Fahrzeugkonzepte und Technologien der nächsten Generation
Vehicle concepts and technologies of the next generation

5. Automotive Photonics, 14. Februar 2019, Ditzingen

Dr.-Ing. Gerhard Kopp
Vehicle concepts - initial situation

- Development of **vehicle production** in selected countries

=> Steadily growing vehicle production in China, South Korea, India, …

Other countries 2016:
- 2.2 Mio. Brazil
- 3.6 Mio. Mexico
- 2.9 Mio. Spain
- 2.0 Mio. France
- 2.4 Mio. Canada
- 1.3 Mio. Russia

Vehicle concepts - initial situation

- Analyze of the proportion of **vehicle classes** according to **population density**

=> No specific vehicles for different purposes and population density

*Proportion of vehicle classes in new registrations for M1 vehicles in Germany 2016 according to population density; (Source: Own description according to approval data; M. Klötze)*
Global Trends and Challenges - Mobility

Traffic jam
- Population growth, urbanization and increase in freight traffic
- Every motorist spends 38 hours a year in traffic jams

Ecological damage
- 18 percent of CO₂ emissions from traffic
- 1.3 kg CO₂-emissions per parking space search

Accidents
- 3,177 fatalities and 388,200 injured in traffic (2017)
- 88 % of accidents due to mistakes of the driver

Mobility in older age
- Demographics: by 2030, the proportion of over-65s in our society will increase from 21 % today to 27.5 %
- More individual, intermodal and efficient through information & communication

Digitalization
- Business models: from product to user-oriented

Source: Prof. Karsten Lemmer, DLR, (2016), "Questions of Future Mobility"

All other information for Germany. Sources: Traffic in Figures 2015/2016; Center for Economics and Business Research 2014; AP COA PARKING Parking Study 2013; Results of the 13th coordinated population projection, Federal Statistical Office; Presentation: especially acatech; Pictures: shutterstock.com: Khongkit Wiriyachan, Vinogradov Illya, OliverSved, Andresr
NEXT GENERATION CAR

driving the future
Systematic approach to solving the challenges

System approach for the future mobility

- Decarbonization (energy and fuels)
- Efficient vehicles (aerodynamic, friction, lightweight construction, …)
- Improved logistics and passenger transport
- Infrastructure (energy / information / …)
- Public transport and multimodality
- Flexible und shared mobility
- Intelligent traffic management

Picture source: DLR
Challenge - Future Complexity

- Future influence on vehicle concepts

Vehicle concepts and packaging

- Sharing
- Mobility
- Sustainability
- Multi-modality
- Urbanisation
- Health

Infrastructure level

- Communication infrastructure consumption
- Energy supply

- Aerodynamics
- Energy management
- Acoustics
- Electrification
- Alternative energy storage
- Safety
- Lightweight
- Function integration
- Communication technology
- Vehicle use
- Comfort
- Safety
- Driving dynamics
- Automation
- Communication
- Safety / Security
- Flexibility
- Vehicle production
- Economics
- Efficiency

Technological innovations

Mobility sector

Vehicle

Affordable

Silver Society

Resource conservation

Traffic management

Mobility

Flaps

Exterior

HMI / Exterior

Electric / Electronic / „Connectivity“

Affordable

Traffic management

Urbanisation

Multi-modality

Sustainability

Mobility

Sustainability

Traffic management

Multimodality

Urbanisation

Affordable

Silver Society

Resource conservation

Sharing

Vehicle concepts and packaging

Vehicle physics

Powertrain / Energy storage

Car body / Doors / Flaps

Interior / HMI / Exterior

Chassis
Mobility on the way to the future

1. Social challenges and ecology
   Emission ($NO_x$, $CO_2$, etc.), energy, …

2. Technological innovations
   Electrification drive train, safety, digitization and automation, lightweight construction, …

3. New vehicle concepts and production technologies
   Example: Urban vehicle concepts, …
Mobility on the way to the future

