VIRTUAL VEHICLE Research Center

Autoative

Rail

Aerospace

HARD FACTS

Founded: July 2002
Staff: > 200 employees
Turnover: EUR 22 million
Location: Graz, Austria

SHAREHOLDERS

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Interdisciplinary Research Topics

- Electrified Powertrain
- Safety and Comfort in Lightweight Design
- Integrated Safety / Autonomous Driving

- HW-SW Co-Simulation (MIL-SIL-HIL) with new System Design Approach
- Integrated Safety: Tool Chain for passive and active Safety to comprehensively assess Driving Assistance Systems
- Control Strategy and Energy Management for Hybrid & Electric Vehicles
Range of Expertise

FIELDS OF RESEARCH

Efficient Vehicle Development
- Electrification
- Integral Safety & Automated Driving
- Energy Management
- Embedded Systems & Advanced Control
- Systems Engineering

Testing and Validation
- HVAC, Comfort, NVH & Friction
- Engine and Powertrain Optimization
- Battery
- Vehicle Safety
- Hybrid HW/SW-In-The-Loop

FACTORS OF SUCCESS

EU Research
- 25 EU Projects
- 9 leading

Non-K
- Contract Research
- FFG Projects

K2 Mobility
- The Solid Basis
- Steadiness

Visibility
- Congresses, Meetings
- GSVF, ISNVH, IAVSD...

Key Player
- In Project Consortia
- Technology Roadmaps

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Selected Topics & Projects
OPTEMUS

Optimized and Systematic Energy Management in Electric Vehicles

Project Goal

Developing an efficient electric vehicle that requires 50% less energy for comfort and 30% less energy for component cooling

Responsibilities of VIRTUAL VEHICLE

- Supporting the development of the CRU (Compact Refrigeration Unit)
- Simulating the refrigeration cycle with different refrigerants
- Modeling of the refrigeration cycle integrated into the cooling system

HARD FACTS

<table>
<thead>
<tr>
<th>Volume:</th>
<th>6.4 m EUR</th>
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<tbody>
<tr>
<td>Duration:</td>
<td>06/2015 - 02/2019</td>
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<tr>
<td>Partners:</td>
<td>15 (Continental, CRF Fiat, ESI, Denso Thermal Systems, etc.)</td>
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Consortium leader

- Coordination
- Dissemination
- Exploitation
Project Goal

Developing wireless sensor networks and applications for citizens and professional users in industry-driven use cases (automotive, rail, aerospace and building)
- Providing tangible demonstrators all over Europe
- Boosting interoperability, standardization and certification of wireless sensor networks and wireless communications

Responsibilities of VIRTUAL VEHICLE

- Supporting the development of automotive applications (wireless update of ECU software, integration platform for wireless sensor networks, interoperability, technology bricks)
- Supporting the development of aviation applications (interoperability, technology bricks)
- Contribution to overall system architecture and know-how transfer

HARD FACTS

Volume: 39.5 m EUR
Duration: 03/2014 - 02/2017
Partners: 58 (Airbus, AVL, Indra, NXP, Philips, Thales, Valeo, Volvo etc.)
**Project Goal**

Developing and demonstrating innovative and energy efficient trucks and load carriers for long distance transport assignments

- Improved load efficiency leading to an overall 25% less energy consumption on a t.km basis
- Lower impact on the road infrastructure
- Hybrid-on-Demand (HoD) driveline

**Responsibilities of VIRTUAL VEHICLE**

- Modular full vehicle simulation based on a model library and variant management
- Component variations for the optimal design of the overall vehicle configuration
- Virtual evaluation of the hybrid-on-demand framework in terms of energy consumption

**HARD FACTS**

- **Volume:** 8.2 m EUR
- **Duration:** 09/2013 – 02/2017
- **Partners:** 14 (Volvo Technology AB, Bosch, TNO, Procter & Gamble, etc..)

Modular hybridization with electrified trailers
Project Goal

epsilon aims to conceptualize and prototype the electric small vehicle of 2020 - 2025

- Specific design for typical transport tasks in urban areas
- Lighter and more energy efficient vehicle that requires less road space than today's sub-compact cars

Responsibilities of VIRTUAL VEHICLE

- Design and development of the powertrain (battery, electric motor, transmission, cooling system)
- Design and development of vehicle thermal management system and heat-ventilation-air-conditioning

Exterior design of the epsilon car

HARD FACTS

- Volume: 3.5 m EUR
- Partners: 9 (fka Aachen, Autoliv, CRF/Fiat, HPL Prototypes, TU Graz, etc.)
EU-Live

