VOLVO

Adapt|I|Ve

Automated Driving Applications and Technologies for Intelligent Vehicles

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HUMAN FACTORS IN VEHICLE AUTOMATION

- Activities in the European project AdaptIVe

Vehicle and Road Automation (VRA) Webinar
10 October 2014

// Outline

- AdaptIVe – short overview
- Collaborative automation
- Human Factors challenge
- Work process
- Functional requirements / design guidelines
  - Examples on driver state
- Outlook

// AdaptIVe

- Duration: JANUARY 2014 – JUNE 2017
- Coordinator: VOLKSWAGEN GROUP RESEARCH, ARIA ETEMAD
- 30 partners: FRANCE, GERMANY, GREECE, ITALY, SPAIN, SWEDEN, THE NETHERLANDS, UK

OEM:

VOLKSWAGEN AKTIENGESELLSCHAFT · BMW GROUP · BMW GROUP Research and Technology · CENTRO RICERCHE FIAT · DAIMLER · Ford · VOLVO · VOLVO · PSA PEUGEOT CITROËN · OPEL Wir leben Autos. · RENAULT

Suppliers:

BOSCH Invented for life · Continental · DELPHI

Research inst.:

bast · CTAG Centro Tecnológico de Automoción de Galicia · DLR Deutsches Zentrum für Luft- und Raumfahrt German Aerospace Center · CHALMERS · LUND UNIVERSITY · ICCS · TNO · ika RWTH AACHEN UNIVERSITY · UNIVERSITY OF TRENTO - Italy · UNIVERSITY OF LEEDS · WIVW · Julius-Maximilians UNIVERSITÄT WÜRZBURG

SME:

alcor consulenza innovazione · eict

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General objectives

- **Widespread application of automated driving to improve traffic safety, efficiency and comfort**

1. Automation in **different environments** and **different automation levels**.
2. Enhanced **perception performance**
3. Driver-vehicle interaction; **collaborative automation**.
4. **Evaluation methodologies**. Assess the impact of automated driving on European road transport.
5. **Legal framework**

// AdaptIVe

Demonstrator vehicles and general use cases

Test and develop applications for parking and low speed maneuvers	Test and develop applications for medium speed maneuvers in complex scenarios	Test and develop applications for error-free driving for cars and trucks on highways

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Subproject structure

Subproject 1: **Integrated project (IP) management** — VOLKSWAGEN AKTIENGESELLSCHAFT

Subproject 2: **Response 4** Legal framework — DAIMLER

Subproject 3: **Human-Vehicle Integration** Collaborative automation — VOLVO

Subproject 4: **Automation in close-distance scenarios** — Ford

Subproject 5: **Automation in urban scenarios** — CRF CENTRO RICERCHE FIAT

Subproject 6: **Automation in highway scenarios** — VOLKSWAGEN AKTIENGESELLSCHAFT

Subproject 7: **Evaluation** framework for automated driving applications — ika INSTITUT FÜR KRAFTFAHRZEUGE RWTH AACHEN UNIVERSITY

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Targeted automation levels (according to SAE's draft levels)

level 0	level 1	level 2	level 3	level 4	level 5
No auto-mation	Assisted	Partial auto-mation	Condi-tional auto-mation	High auto-mation	Full auto-mation

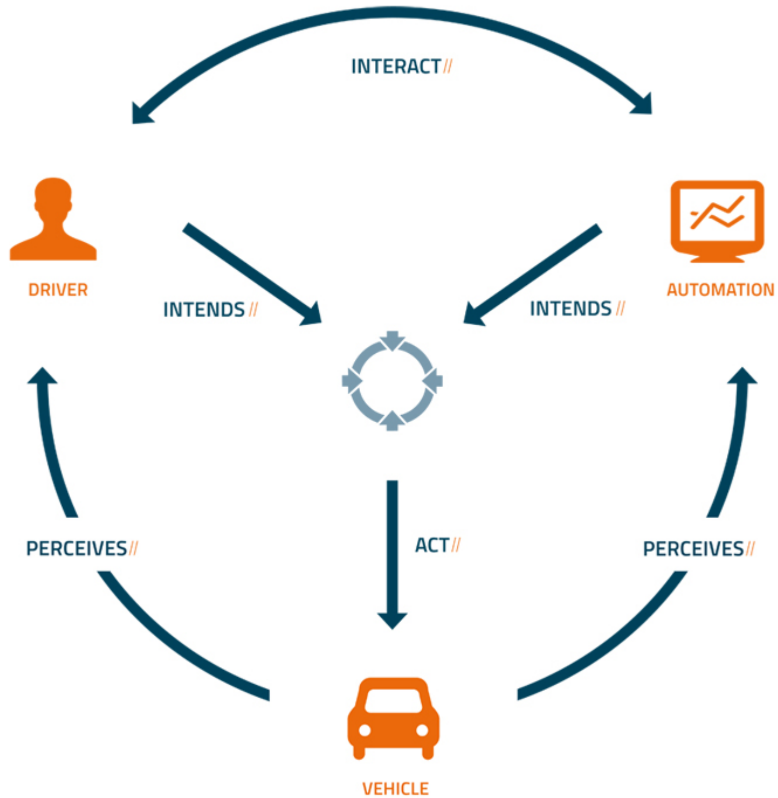
Examples of applications:

