Designing Safe Automated Driving Functions - Challenges from the legal framework
## Overview

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Motivation: why dealing with automated driving now?

Technology advances are visible
- Driver assistance systems become more sophisticated and more widespread
- Research demonstrates that higher level of automation will become feasible

Public interest is growing
- Considerable public attention for demonstrators > DARPA Grand Challenges
- Government projects on technology and legal implications are ongoing / emerging
- State of Nevada has initiated legislation (most recently also Florida)

It is promising
- Attractive customer functions
- Can help on traffic flow management and contribute to CO2 savings
- Human error is the major course of accidents: in the long run can help prevent accidents

It is a long way to go
- Technology and boundary conditions (e.g. legal) should be tackled in parallel
- In both areas there are still significant challenges
What is automated driving?
General Categories of Automation
(defined by BASt Expert Group)

- **Driver assistance**
  - Reference point
  - Driver exerts full control of the vehicle

- **Partly automated**
  - Driver needs to permanently supervise automated functions, no non-driving related activities

- **Highly automated**
  - System will recognize its performance limits and request driver to take over control with sufficient warning time
  - Non-driving related activities possible to some degree

- **Fully automated**
  - System can cope with all driving situations
  - No supervision by driver necessary
  - Non-driving related activities possible, also vehicle without driver

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Additional Differentiation of the Application Range

- Functions at low speeds (e.g. < 10kph)
- Only minimal risk of injuries
- e.g. automated parking

- Functions that can be accomplished within few seconds
  - e.g. lane change or passing a single vehicle

- Function that stays „ON“ for a longer period of time
  - e.g. longitudinal + transversal control on highway
<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parking assistant</td>
<td>• Driver-initiated automated parking.</td>
</tr>
<tr>
<td></td>
<td>• Driver needs to supervise continuously, must interrupt if necessary.</td>
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<tr>
<td>Passing assistant</td>
<td>• Driver-initiated automated passing (single maneuver)</td>
</tr>
<tr>
<td></td>
<td>• Highway only</td>
</tr>
<tr>
<td></td>
<td>• Driver needs to supervise continuously and retain control as necessary</td>
</tr>
<tr>
<td>Construction site</td>
<td>• Automated longitudinal and transversal control</td>
</tr>
<tr>
<td>assistant</td>
<td>• Construction sites on highways only</td>
</tr>
<tr>
<td></td>
<td>• Driver needs to supervise continuously and retain control as necessary</td>
</tr>
<tr>
<td>Lane change chauffeur</td>
<td>• Driver-initiated automated lane change</td>
</tr>
<tr>
<td></td>
<td>• Highway only</td>
</tr>
<tr>
<td></td>
<td>• Driver does not need to supervise</td>
</tr>
<tr>
<td>Highway chauffeur</td>
<td>• Automated longitudinal and transversal control</td>
</tr>
<tr>
<td></td>
<td>• Highway only</td>
</tr>
<tr>
<td></td>
<td>• Driver does not need to supervise, will be requested to take over control in due time</td>
</tr>
<tr>
<td>Parking pilot</td>
<td>• Automated valet parking.</td>
</tr>
<tr>
<td></td>
<td>• No driver resp. driver goes away from vehicle</td>
</tr>
<tr>
<td>Automated emergency</td>
<td>• Automatically bringing the vehicle to a safe state if driver becomes unconscious etc.</td>
</tr>
<tr>
<td>stop</td>
<td></td>
</tr>
<tr>
<td>Highway pilot</td>
<td>• Automated longitudinal and transversal control</td>
</tr>
<tr>
<td></td>
<td>• Highway only</td>
</tr>
<tr>
<td></td>
<td>• Driver does not need to supervise, no need to take over control</td>
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Legal and Liability Issues with Automation
Results from BASt Expert Group

Consistency with Regulatory Law (Regulatory Law = National Road Traffic Codes)

- Partial automation remains in line with today’s situation
- High and full automation (i.e. taking the driver ‘out of the loop’) will lead to a breach of the driver’s duties
- Cross-check with (other) national regulatory law necessary!

A change of the basic model
„Driver – Vehicle“ through automation

What has to be changed now?

