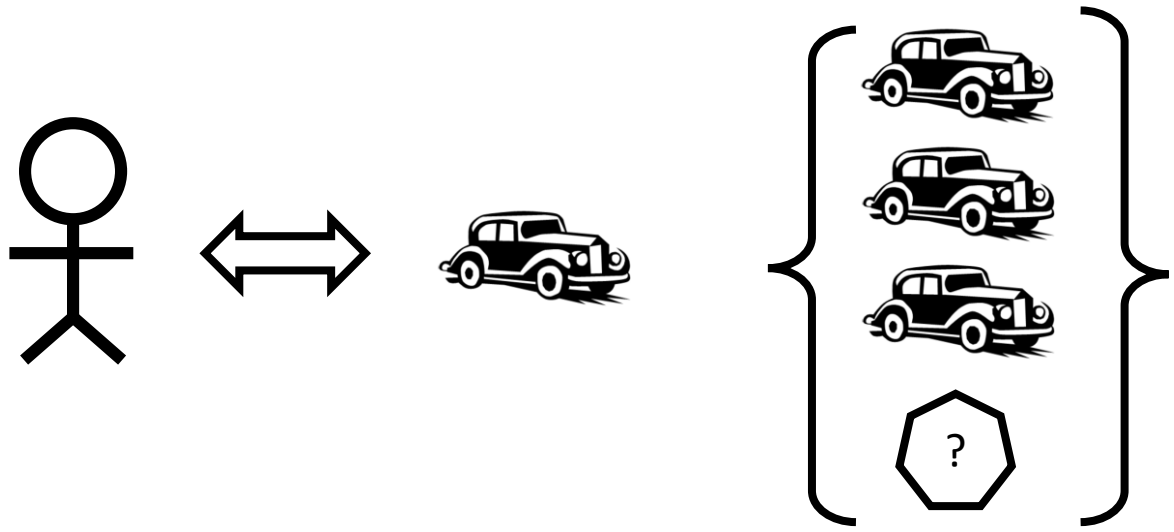

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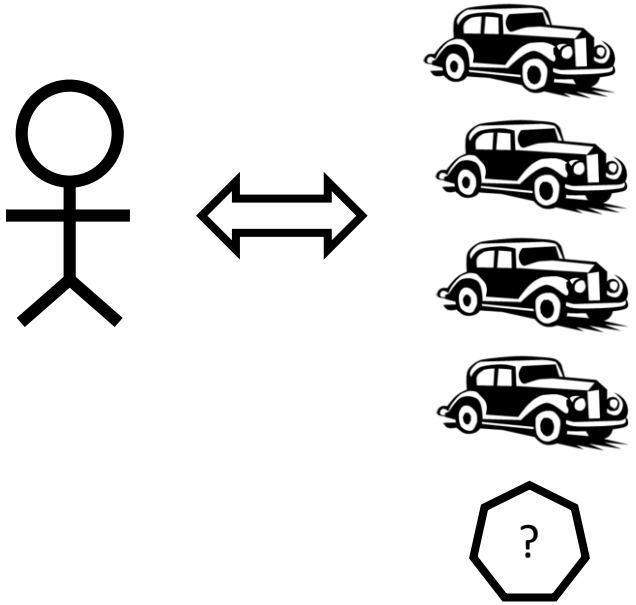