- Parking with remote control
- Garage parking
- Parking in special areas
- Parking in a multi-level garage
- Stop & go
- Safe stop

// Human Vehicle Integration – collaborative automation

Subproject 3

- Collaborative automation:
  - implies the idea of **complementary skills** of human and automation that are **used together** to achieve **one common goal**.
  - The basis is continuous **communication and interaction** between the two partners, with regard to respective **intentions, abilities, actions** and **limitations.**



//Human Factors challenge

- So far, there is **no fail proof software**
- To replace the human behind the wheel being with a machine (designed by another human) only works if the task environment is **very static and predictable and a priori controllable**...
- So what to do with the driver?

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//Human Factors challenge

Option 1: The driver monitors the automated control system

- Unfortunately, humans make **poor monitors**
- **Vigilance** problems etc.
- Ironically, **overreliance** increases if the system has high reliability and low failure rate

Option 2: The driver act as a back-up to the automation

- Controllers need manual and cognitive **skills** to function. In absence of practice these skills degrade
- **Out of the loop**

// Which are the best alternative designs to avoid a passive driver?

?

// Human Factors challenge

Option 3: The human and automation can both participate in the control through some sort of partnership

- How do we find **the correct partnership**?
- Who will have **the final authority** if the driver and computer disagree?
- Automating part of the tasks might make **the more difficult tasks even harder** for the driver.

// How much knowledge can be transferred from other domains to vehicle automation?

?

