Code of Practice

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Robert Martinez v. Bülow, BMW Group
History of the Code of Practice (CoP).
Why do we need a Code of Practice for automated driving?

• The transition from low level automation (ADAS) to high level automated driving requires significant technical developments involving new technologies.
Why do we need a Code of Practice for automated driving?

- New challenges in development need to be addressed in order to ensure safest possible product for the users:
What is our goal?

Provide a comprehensive guideline with best practices for the development of AD functions:

**Code of Practice** for automated driving.

- Collect best practices on relevant topics.
- Describe a typical development process for an automated driving function.
- Include hands-on checklists for developers.
Scope of the Code of Practice for Automated Driving.

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

Extend to selected non-EU regions

Extend to selected level 4/5 robot taxi applications

Extend to driving scenarios in urban / rural environment
Categories of the CoP:

• Categories of the CoP according to D2.1 „Code of Practice Framework“¹:

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

Code of Practice Framework.

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
  - Combinatorial simulation, proofworking

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

- **Verification**
  - Testing of functionality

- **Validation & Sign off**
  - Safety validation

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

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

Safety in Use Analysis

- **Validation**
- **Remaining Risk Analysis**
- **Requirements / Measures**
- **Effectiveness Analysis**
- **V&V methods to prevent unintended (mis-)use**

Field observation

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Example 2: Human-Machine Interaction.
L3 HMI Checklist.

- **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.
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>Colour Coding Requirement</th>
<th>Source</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.

Robert Martinez v. Bülow, BMW

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L3 HMI Checklist. Summary of checklist topics.

**Evaluation-Criterion**

- **Level of information processing**
- **Noticing the message**
- **Information processing**
- **Action selection**
- **Action implementation**

**Corresponding items of expert evaluation checklist**

- Indications of system mode
- Display installation and information presentation
- Design of auditory and vibrotactile messages
- Legibility
- Colour coding
- Understandability
- Design of warning messages

Out of scope of expert assessment
L3 HMI Checklist.
Expert Assessment Test Procedure - Checklist items.

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