Autonomous Driving

Meeting critical factors in times of change

Oktober 2021

Prof. Tjark Siefkes
Ingrediencies of Mobility

Moritz von Schwind: „The Honeymoon Voyage“. Original from 1850. Etching from 1879. Collection Tjark Siefkes
Ingrediencies of Mobility

Human Needs

Energy

Means of Transportation

Source: DLR
The Hierarchy of Human Needs

- **Fundamental Physiological Needs**
  - Food, Water, Oxygen, Sleep

- **Safety & Security Needs**
  - Health, Income, Property, Morality, Freedom of Fear

- **Social Needs**
  - Connection, Friendship, Trust

- **Cognitive Needs**
  - Knowledge, Confidence, Self-esteem, Respect

- **Aesthetic Needs**
  - Order, Beauty

- **Self-actualization**
  - Realization of own Potential

Ingredients of Mobility

Human Needs

Means of Transportation

Energy

Means of Transportation
Digitization in the Automotive Industry

“The number of transistors in a dense integrated circuit doubles approximately every two years” Gordon Moore, 1965.

Illustrated for a 1971 VW Beetle:

<table>
<thead>
<tr>
<th>1971</th>
<th>2021</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Speed (Performance)</td>
<td>b) Costs</td>
</tr>
<tr>
<td>120 kph</td>
<td>4 Billion kph</td>
</tr>
<tr>
<td>2900 Euro</td>
<td>0,14 Euro</td>
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Foto: Classic Driver Market
How does driverless Driving affect the Transport System?

**Potential Benefit**
- Reducing mileage and number of vehicles through
  - **Bundling** of trips (Ridesharing)
  - **Modal shift by linking different modes**, more use of bicycles, pedestrian traffic, public transport
- Optimization of traffic flow (**low energy consumption; reduction of traffic jams**)
- Location of sensors and data processing into infrastructure; shared use
- **New business models**

**Potential Risk**
- Mileage and number of vehicles increase through
  - **Ease of driving**
  - **Empty trips** (mobility on demand); it could even be that the average occupancy level drops below 1
  - In the event of a **malfunction**: Dependence on specialist staff
  - **Higher average speed** (motorways)
  - **Increased energy consumption** of sensors and IT

*Source: DLR*
Mobility Areas in Germany

- Suburban
- Suburban + Rural
- Example Motor Vehicle Traffic: Decrease | Increase 2010 to 2040

Source: DLR
Connected and Automated Driving in Real Traffic in Germany

26 Digital Mobility Test Fields
142 Digital Mobility Projects
Application Platform Intelligent Mobility & Test Field Lower Saxony

- **Various types of roads** (280km)
- **Road capturing units** – anonymized acquisition of traffic objects and their trajectories → Ground Truth
- **Communication technology** – Car2X via WiFi 802.11p and cellular radio
- **Maps** – highly accurate and up-to-date for simulations and real vehicles
- **Scenarios and models** – parameterizations and sub-models for setting up ecologically valid simulations
- **Interfaces to signal and detection technology and to information systems** – connection to traffic control technology or traffic management
- **Background systems** – data management and provision of online services
- **Cadastre for the condition of the test field** – documentation of the test field quality

Source: DLR
Application Platform Intelligent Mobility & Test Field Lower Saxony
Finding Solutions for an extreme high Amount of Challenges

Challenges are e.g.
✓ Dealing with uncertainties
  ▪ in the detection area
  ▪ outside the detection area
✓ Dealing with unknown situations
  outside the defined operational design domain (ODD)

Solution approaches e.g.
✓ Technical supervision
✓ Remote operation
✓ Car to Infrastructure Connectivity
✓ Comprehensive fleet learning

Example: Technical Supervision - Minimum Risk Maneuver, MRM
The Big Picture
The Challenge of Decoupling and how CCAM* can help

Source: Conference of European Directors of Roads (CEDR), Working Group Connectivity, Automation and Data (CAD)

*CCAM: Cooperative, Connected and Automated Mobility
Autonomous mobility in urban and suburban areas. Source: DLR
Introducing Industry 4.0 into Mobility
Towards 24/7 Operation – Taking Mobility to a Higher Level

Four Design Principles
• Interconnection
• Information transparency
• Technical assistance
• Decentralized

Four Major Technology Components
• Cyber-physical systems
• Internet of things (IoT)
• On-demand availability of computer system resources
• Cognitive computing

Managed Automated Driving

Source: DLR
U-Shift, size: 3.5t.
Source: DLR
U-Shift

Economical Urban Mobility Concept

24/7

Modularization “on the road”

High flexibility and adaptability
Managed Automated Driving  
Increase of Complexity and Benefits

Location of Data Processing  
many variants: vehicle, infrastructure, cloud

Data Security  
• Technology for anonymization - privacy by design, e.g. faces / license plates  
• Protection against unauthorized access - security by design  
• Regulation of access rights  
• Legal regulation like GDPR

Acceptance / Certification

Ownership & Operation

Business Models

Possible architecture concept for managed automated driving with control center, data processing in the cloud.
Managed Automated Driving
Increase of Complexity and Benefits

Higher safety and efficiency in mixed traffic

Local zoning

Stepwise introduction!

Possible architecture concept for managed automated driving with control center, data processing in the cloud.

Picture: DLR
Automated Driving Technologies
Technical Roadmap & Guidance for Industry

Click & Learn “Upcoming Technologies”

Pilot Point “Transformation Knowledge”

https://www.transformationswissen-bw.de/technologiekalender-app#/

Source: DLR
The Hierarchy of Human Needs
Dialogue with Civil Society

Technology or a transport innovation alone does not lead to a transformation of the transport system. User acceptance makes the difference.

Mission
• Active dialogue on the vehicle concept with potential future users
• Recording of ideas for use cases of the U-Shift as well as related questions and suggestions
• Enable room for questions and feedback

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