// Work process

Functional requirements /design guidelines

Experiments

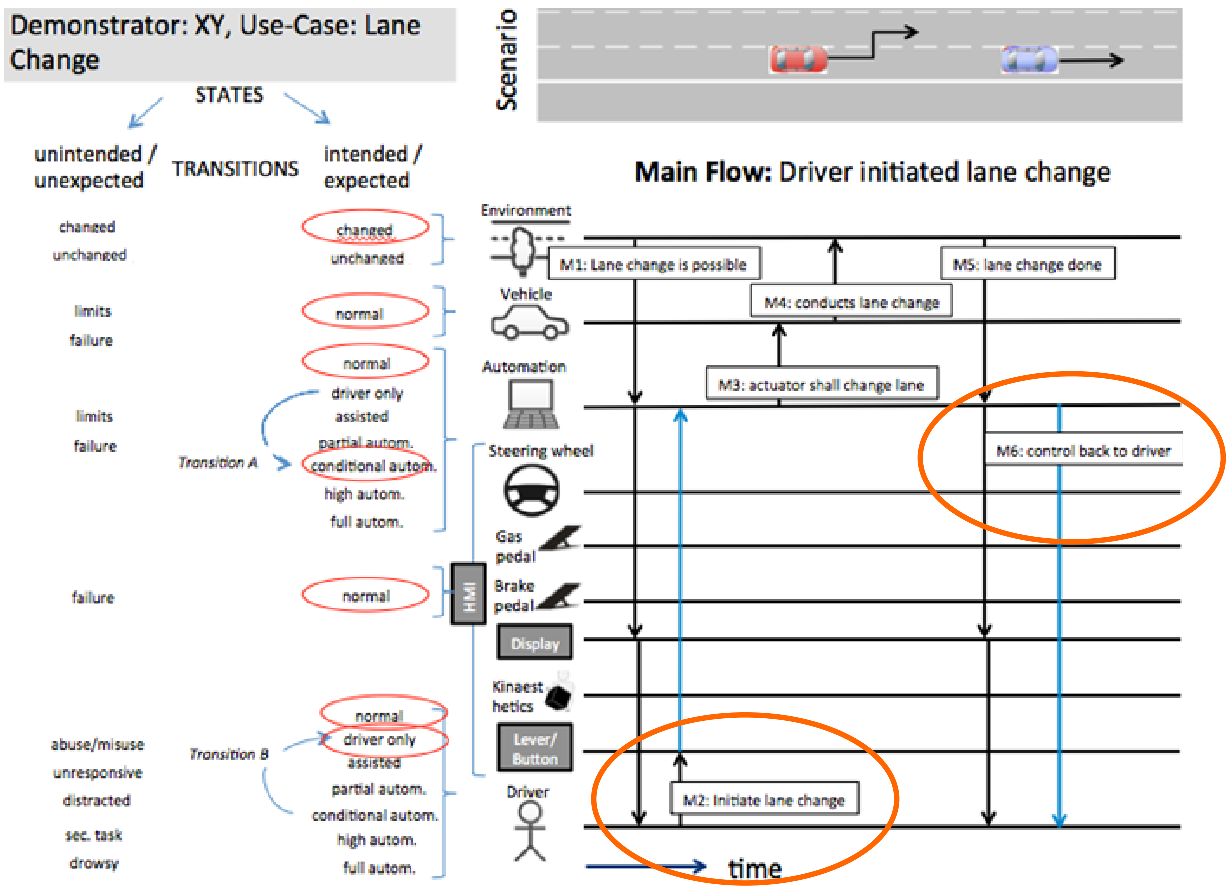
Use Cases

Human-vehicle integration

State of the Art of Human Factors research

Research questions

// Use Cases


Demonstrator: XY, Use-Case: Lane Change
STATES
unintended / unexpected
TRANSITIONS
intended / expected
changed
unchanged
limits
failure
normal
driver only
assisted
partial autom.
conditional autom.
high autom.
full autom.
Transition A
abuse/misuse
unresponsive
distracted
sec. task
drowsy
Transition B
HMI
Scenario
Main Flow: Driver initiated lane change
Environment
Vehicle
Automation
Steering wheel
Gas pedal
Brake pedal
Display
Kinaesthetics
Lever/ Button
Driver
M1: Lane change is possible
M2: Initiate lane change
M3: actuator shall change lane
M4: conducts lane change
M5: lane change done
M6: control back to driver
time

// Functional requirements /design guidelines

- **'Awareness problems'**
  - Perception
  - Comprehension
  - Mode awareness
  - Attention
  - Beliefs
  - …
- **'Intention/decision problems'**
  - Goal setting
  - In-vehicle tasks/task allocation
  - Responsibility
  - Unintended use (misuse?)
  - …
- **'Agent state problems'**
  - State (failure, limits)
  - Environmental conditions
  - Drowsiness/fatigue
  - Workload
  - Knowledge/experience
  - …
- **'Interaction problems'**
  - Visual, auditive, haptic, kinestetic communication, interaction, information, confirmation
  - Feedback
  - Arbitration
  - Mental models
  - Transition
  - …
- **'Action problems'**
  - Physical constraints
  - Motoric constraints
  - Lack of skills
  - Controllability
  - …

***Categorization from D3COS**

***Alot of input from interactIVe and HAVEit**

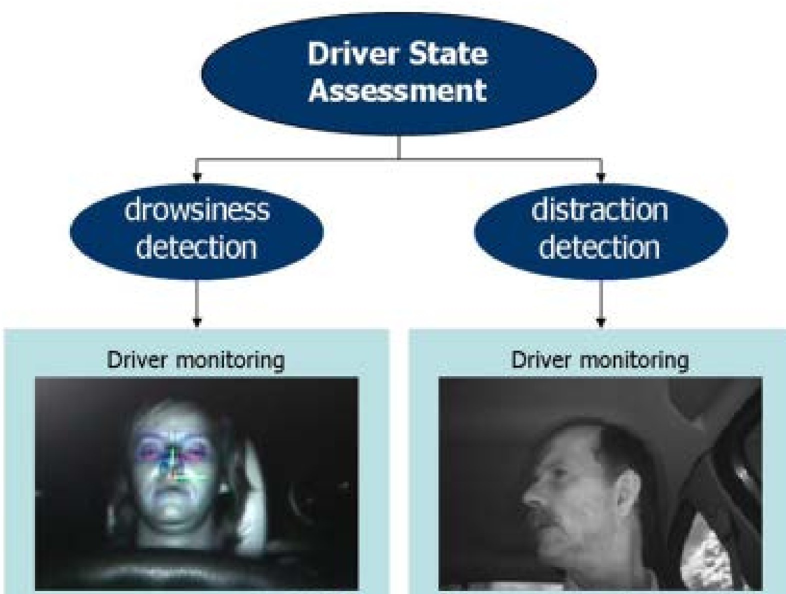
//Functional requirements /design guidelines (examples)