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Legal and Liability Issues with Automation
Results from BASt Expert Group

- Liabilities
  a) Road Traffic Liability >> not fully harmonised in Europe – therefore following statements only according to German Law:
     - Liability of the vehicle “keeper”: No limitations in terms of automation-degree identifiable
     - Insurances will be jointly and severally liable with the “keeper” (same as today)
     - Liability of the driver: Restricted to fault >> no longer applicable in case of highly and fully automated vehicle operation
  b) Product Liability > most relevant for manufacturer
     - Damages during highly and fully automated operation mode lead to manufacturer’s liability (in case the accident is not solely caused by ill-driving on the side of a third party)

RESPONSE-projects
- Product Safety: Describing a safe operation of the product
- Functional Safety of E/E-Systems: Safe product in case of failures
ISO 26262 Since 11/2011

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Legal problems and suggested solutions in connection with the development of Driver Assistance Systems

Dr. Juergen Schwarz (Daimler AG)
Product Safety of Driver Assistance Systems

Main focus of IVIS
ABS, ESP/DSC, ...
Vehicle

Main focus of ADAS
Navigation
Determination of Destination and Travel Time

Stabilisation
Operation of throttle, brakes, steering wheel, gear change, ...

Manoeuvring
Mental determination of a collision-free corridor
partly /highly/ fully automated

Distraction
ESoP

Safety approved

Code of Practice

What to do?
law/safety

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A product is defective, if

- it does not provide the **safety that can reasonably be expected** taking into account all circumstances,

  - in particular the presentation of the product,
  - the use of the product that can be expected in faith

How to translate that into the design of automated driving functions?
Challenges for OEMs and Suppliers

Advanced Driver Assistance Systems support the driver in his primary driving task, therefore:

• complex interaction of system and driver in multiple traffic situations

• New challenges for product safety
Complexity – imagine a roundabout
Complexity – imagine an intersection

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Rationale for RESPONSE 3

• What can be done about legal risks linked to ADAS?
  – How to ensure, that the product is \textit{reasonably safe}?
  – How to ensure, that the manufacturer has fulfilled his \textit{duty of care}?
  – What is the state of the art for development and validation of ADAS/automated driving?

The solution: \textbf{Next Code of Practice?}
Rationale for RESPONSE 3

- Codes of good practice play already a role on a European level in product safety law,

- Codes of good practice describe state of art and technology

- The Code of Practice is a guideline for development and validation of "safe" ADAS >> translation of „reasonable safety“ and „duty of care“ into engineering practice

Facilitates market introduction
Content - Overview

- Estimation of controllability problems
- Identification of potentially critical situations
- Specification Framework
- Evaluation of controllability

Controllability final proof
Example of checklist content

<table>
<thead>
<tr>
<th>Phase</th>
<th>Application phase</th>
<th>Yes</th>
<th>No</th>
<th>Not-</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>10. If the use of the equipped vehicle removes the driver from the physical control loop, is this in line with current legislation?</td>
<td>□■□□</td>
<td></td>
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</tr>
<tr>
<td>9. Does the user manual describe system functions, handling and limits in an understandable way?</td>
<td>□□□■</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>8. Are there differences in vehicle behaviour between a vehicle equipped or not equipped with the system which are apparent to other road users?</td>
<td>□□□□</td>
<td></td>
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<tr>
<td>7. Is it possible for the driver to deactivate or overrule a system which assists a driving task at any time?</td>
<td>□□■□</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>6. Have legal requirements and standards been complied with? (ask your homologation or law department for more information)</td>
<td>□■■■</td>
<td></td>
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Conclusions
Product Liability on ITS applications

• To yield optimal product liability prevention there is a need to have a basis to describe
  1. The safe operation of a product > e.g. Standards/Code of Practice for ITS applications
  2. The safety of the product in case of failures > for automotive industry now standardised using ISO 26262

• In principle The Code of Practice approach is possible for all new ITS applications

A Code of Practice facilitates market introduction
Conclusions

Needs for Action > Automated Driving Functions

• Identify legal questions and obstacles
  • Vehicle regulations
  • Code of the road: law addressing the driver
  • Liability considerations
• Avoid that emerging state rules become diverse/contradictory
• Define basic safety requirements
• Seek for a worldwide validation of basic safety requirements.

• It is important to start work on legal issues now in order to avoid a situation that the technology would be ready but not the legal framework
• Cooperation between government and industry is important