HAVOC

Heavy Automated Vehicle Operation Center

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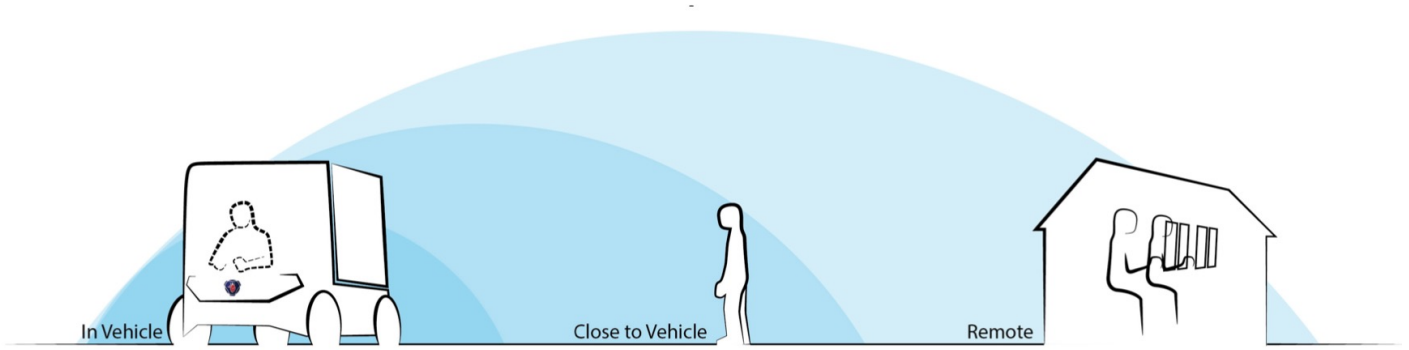
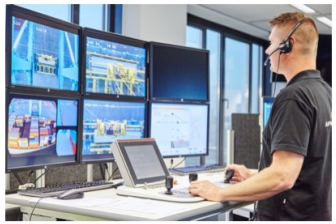
Background

- Collaboration between RISE and Scania over approx. 1 year, funded by Vinnova FFI