- Agent-state-related problem; driver state
  - An inattentive driver (e.g. drowsy or engaged in non-driving related tasks) **will need longer or will even be unable to react to a system-initiated transition; the system need to know this limitation**
  - In order to assess whether the driver will be able to react appropriately to a system-initiated transition **a driver state monitoring component must be implemented in the vehicle**

***based on work in e.g. HAVEit**

//Functional requirements /design guidelines (examples)

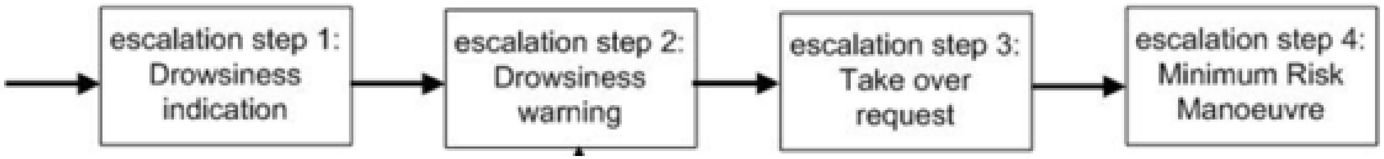
- Agent-state-related problem; driver state
  - Driver state assessment should be able to **both detect short-term inattention, such as engagement with non-driving related tasks as well as long-term inattention** (such as drowsiness, driving under alcohol, other substances etc.)



***based on work in e.g. HAVEit**

// Functional requirements /design guidelines (examples)

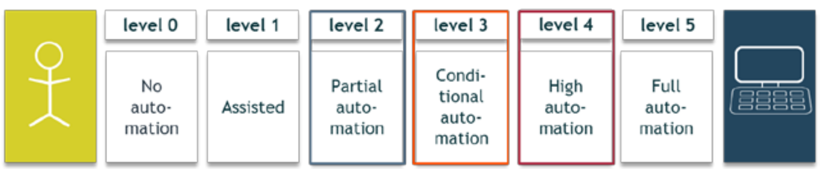
- Agent-state-related problem; driver state, transition:
  - In case of an impaired driver state **a stepwise escalation scheme** should be implemented to bring the driver back into the loop



***based on work in e.g. HAVEit**

// Functional requirements /design guidelines (examples)

- Agent-state-related problem; driver state, transition:
  - In a time-critical situation the driver **must be brought back to the loop quicker** compared to a **non-critical situation**; the **higher the automation level** the **more time** can be given **to bring the driver back to the loop**
  - the escalation scheme should be **adaptable to the criticality of the situation and to the current automation mode**



***based on work in e.g. HAVEit**

//Functional requirements /design guidelines (examples)

- Agent-state-related problem; driver state, transition:
  - a driver could probably use the system in a **unintended way,** e.g. to **sleep.**
  - in case of unintended use* **the highly automated mode should be disabled, however still preventing the driver from safety-critical situations**

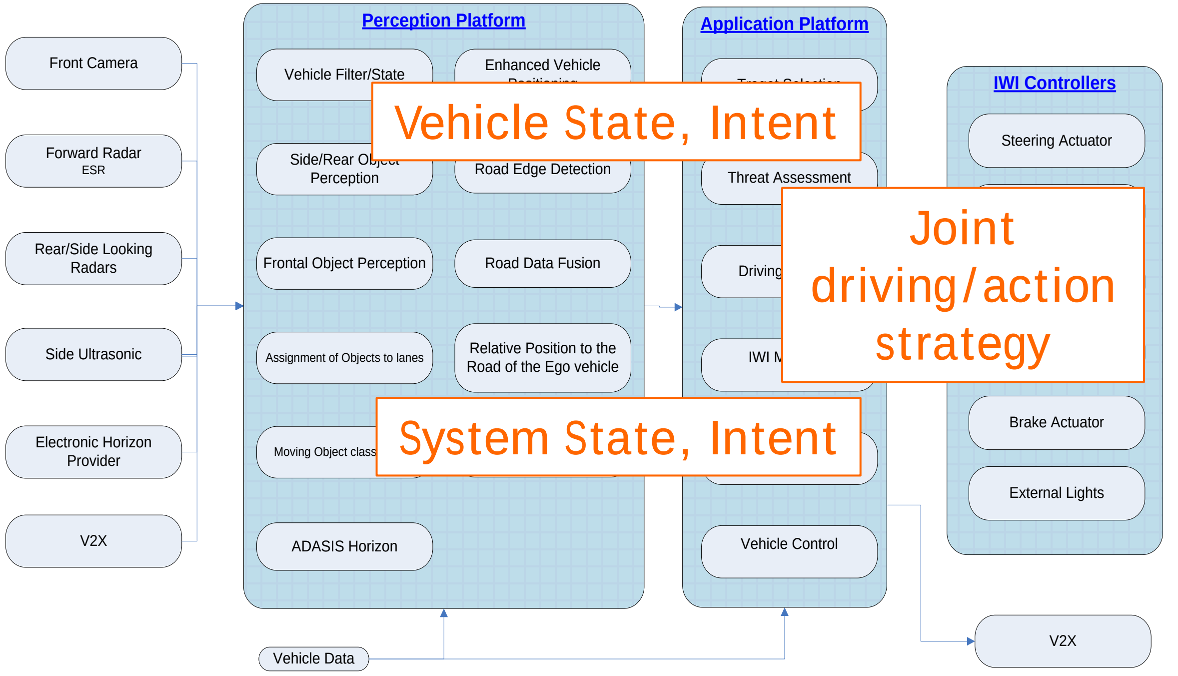
****Unintended use, misuse, abuse: We need to define** unintended use and create a design **that makes the intended use clear** and will **avoid obvious misuse**.*