Social challenges and ecology
Emission (NO$_x$, CO$_2$, etc.), energy, …
Social challenges and ecology

**Emissions and energy consumption**

- **Objectives and planned CO₂-emissions, normalized to NEFZ [g/km]**

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* Till 2016 „actual value”

**Goal:** Decarbonisation of transport sector + ren. energy (Paris)
Social challenges and ecology

- **Emissions** and energy consumption

=> Implementation of renewable energy sources for new vehicles to achieve the 1.5°C C limit

Social challenges and ecology

- **Emissions** and energy consumption

**Greenhouse gases:** significant share of cities\(^1\)

**Pollutants:** burden often far above limits

Restrictions:
- Europe: 500 measures in 40 cities
- 15 cities with city toll today
- China (for example Beijing, Guangzhou)
  Issuing license plates as an inventive for new energy vehicles
- London: “Ultra Low Emission Zone“ from 2020
- Paris: Low Emission Zone is tightened
- Stuttgart: From 2018 - driving bans for diesel vehicles\(^2\)

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\(^1\) C40 http://www.c40.org/researches/deadline-2020
Social challenges and ecology

- Emissions and energy consumption

Source: THGNV-Szenario des Energiebedarfs im Verkehrssektor; Szenario für einen treibhausgasneutralen Verkehr im Jahr 2050, Treibhausgasneutrales Deutschland im Jahr 2050, Umweltbundesamt 2014, https://www.umweltbundesamt.de/publikationen/treibhausgasneutrales-deutschland-im-jahr-2050-0; 15.06.2018
Mobility on the way to the future

1. Social challenges and ecology
   Emission (NO\textsubscript{x}, CO\textsubscript{2}, etc.), energy, …

2. Technological innovations
   Electrification drive train, safety, digitization and automation, lightweight construction, …
Technological innovations

- **Electrification** drive train

Source: Own compilation from different sources, in the context of the study "Ökonomischer und ökologischer Nutzen des Konzept-Leichtbaus: Ungenutzte Potentiale heben" for the Landesagentur Leichtbau BW, 2018/2019
Technological innovations

- **Electrification** drive train - Lower specific energy densities of alternative storage media and novel vehicle architectures / platforms

=> Variety of drive train and energy storage rises

Technological innovations

- **Safety** - example of road vehicle structures
Technological innovations

• Safety - combination of active and passive safety – scenario side impact

"Following non-intelligent" vehicle or commercial vehicle

According to certification requirements

Structural weakened long beam with active energy absorber
Technological innovations

- Digitization and automation

Roadmaps for different scenarios of automation in road traffic

Level 5
- Fully Automated Private Vehicles
- Driverless driving

Level 4
- Cargo Parc Pilot
- Highway Autopilot
- Semi-Autonomous Cars
- Urban driving

Level 3
- Highway Chauffeur
- Driving on highway
- Traffic Jam Chauffeur
- City Pilot

Level 2
- Traffic Jam Assist
- Park Assist

Technological innovations

- Digitization and automation

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**Evolution of autonomous car sales by level of automation**

<table>
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<tr>
<th>Level</th>
<th>Car sales (Mio. units)</th>
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Technological innovations

- Digitization and automation

Highly automated with driver's workplace

Autonomous, driverless

Rinspeed Oasis

Local Motors Olli

Navya Arma

NGC UMV Basic und Cargo Long

NGC UMV People- und Cargomover Long

=> Increasing architecture diversity (derivatives) for different use cases (sharing, public transport, ...).
Technological innovations

• Resource protection / light construction

Source: Own compilation from different sources, in the context of the study "Ökonomischer und ökologischer Nutzen des Konzept-Leichtbaus: Ungenutzte Potentiale heben" for the Landesagentur Leichtbau BW, 2018/2019
Technological innovations

- Resource protection / light construction

=> The combination with an intelligent lightweight design (change of topology) with the right system boundary is necessary

Technological innovations

• Resource protection / light construction

**NGC Save Light Regional Vehicle (SLRV)**
- Metal-foam-sandwich body in white
- Crash safety state of the art of today automotive vehicles (M1 class)
- Body in white mass lower than 90 kg