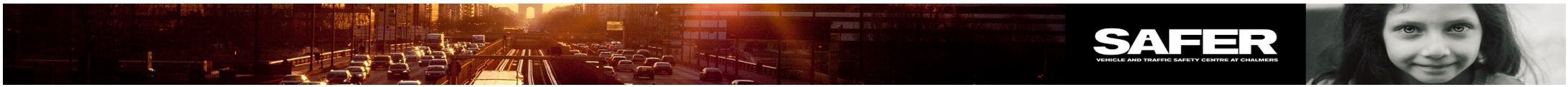


Driver

Close Operator



Remote Operator

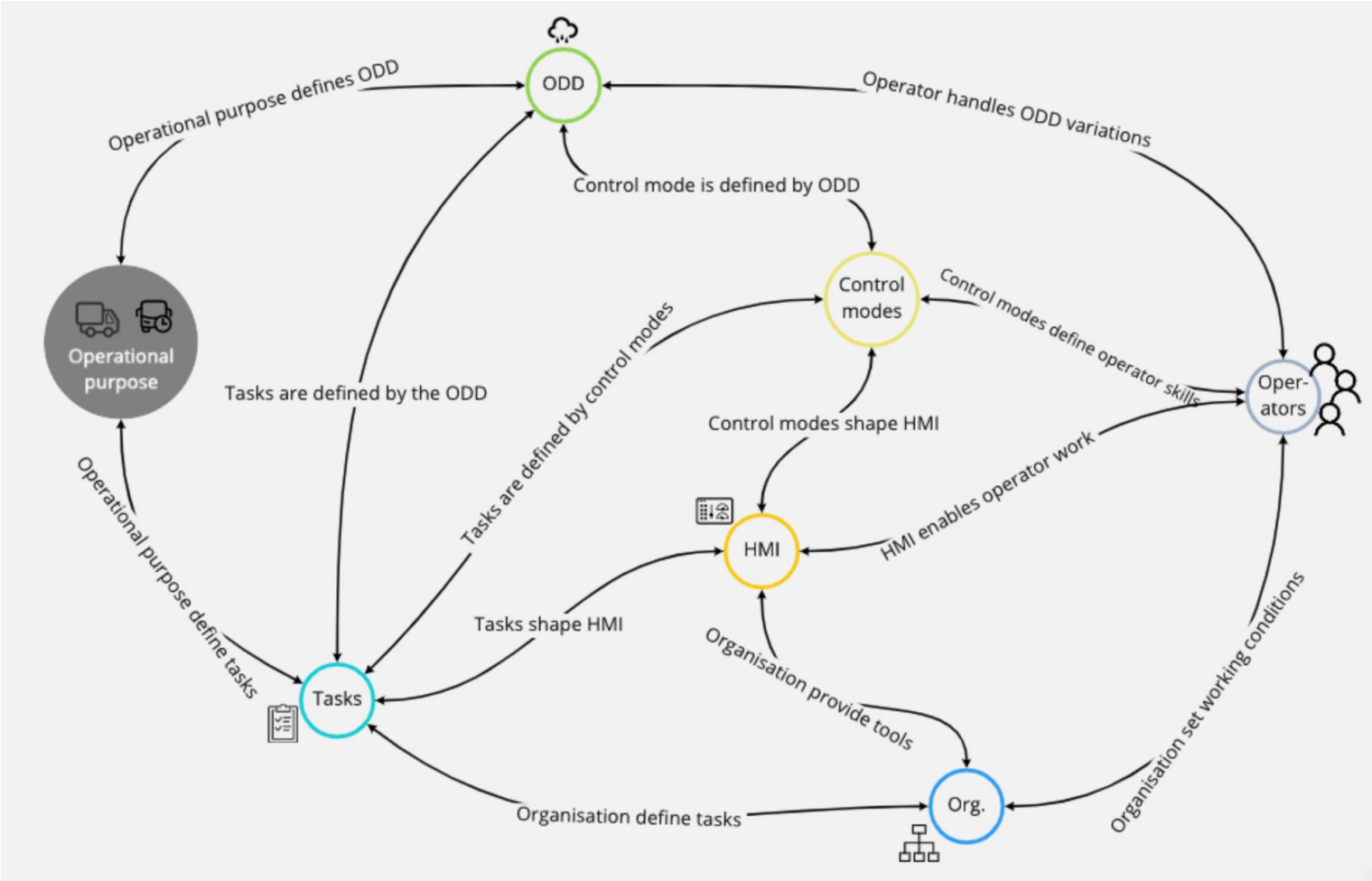


Research questions

How should remote operation center be designed from a human factors perspective?

- The specific research questions the project are:
  - What requirements are posed on humans and HAVs for different remote operating applications: assessment, assistance, and driving?
  - What is required from a human factors perspective to scale up the number of vehicles a human operator can remotely operate (1:X ratio)?
  - How should a remote operation center be designed to allow the operator to swap between different remote operating applications (assessment, assistance, driving)?

A socio-technical model of remote operation

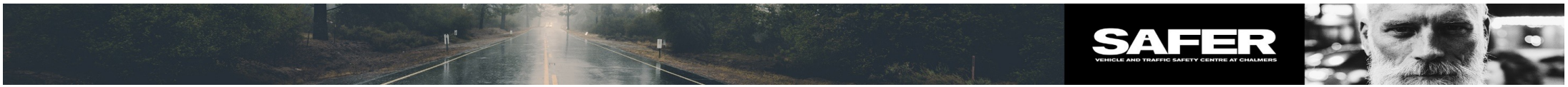


HAVOC simulator setup and user study

- Simulator using a game engine back-end built in Unity
- Three control modes deployed: **Assessment, assistance and driving**
- Two working stations – mouse/keyboard (assessment, assistance) + SW/pedals (driving)
- Main operator task: monitor vehicles and respond to problems
- Test assignement: Keep vehicles at an even time distance between the hubs

Five events to simulate control modes

- “Road works” (Assessment) – vehicles slowed down on road
- “Water puddle” (Driving) – vehicle stopped
- ”Bath tub” (Assistance) – obstacle on road
- “Loading dock” (Driving) – vehicle stopped in hub
- “Sensor degradation” (Assistance) – sensor problem leading to safe stop

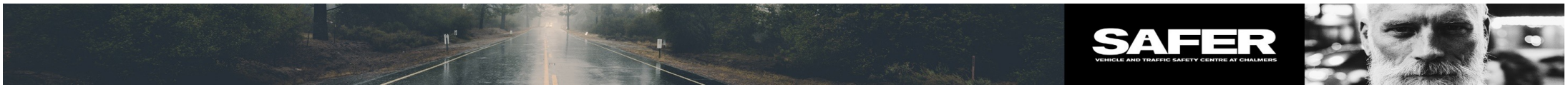


HAVOC simulator setup and user study

- Exploration of mid-fidelity prototype, based on earlier Scania remote operation concept
- Task: monitor and control ten vehicles in a hub-to-hub scenario – “Arlanda-Rosersberg”
- 15 participants
- Scania employees
  - automated vehicle professionals from different disciplines – ADAS, UX, AD

