Mobility of Tomorrow – Research Topics of DLR-FK

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Mobility of Tomorrow – Research Topics of DLR-FK

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The DLR at a Glance – Aeronautics and Ground Based Transportation?

Locations and Research Areas
The German Aerospace Center (DLR) is the national aeronautics and space research center of the Federal Republic of Germany.

DLR has approximately 8000 employees at 20 locations in Germany and international offices in Brussels, Paris, Tokyo and Washington D.C.

- Aeronautics
- Space Research and Technology
- **Energy and Transport**
- Defence and Security
- Space Administration
- Project Management Agency
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The DLR at a Glance – Aeronautics and Ground Based Transportation?

Superior Goals
• Assurance of mobility
• Protection of environment and resources
• Improvement of safety

Strategic basis elements
• Independent transport strategy
• Extension of the transport-specific range of skills
• Use of DLR internal synergies
• Intensified focus on applications
• Complex systems research
• Design and use of large-scale plant
• Cooperation with excellent partners from industry and science on a strategic basis
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The DLR at a Glance – Aeronautics and Ground Based Transportation?

Challenges for the transport system:

Ecological damage
- 18 percent of CO2 emission attributable to transport sector
- 1.3 kg CO2 on 4.5 km drive when looking for parking space
- Population growth, urbanization and growth of freight transport

Traffic jam
- Every car driver spends 38 hours per year in traffic jam
- cf. average travel speed in Beijing: 7.5 mph

Accidents
- 3,475 fatalities and 393,744 casualties in road traffic (2015)
- 88 percent of accidents are caused by drivers’ mistake

Mobility in old age
- Demography: share of over 65 year-old rises from today 21 percent to 27.5 percent in 2030

Digitalization
- individual, intermodal, efficient through information and communication
- business models are changing from product- to user-oriented

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Institute for Vehicle Concepts – Our Vision

• We count among the best system-institutes in Europe

• We are a nationally and internationally requested provider of research and development services

• We take a leading position in the relationships with our customers and business partners

• We provide through our engineering results significant contributions to the HGF-program

• We make safe and interesting jobs with our most important asset: continuous educated employees
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Institute for Vehicle Concepts – Our Mission

• We research, develop and evaluate

  ...innovative vehicle concepts for road and rail

• Design, development and evaluation of application-oriented technical solutions within the overall vehicle system

• We provide research and development services in the areas
  
  • Increase the energy efficiency
  • Reduction of running resistance
  • Systemic relevant vehicle technologies

• We improve the offer of lectures and the policy consultation by engineer-scientific results
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Institute for Vehicle Concepts – The 6 Fields of Innovation

NEW ROAD VEHICLE CONCEPTS

NEW RAIL VEHICLE CONCEPTS

VEHICLE
- DRIVE AND
- ENERGY

VEHICLE
- ARCHITECTURES
AND
- MATERIAL
ENGINEERING

VEHICLE
- SYSTEMS AND
TECHNOLOGY
ASSESSMENT

DISRUPTIVE CONCEPTS
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Institute for Vehicle Concepts – The 6 Fields of Innovation
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Motivation
• New user and logistics concepts, resource shortage and environmental pollution as well as increasing urbanization require novel vehicle-concepts and technologies.

Research Tasks
• Draft and demonstrators of innovative vehicles concepts
• Research and holistic assessment of new technical solutions

Key Results
• VECTOR21 scenario model for motor vehicle and commercial vehicle drives
• Concept family Next Generation Car (NGC)
  • Urban Modular, Safe Light Regional and Interurban Vehicle
• fuel cell demonstrator
• Modularization and platform strategies
• Urban Vehicle and Mobility concepts
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Motivation
• Mass transport between megacities and energy efficiency set the boundary conditions for rail transport.

Research Tasks
• Novel multiple unit concepts & Increase energy efficiency

Key Results
• Concept family Next Generation Train (NGT)
  • High speed train NGT-HGV
  • Commuter Train NGT LINK with hybrid drive concepts
  • High speed Cargo Train NGT CARGO
• Novel access concept for the middle carriages in double decker design
• Contactless energy transmission (FEÜ) & Wheel-integrated power trains
• Software tools for evaluating high speed traffic potentials HGV, LCA and Modelica-library
• Railway Station Concept Next Generation Station (NGS)
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Motivation
• Disruptive solutions enable new business models and support the transformation process within the automotive industry
• Research on the disruptive mobility and transportation solutions as well as their impact on the future design of vehicle concepts and technologies

Research Tasks
• Identification, derivation and motivation of user oriented vehicle concepts as a result of rising individualization
• Dimensioning of enabling technologies
• Analyzing the individual demand on mobility and transportation of express deliveries, trade and industry
• Revealing of use cases and new business models, consideration of all transportation modes

Key Results
• Skofi Study with the vehicles: FTRM und LHRT
• BMBF-application „MAUDE“: Auto-Dis
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Institute for Vehicle Concepts – Innovation Field: Vehicle Drive and Energy

