Piloting Automated Driving on European Roads

IEDAS 2018
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Raisch, BMW Group
Naujoks, BMW Group
Facts.

- **€68 million BUDGET**
- **48 months DURATION, starting in September 2017**
- **€36 million FUNDING**
- **34 PARTNERS**, among them OEMs, suppliers, research, SMEs, insurers, authorities and user groups
- **12 COUNTRIES** involved: Austria, Belgium, France, Finland, Germany, Greece, Italy, Netherlands, Norway, Sweden, Switzerland, UK

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 723051.
Partners.

OEMs
- VOLKSWAGEN
- BMW GROUP
- FCA
- DAIMLER
- PSA
- GROUPE RENAULT
- HONDA
- JAGUAR
- LAND ROVER
- TOYOTA
- FORD

Suppliers
- Autoliv
- DELPHI
- FEV

SMEs
- ADAS Management Consulting
- eict

Researchers
- bast
- DLR
- German Aerospace Center
- INSTITUT FÜR KRAFTFAHRZEUGE
- RWTH AACHEN UNIVERSITY
- Chalmers University of Technology
- Centre for Applied Research
- UNIVERSITY OF LEEDS
- UNIVERSITY OF WARWICK
- VTT
- WIVV
- UNIVERSITÀ DEGLI STUDI DI GENOVA

Insurers
- Allianz
- Swiss Re

Authority
- RDW

User group
- FIA

Driving Automation
From euroFOT to L3Pilot.
1,000 drivers 100 cars 10 European countries Piloting Automated Driving on European Roads.

Methodology

Data

Evaluation

Fleet

Piloting

Code of Practice

PREPARE

DRIVE

EVALUATE

Traffic Jam

Motorway

Parking

Urban
Pilot across Europe.
SP2 „Code of Practice“. Objectives, Partners & History.

Provide a comprehensive guideline with best practices for the development of functions: Code of Practice for automated driving.

- Collect best practices on relevant topics.
- Describe a typical process for an automated driving function.
- Include hands-on checklists.
- Include safety aspects and methods to confirm a safe operation of automated driving functions.

Partners: Daimler (Lead), BMW, CRF, Ford, Jaguar Land Rover, Opel, PSA, Renault, Toyota, Autoliv, Aptiv, RWTH Aachen University (ika)
According to SAE document J3016, “Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles”, revised 2016-09-30, see also http://standards.sae.org/j3016_201609
Categories of the CoP.

<table>
<thead>
<tr>
<th>Operational Design Domain</th>
<th>Operational Design Domain</th>
<th>Safe Guarding Automation</th>
<th>Human-Machine Interaction</th>
<th>Behavioral Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicle Level</td>
<td>Traffic System Level</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Function description, system limits, test-/scenario catalogue</td>
<td>Remote assistance, V2X, MRM etc.</td>
<td>Functional safety, cyber security, SOTIF, updates (e.g. over the air) etc.</td>
<td>Provide guidelines for HMI, mode awareness/confusion, controllability etc.</td>
<td>Traffic safety (mixed traffic), references to Ethics</td>
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</tbody>
</table>

Code of Practice Framework.

Categories

Development Phases

- Definition Phase
  - Concept Selection
  - Proof of Concept
- Design Phase
- Verification
- Validation & Sign off
- Post Start of Production Phase

- Requirements Specification
- System Specification
- Start of Production
Example 1: Safe Guarding Automation. SOTIF - Safety in Use Analysis.

Development Phases

**Definition Phase**
- Function / System safety requirements
- Safety in Use analysis

**Concept Selection**
- Architecture selection
- Fallback strategy

**Proof of Concept**
- Trigger events assessment
- Combinations simulation proof of work

**Design Phase**
- Functionality refinement
- Root cause analysis

**Verification**
- Testing of functionality

**Validation & Sign off**
- Safety validation

**Post Start of Production Phase**
- Field Operational Test

**SOTIF**

Finding safety use cases (foreseeable (mis-)use)

Safety in Use Analysis
- V&V methods to prevent unintended (mis-)use
- Field observation

Effectiveness Analysis

Requirements / Measures

Remaining Risk Analysis

Validation

- **Goal**: Establishment of a comprehensive and easy-to-use checklist to assess the compliance of HMIs of AVs with most important best practices and standards
L3 HMI Checklist. 
Summary of checklist topics.

<table>
<thead>
<tr>
<th>Evaluation-Criterion</th>
<th>Level of information processing</th>
<th>Noticing the message</th>
<th>Information processing</th>
<th>Action selection</th>
<th>Action implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corresponding items of expert evaluation checklist</td>
<td>- Indications of system mode</td>
<td>- Display installation and information presentation</td>
<td>- Legibility</td>
<td>- Colour coding</td>
<td>Out of scope of expert assessment</td>
</tr>
<tr>
<td></td>
<td>- Design of auditory and vibrotactile messages</td>
<td>- Understandability</td>
<td>- Design of warning messages</td>
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</tbody>
</table>
# L3 HMI Checklist: Expert Assessment Test Procedure - Checklist items

<table>
<thead>
<tr>
<th>Area / purpose</th>
<th>Item</th>
</tr>
</thead>
</table>
| **Operational principles:** | Guideline #1: Unintentional activation and deactivation should be prevented.  
- System operation controlled by driver  
- Necessary mode indicators are present in the HMI  
Guideline #2: The system mode should be continuously displayed.  
Guideline #3: Mode changes should be effectively communicated. |
| **Display installation and information presentation** | Guideline #4: Visual interfaces used to communicate system states should mounted to a suitable position and distance. High-priority information should be presented close to the driver’s expected line of sight  
- Displays are mounted at suitable positions  
- Visual workload of information search is minimized  
Guideline #5: HMI elements should be grouped together according to their function.  
Guideline #6: Time-critical interactions with the system should not afford continuous attention. |
| **Colour coding:** | Guideline #13: Not more than five colours should be consistently used to code system states (excluding white and black).  
- Promoting intuitive understanding  
- Avoiding colour blindness issues  
Guideline #14: The colours used to communicate system states should be in accordance with common conventions and stereotypes.  
Guideline #15: Design for colour-blindness by redundant coding and avoidance of red/green and blue/yellow combinations. |
L3 HMI Checklist.
Example: Colour Coding.

- **Guideline #15: Design for colour-blindness by redundant coding and avoidance of red/green and blue/yellow combinations.**

<table>
<thead>
<tr>
<th>Statement</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Redundant coding is required (e.g. in case of colour-blind people).”</td>
<td>[18], S.48, NFR4A_UNI.4</td>
</tr>
<tr>
<td>“Red/green combinations are avoided. Blue/yellow colour combinations are avoided.”</td>
<td>[17], S.13</td>
</tr>
<tr>
<td>“Red/Green and Blue/Yellow codings should be avoided. Combinations of Blue and Red from the extreme end of the visible spectrum should also be avoided.”</td>
<td>[11], S.338</td>
</tr>
<tr>
<td>“Red/green and blue/yellow combinations should be avoided since these colour combinations might be confusing for people who are colour blind.”</td>
<td>[15], S.21</td>
</tr>
</tbody>
</table>

[17]: Stevens, A., Cnyk, S.: Checklist for the assessment of in-Vehicle information systems, Research Laboratory (2011)
[18]: AdaptIVe D3.3 (2017)
Thank you for your kind attention.

Florian Raisch, BMW

Special thanks to all L3Pilot SP2 partners and F. Naujoks (BMW Group), S. Hergeth (BMW Group), A. Keinath (BMW Group), K. Wiedemann (WIVW) and Nadja Schömig (WIVW) for proving input to the presentation.

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