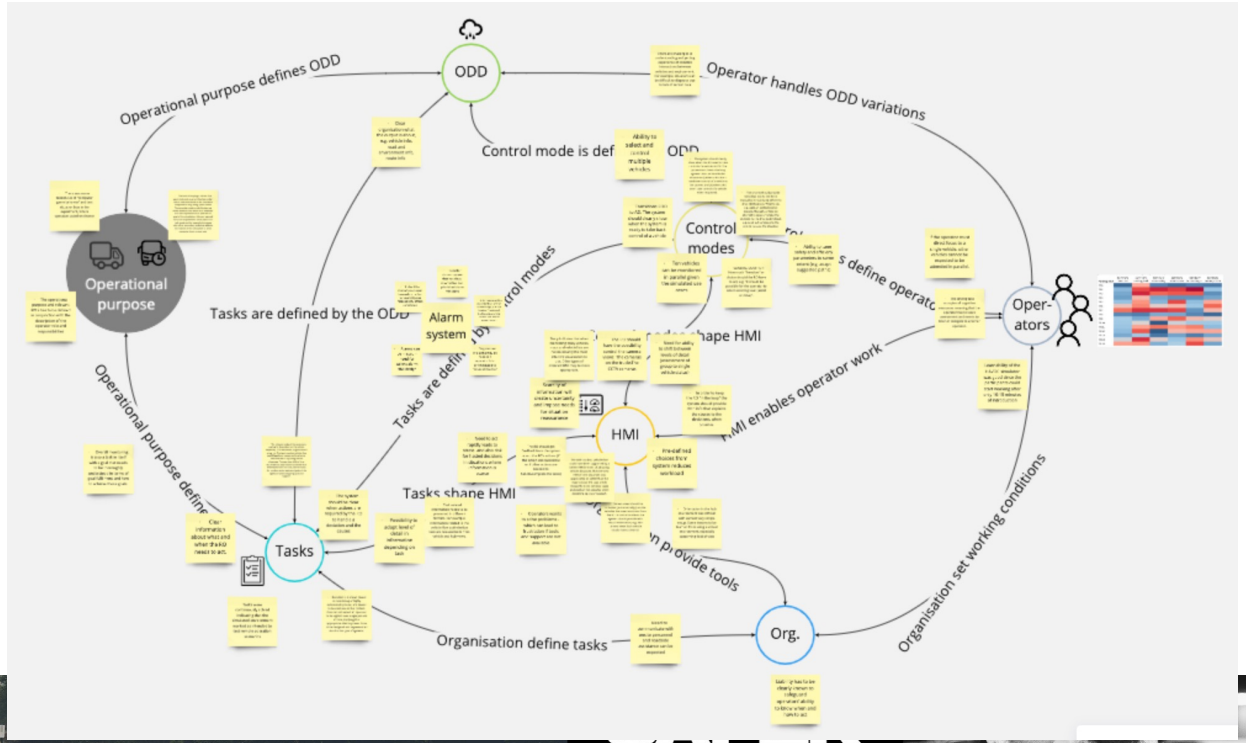
- 15 min introduction
- Min 1,5 h working as a remote operator
- 15 min post interview

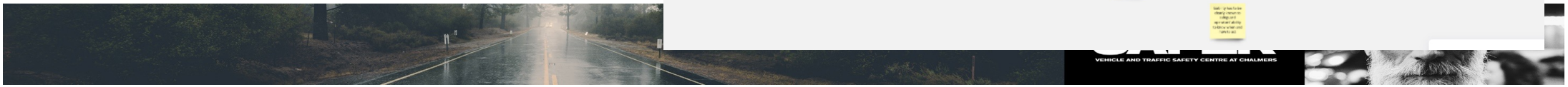
- Explorative approach
  - Think aloud protocol during test
  - Subjective ratings after each event (NASA-TLX)
  - In the end, semi-structured post interview and subjective ratings (van der Laan, Scania 10-scale, rating of event difficulty, time to detect)



RQ1

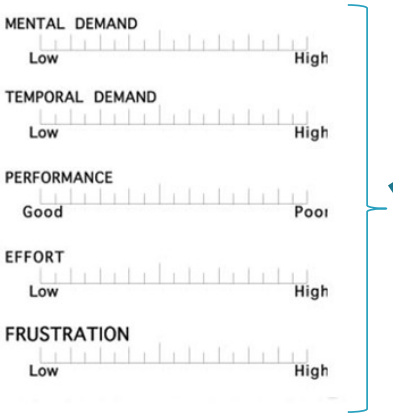
- **What requirements are posed on humans and HAVs for different remote operating applications: assessment, assistance, and driving?**
  - In general, results show that generic requirements for human-automation interaction and remote operation apply
  - HAVOC requirements web page under construction