Efficient Urban Light Vehicles

Project Goal

Development and application of a systematic approach for efficiently designing, developing and constructing a wide range of L-category vehicles for the urban area (2-, 3- and 4-wheelers)

- Innovative solutions regarding cost-efficient, energy-efficient, low-emission and low-noise electrified powertrains
- Future-proof, flexible and scalable vehicle architectures
- Modular vehicle bodies for different usage scenarios (private, delivery services, sharing fleets, etc.)
- Efficient transfer of expertise from automotive to light vehicle industry

Responsibilities of VIRTUAL VEHICLE

- Virtual demonstrators (requirements, modeling of subsystems, modular simulation for PHEV 3-wheeler, BEV 2-wheeler and innovative 4-wheeler)
- Model design and vehicle dynamics simulation for PHEV 3-wheeler and BEV 2-wheeler
- Contributing to HVAC and cooling concepts for interior and in-wheel motors
- Test of the complete PHEV 3-wheel demonstrator on the acoustic test bench

HARD FACTS

Volume: 6.7 m EUR
Duration: 06/2015 – 05/2018
Partners: 12 (PSA, Peugeot Motorcycles, Continental, Magna Steyr Battery Systems, etc.)

Consortium leader
- Coordination
- Dissemination
- Exploitation
EFFECTIVENESS ASSESSMENT

- Based on real world or generic accident scenarios
- Modular simulation framework
- Continuous simulation from uncritical driving to IN-crash
- Automatic batch processing
- Assessment based on injury criteria (occupant and VRU) using FEM crash simulations
ICOS is an independent Co-Simulation platform for the dynamic integration of CAE modeling tools from various domains.

The complex interaction between the subsystems is realized by advanced coupling algorithms which enables a global system optimization.

A Continuous Development Process

- Designed for a **continuous support of the virtual development process** → the overall system behavior can be analyzed at any time
- Depending on their availability sub models from **different development iterations** and in **different modeling depths** are coupled to form the overall system model
ACoRTA ensures the consistent application of the co-simulation approach during the whole V-Model.

Occurring coupling imperfections, like introduced communication time delays, noisy measurements and data-losses, caused by the incorporation of real-time systems are handled via model-based coupling algorithms.
Automated Driving

RESEARCH TOPICS
in national and international multi-firm research projects

- Functional design and virtual validation of automated vehicles in the concept phase (high speed area)
- Networking of vehicles: Requirements for open source software platform
- Virtual full vehicle protection by simulating the environment

Using real-time Linux

- Analyzing and defining **requirements for the architecture** of the areas **reliability, availability, safety, security** and **efficiency**
- Implementing an **open source software platform** based on real-time Linux for high performance computing
- Creating a **qualification process** for open source software in safety-related automated driving functions
- Considering **dynamic software components** in close cooperation with AUTOSAR for future standards

Virtual Validation ADAS

- **Requirements definition** for specific ADF: e.g. motorway assistant (**Level 2**), motorway chauffeur (**Level 3**),
- **Implementation** of ADF in **simulation** at **system level** (Algorithms: C and Simulink, Simulation: CarMaker) (decision making, path and trajectory planning, low level control lateral and longitudinal)
- Creating virtual validation and test environment for ADAS/ADF functions.
Worker-Centric Workplaces in Smart Factories

Project Goal

Leveraging the large potential added value of manufacturing data, information and knowledge in a worker-centred way

• Developing worker-centric solutions through which workers become the smart element in smart factories, interacting by deploying a flexible smart factory infrastructure
• Increasing problem-solving and innovation skills of workers by providing individual information and using modern information tools
• Increasing cognitive job satisfaction as well as average worker productivity by 10%

Responsibilities of VIRTUAL VEHICLE

Participation in all work packages (particularly in terms of requirements, rolling out, system design and industrialization)

HARD FACTS

Volume: 7.9 m EUR
Duration: 12/2014 – 11/2018
Partners: 15 (Johnson Control, Schaeffler, ThyssenKrupp, etc.)
Systems Engineering at VIRTUAL VEHICLE

- Identification and analysis of potentials and benefits in the application of MBSE
- Consulting and supervision in the adaption of development processes, development methodologies and IT infrastructure for MBSE introduction
- Development of an enterprise-specific MBSE environment (methodology, training and IT tooling)
- Embedded coaching and training for futureSE users and managers

Cross-Industry Key Success Factors

- Enabling system thinking, handling of complex systems
- Providing consistent information & data, re-using knowledge, sustainable cross-linking of information
- Enabling multi-disciplinary collaboration