**NGC Urban Modular Vehicle (UMV)**
- Modular multi-material-design body in white
- Adaptable safety structure with combination of active and passive safety
- Body in white mass lower than 180 kg

**NGC Interurban Vehicle (IUV)**
- Fiber reinforced intensive body in white
- Function integrated FRP (e.g. structure integrated sensors)
- Body in white mass lower than 250 kg
Mobility on the way to the future

1. Social challenges and ecology
   Emission ($\text{NO}_x, \text{CO}_2$, etc.), energy, ...

2. Technological innovations
   Electrification drive train, safety, digitization and automation, lightweight construction, ...

3. New vehicle concepts and production technologies
   Example: Urban vehicle concepts, ...
New vehicle concepts and production technologies

Multiple Urban Use Cases
- Urban / suburban use field
- Concept for different Urban Use-Cases
- Private up to Shared
- People up to Cargo
- Variable interior, ergonomic opening concept, 4 doors

<table>
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<th>Peer-Group</th>
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New vehicle concepts and production technologies

• Modular MMD body in white

  • Modular multi material platform
  • Optimized body structures for electric vehicles in the sense of purpose-design

  • Innovative floor crash module
  • Combined active and passive safety concepts

=> Urban Modular’s six main modules build together different vehicles across a number of different classes and open up new potential for synergies

Modular and safe body design – Modularization Strategy

UMV Basic

UMV Peoplemover

=> Aluminum intensive frame structure with profiles and nodes with functionally integrated sandwich surfaces and flat components in FRP

Modular and safe body design – Modularization Strategy

UMV Basic

UMV Peoplemover

=> Aluminum intensive frame structure with profiles and nodes with functionally integrated sandwich surfaces and flat components in FRP

Modular and safe body design – Modularization Strategy

UMV Basic

Variable greenhouse front

Variable greenhouse rear

Scalable front modules

Scalable rear modules

Length variability

UMV Peoplemover

Modular and safe body design – Modularization Strategy

Modular and safe body design – Modularization Strategy

UMV Basic

UMV Basic greenhouse

UMV Basic BIW

UMV Peoplemover

Modular and safe body design – Modularization Strategy

UMV Basic

UMV Basic greenhouse

UMV Basic BIW

UMV Peoplemover

UMV Peoplemover greenhouse

UMV Peoplemover BIW

Modular and safe body design – Modularization Strategy

UMV Basic

UMV Peoplemover

Battery-Box

New vehicle concepts and production technologies

- Lightweight optimized and flexible structures for vehicle construction

Example strut dome and damper attachment

Conventional approach

Variable component elements

Hybrid approach

Add. Man.

Cast structure

Basic component elements

=> Optimized geometry and material used to adapt to different load requirements and vehicle configurations

Trends in the area of future vehicle concepts

Current vehicles and possible, future developments

- Mass motorization with standard vehicles
- VW Käfer
- Variety and concept variety through platforms, modules and modularization (Customization)
- VW Golf (MQB A / B)
- Flexible and adaptable concepts („Modular-on-the-fly“)
- Use-Case optimized vehicle concepts
- Electrified, highly automated, safe vehicles on optimized platforms („Modular 2.0“)

Picture source: Volkswagen, Airbus, Rinspeed, Navya, StreetScooter, DHL
Summery

Requirements

• Future mobility must be ecologically compatible (sustainable)

• Technologies must be energy efficient

• Vehicles will be electrified, automated and protecting resources
Summery

Requirements

• Future mobility must be ecologically compatible (sustainable)

• Technologies must be energy efficient

• Vehicles will be electrified, automated and protecting resources

Approach

• Increasing efficiency in the field of drive train and energy storage

• Alternative fuels

• Resistance reduction and resource protection (including lightweight construction)

• New approaches in the field of vehicle development and flexible manufacturing processes / production to accommodate the significantly increasing product diversity
Thank you for your attention