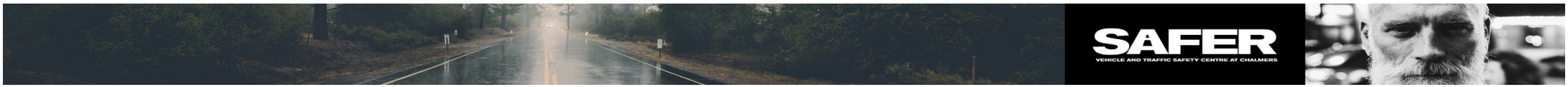
NASA-TLX – workload ratings after each event

Event
Road works
Water puddle
Bath tub
Loading dock
Sensor degradation
Monitoring



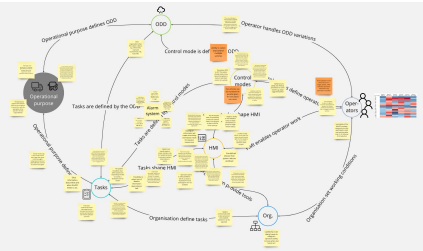
NASA-TLX summarized ratings

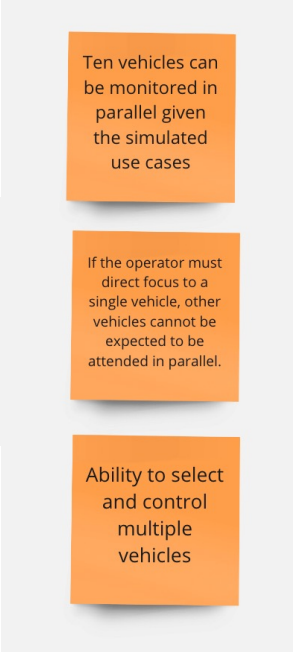
Participant #	Summary Bath tub	Summary Loading dock	Summary Monitoring	Summary Road works	Summary Sensor degra..	Summary Water puddle
TP1						
TP2						
TP3						
TP4						
TP5						
TP6						
TP7						
TP8						
TP9						
TP10						
TP11						
TP12						
TP13						
TP14						
TP15						
Control mode:	Assistance	Driving	Assessment	Assessment	Assistance	Driving



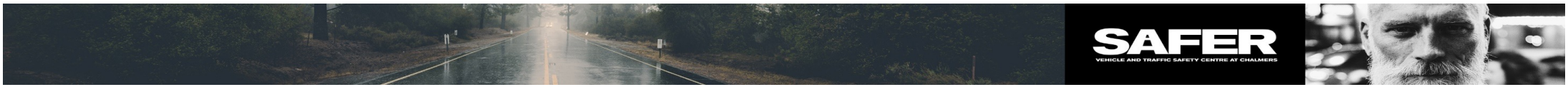
RQ2

- **What is required from a human factors perspective to scale up the number of vehicles a human operator can handle remotely (1:X ratio)?**





- 1:10 ratio is feasible in assistance and driving given the prerequisites in the HAVOC setup (system manage vehicles – operator responds)
- A single operator can not be expected to assess system level in parallel to driving (directed attention)
  - → efficient monitoring HMI to work back in to the assessment loop
  - → alarm management will be of importance
- Given the HAVOC optimisation task (keeping even vehicle flow) operators wanted to control more than one vehicle at a time

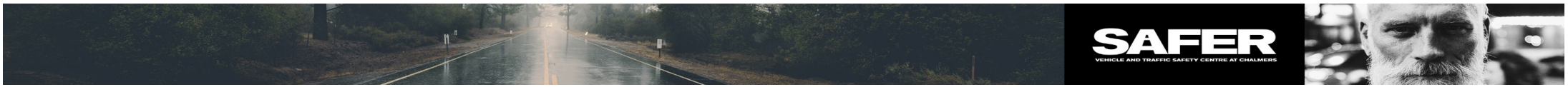


RQ3

- **How should a remote operation center be designed to allow the operator to swap between different remote operating applications (assessment, assistance, driving)?**