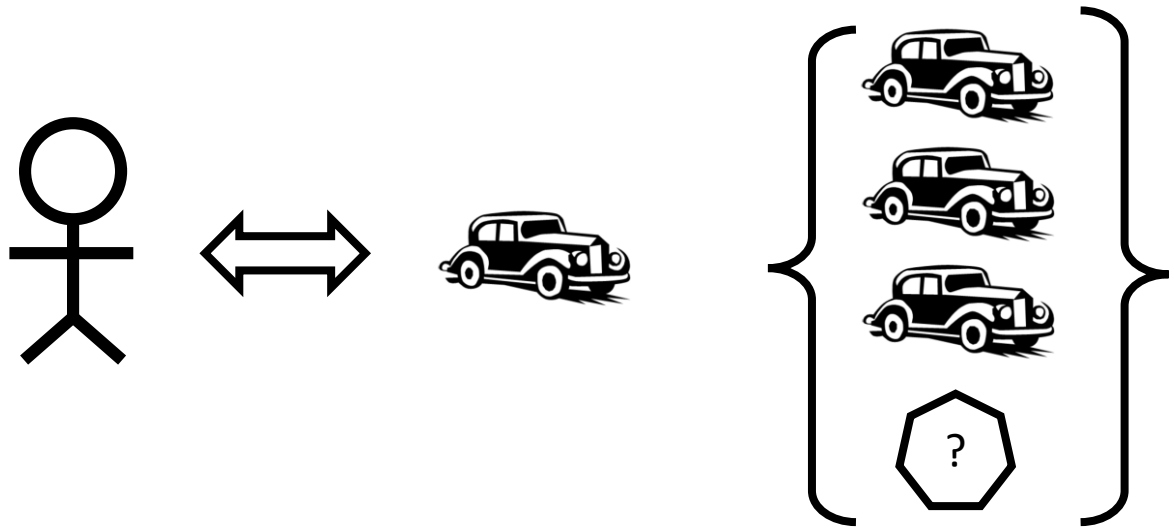

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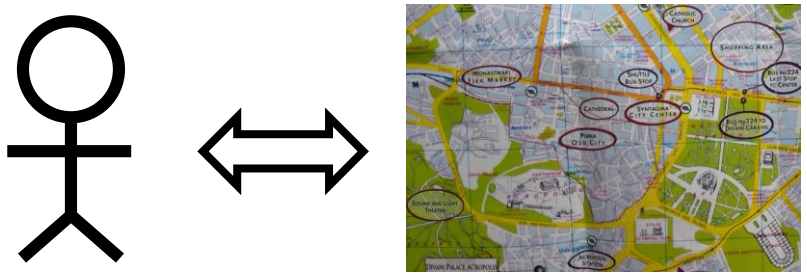
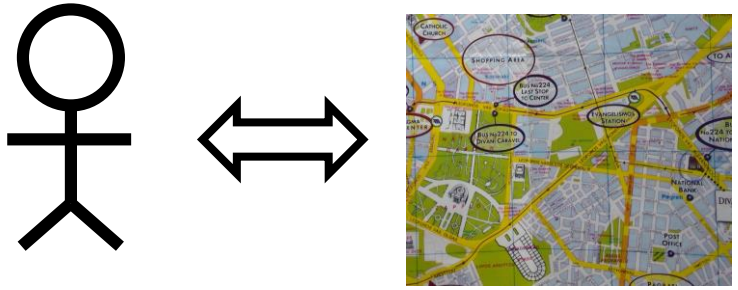




Defining the Skills and Requirements

- Individual abilities
- Training and working situation
- Certification
- …

A Calculation

- 1 : N or
  M : N as a working situation?

- MTBF for the technical system AV
- MTBF for the human operator
- MTTR to solve the problem
- p (E_{veh_1} /E_{veh_2})

- Probabilities of independent critical incidents (individual sensor defect)
  Probabilities of general regional problems (e.g. bad weather)

Time Based Considerations

- MTBF = Σ(start of downtime – start ofuptime)/number of failures
- Availability
  MTBF/MTBF+MTTR
- $Availability_{System} = Availability_{AV} * Availability_{Operator}$

Calculation of System Availability

$$MTBF_{System\_teleop} = {}^{1}\Big/ \frac{1}{MTBF_{AV}} + \frac{1}{MTBF_{Human}} + \frac{MTTR}{MTBF_{AV} * MTBFHuma_{n}}$$

- $p_{AVFailure}$:= ?
- $p_{HumanError}$:= ? (Swain & Guttmann 1980)
- MTTR := ?

What is the Data Situation

- We have the accidents/mileage
- Sometimes we have the critical incidents/mileage

To define the working situation and the team model

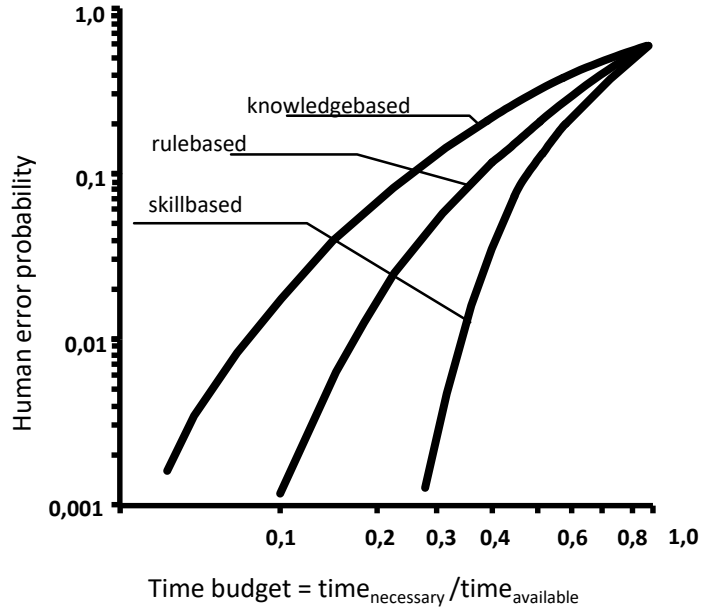
- We would need critical incidents/hrs
  and related situation duration and parameters

We Could Make an Inverted Calculation

Given as premises/requirements

$MTBF_{System\_teleop}$

Human Reliability



$$MTBF_{System\_teleop} = {}^{1}\Big/ \frac{1}{MTBF_{AV}} + \frac{1}{MTBF_{Human}} + \frac{MTTR}{MTBF_{AV} * MTBFHu_{man}}$$

What is the necessary $MTBF_{AV}$ and MTTR

Research Questions

- Probability of events (i.e. technical reliability)
- Characteristic of events (sensoric, infrastructure, passengers, other road users)
- Definition of potential MRMs
- Optimized HMI on the guidance level
- Human reliability in teleoperation
- Working models for fleet operation
- What aspects should/can be internationally standardized?