Motivation
• The combustion engine (hybrid)
• Innovative energy and thermal management is mandatory
• System efficiency for E-mobility

Research Tasks
• Holistic modeling for vehicle energy architectures
• Topics to significantly improve efficiency of future drives
• Novel energy conversion concepts

Key Results
• Robust modular fuel cell systems for drives and Range Extender
• Secondary energy usage with thermoelectric generators
• Brushless rotor supply for electrically excited synchronous traction machine
• Thermal high performance storage for increase of vehicle range (MonoTherm/DuoTherm)
• Integrated thermal management & modeling energy flows with in-house libraries
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Institute for Vehicle Concepts – Innovation Field: Architectures and Material

Motivation

• Changed business models require new vehicle architectures, digitalization and new material and process

Research Tasks

• Lightweight construction concepts and new technical solutions for ground-based vehicles
• Integral processing methods, materials and constructions

Key Results

• CFRP-intensive multi-material design
• Structural sandwich components
• Adaptable crash-safe front module for alternative power trains
• Function integrated lightweight chassis
• Intelligent and safe structures (active and passive)
• Improved component crash test’s methods
• New crash concepts for rail vehicles
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Institute for Vehicle Concepts - Innovation Field: Systems and Technology assessment

Motivation
• Identification of technically feasible and economically reasonable solutions for a networked, sustainable and user-oriented mobility

Research Tasks
• Identification, Derivation, Motivation and Assessment of new vehicle concepts and technologies from a systemically view
• Focus: energy, emission, cost

Key Results
• Scenario model VECTOR21 / Demonstration / Scenario Lab
• Transport and Environment (VEU) / Urban Mobility
• Ecological Balance / Mass flow and emission measurement
• Development of the bus usage concept (Reallabor Schorndorf)
• Incentives for Cleaner Vehicles in Urban Europe (I-CVUE)
• Steering for Key Project "Key technologies for e-mobility"
• Effect on employment and location caused by e-mobility
DLR Meta Projects - NGC and NGT
Multiplier of DLR’s system expertise and technology know-how by cross-linking and integrating research institutes, infrastructures and demonstrators

Development of novel vehicle concepts for future mobility

Demonstration of DLR’s breakthrough technologies

Platform for strategic collaborations with industry and research
The project Next Generation Car (NGC) focuses DLR activities and research for road vehicle technology. Its contents are methods and technologies for a holistic development of road vehicles of the near and far of future:

- Vehicle Concepts
- Vehicle -structures and -materials
- Alternative Drive Technologies
- Chassis Mechatronics
- Energy Management
- Vehicle Intelligence
The project **Next Generation Train** (NGT) focuses DLR activities and research for rail vehicle technology. In the frame of the meta project Next Generation Train all the cross-bounded competences of DLR in the field of conception and technologies of rail vehicles get deployed:

- Innovative rail vehicle concepts
- Lightweight construction and structures (Crash)
- Aerodynamics: wind tunnel makes stability in crosswinds observable
- Simulation of passenger flows / Station infrastructure
- Life cycle cost and high-speed route evaluation
- Simulating energy flows
- System dynamics of wheels and rails
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Institute for Vehicle Concepts – Expertise and Equipment

Research and Development Chain

- Expertise
  - e.g. Concept-Lab
  - e.g. Catia

- Equipment
  - e.g. Calculation / Optimization Clusters
  - e.g. Additive Manufacturing Equipment
  - e.g. Crash-Test Facility, Static Loads Test Facility

Development Methods

- Architectures
- Construction
- Simulation and Optimisation
- Demonstrators: Design and Construction
- Verification and Validation
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Development of an Innovative and Optimized Structure of an Electrified Bus

• The idea of a innovative concept for an urban bus system
• The concept is a bus stopples urban quarter bus system
• Realization of the ideas and approaches as a pilot in real-life operation
• Funded by the ministry of science, research and art of Baden-Württemberg
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Optimized Structure of an Electrified Bus – Requirements and Topology Optimization

Requirements:
• Up to 10 persons
• Max. dimensions: 5m x 2.5m x 2.5m (L x W x H)
• Full electric
• Autonomous driving
• Barrier-free
• Turn Radius: <12m
• Max. Weight: 400kg
• Max. Displacement: <10mm
• Torsional Stiffness: >20kNm/°
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Optimized Structure of an Electrified Bus – Requirements and Topology Optimization

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Design Space(s) & Topology optimization:
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Optimized Structure of an Electrified Bus – Optimization of a Generic Design Structure

Simplified parametric FEM-Model

FEM-Solutions

Results

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<th>Parameter</th>
<th>Case 1</th>
<th>Case 2</th>
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</table>

MasterThesis: A. Muth
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Optimized Structure of an Electrified Bus – Outlook and next Steps

- Adaption of Method to new Design
- Detailing of CAD-Data
- Detailed FEM-Simulation of all Load Cases