***based on work in e.g. HAVEit**

//Outlook

- System need to be designed based on *both* automation's and driver's **state**, **intent** and **actions**

- Human Factors work have implication on how to design **sensor/perception** layer, **application/function** layer as well as **interaction/output** layers



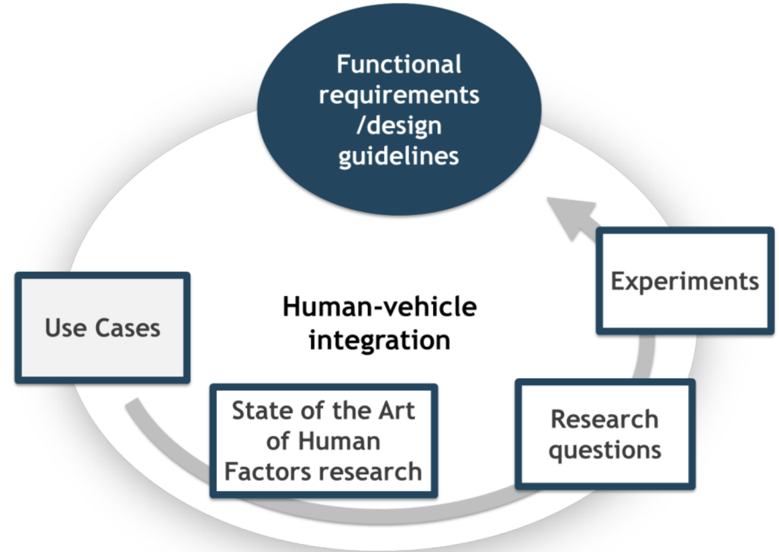
//Outlook

1. Create first version of Functional req./guidelines based on current SoA (main input from HAVEit, interactiVe, H-mode)

2. Collect research questions

3. Run experiments
   - 16 exp between end of 2014→beginning of 2016)

4. Update requirements → input to design of demonstrator vehicles + beyond AdaptIVe




Leeds driving sim.


DLR driving sim.


WIVW driving sim.


FORD fixed based sim.


VOLVO ATR truck sim.


VCC fixed based sim.


DLR FASCar

// Which research questions should be the most important ones?

?

// Outlook - Experiments (examples of categories)

Driver in the loop
- Situation awareness
- Mode awareness

Controllability
- Managing system limits/ failures

Shared control
- Driver and automation act in parallel?
- On different levels of control?

Transitions
- System and driver initiated
- Intended and unintended

Driver attention state
- Secondary-task engagement
- Drowsiness

Interface design
- Modality and timing of information

//SP3 team

- VOLVO GROUP Trucks Technology
  - Emma Johansson, Pontus Larsson
- FORD
  - Stefan Wolter, Martin Brockmann
- VOLVO CARS (VCC)
  - Mikael Ljung Aust, Trent Victor, Malin Farmasson
- DLR
  - Johann Kelsch, Marc Dziennus
- University of LEEDS (LEEDS)
  - Natasha Merat, Georgios Kountouriotis, Tyron Louw
- WIVW
  - Nadja Schömig, Katharina Wiedemann

VOLVO

Ford

VOLVO

DLR Deutsches Zentrum für Luft- und Raumfahrt German Aerospace Center

UNIVERSITY OF LEEDS

WIVW

(SP3 partners have experience from H-mode, aktiv, HAVEit, interactIVe, SARTRE, D3CoS, CityMobil and our work in SP3 very much starts from this)

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Automated Driving Applications and
Technologies for Intelligent Vehicles

Thank you.

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