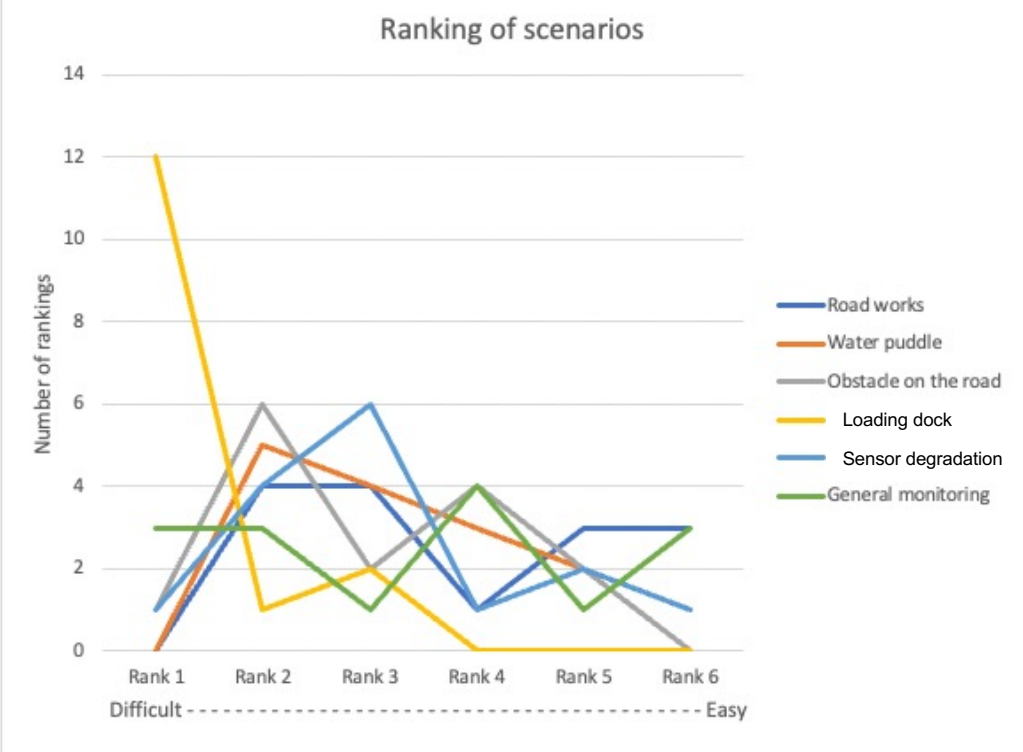
  - RQ 3 was explored by implementing the different events corresponding to assessment, assistance and driving
    - Assessment < - > Assistance
    - Assessment < - > Driving

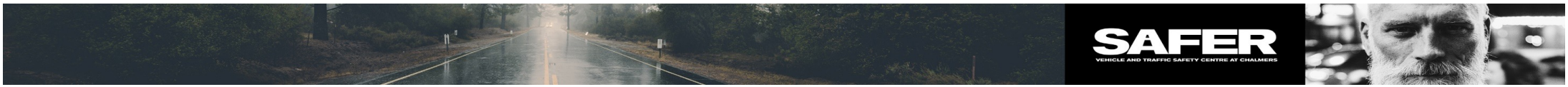
  - We hypothesized that transitions between control modes would be effortful and require time to regain situation awareness when moving between the modes
    - Results show it was easy to transition between assessment, assistance and driving (little effort and time)
    - Some events were experienced as more effortful than others



Ranking of event difficulty

- ”Loading dock” stands out as most difficult
  - Limited FOV
  - Tight Maneuvering
  - Risky situation
- “Road works” was perceived as tricky
  - Limited sensor information required operators to diagnose cause of deviation (lower speed at part of road)
- Assistance events
  - With guidance text and suggestions from system, assistance events were quickly resolved
  - Too quickly?





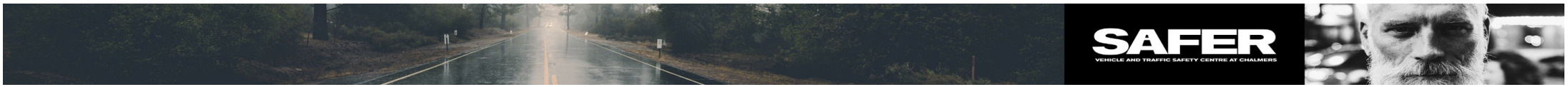
Methodological reflections

- Simulator environment
  - Gap between simulated and real environment (gamification effect)
    - Will this effect remain in real operation?
    - Sometimes more important to finish task than act in safe way
      → Importance of KPI:s presented in the HMI, since KPI:s will guide operator behaviour and trade-offs
      - Importance of risk assessment of behaviour when operator is “out of risk”

- Recruitment of participants
  - How important is experience as truck driver vs. knowledge of automation technology?

- Importance of HMI design
  - Is the map really that important?
  - Task based HMI for vehicle flow was useful and can be developed further

- XAI - Explainable AI could lead to over reliance, depending on how it is implemented



Thank you!

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