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VALIDATE –
Virtual Development of Vehicle Systems for Fuel Consumption Reduction in Hybrid Electric Vehicles

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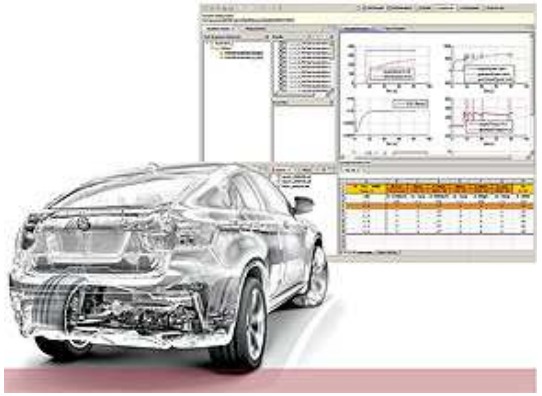
Outline

- Virtual Development
- VALIDATE
- Application Examples
- Expected Results
- Outlook

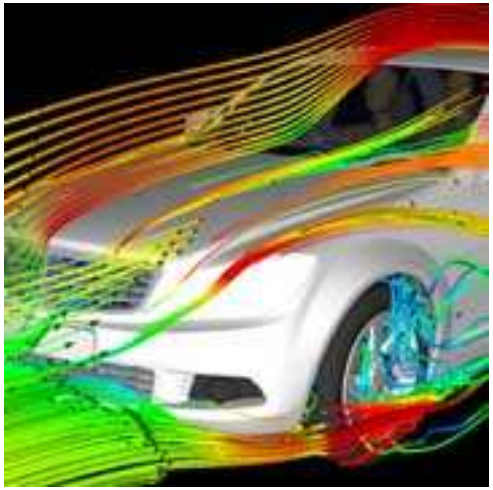
Virtual Development

Source: DLR Braunschweig

Source: Ford / Spiegel online



Source: BMW / ATZ



Source: Mercedes / Spiegel online

Source: TU Darmstadt / Dr. Hoffmann

Source: Uni Duisburg-Essen

Virtual Development

What is?

- Vehicle / System models for simulation (SIL)
- Hardware-in-the-Loop
- Driving simulators – static / dynamic

Why?

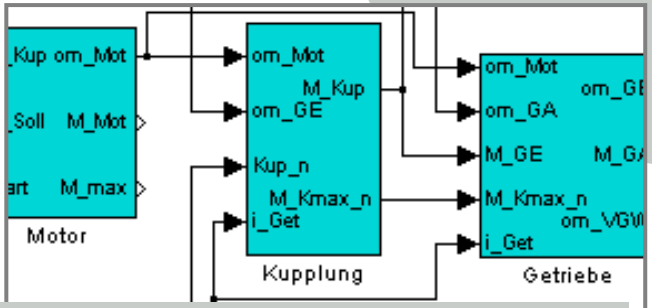
- Assessment of new systems without complete vehicle prototype
- Reproducibility in tests
- Real driver in Virtual Reality – safety aspects
- Cost / Time efficiency

Tools for Virtual Development

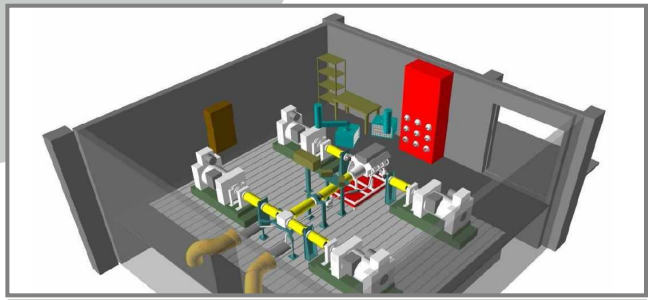
Measurement Vehicle:
Road measurement, driver analysis

Driving Simulator:
Virtual surroundings, real driver

VALIDATE



Prototypes of vehicle control or driver assistance functions



Power train dynamometer:
Real component testing

VALIDATE – Platform for Virtual Development

Virtual Automotive Lab for Integrated Digital Automation Technologies

Funding: 100% by German Federal Ministry of Education and Research (BMBF)

Budget: 3,7 Million Euro

Runtime: July 2008 until June 2011

Partners: IVK, ISV, IHR / HLRS

GEFÖRDERT VOM

Bundesministerium für Bildung und Forschung

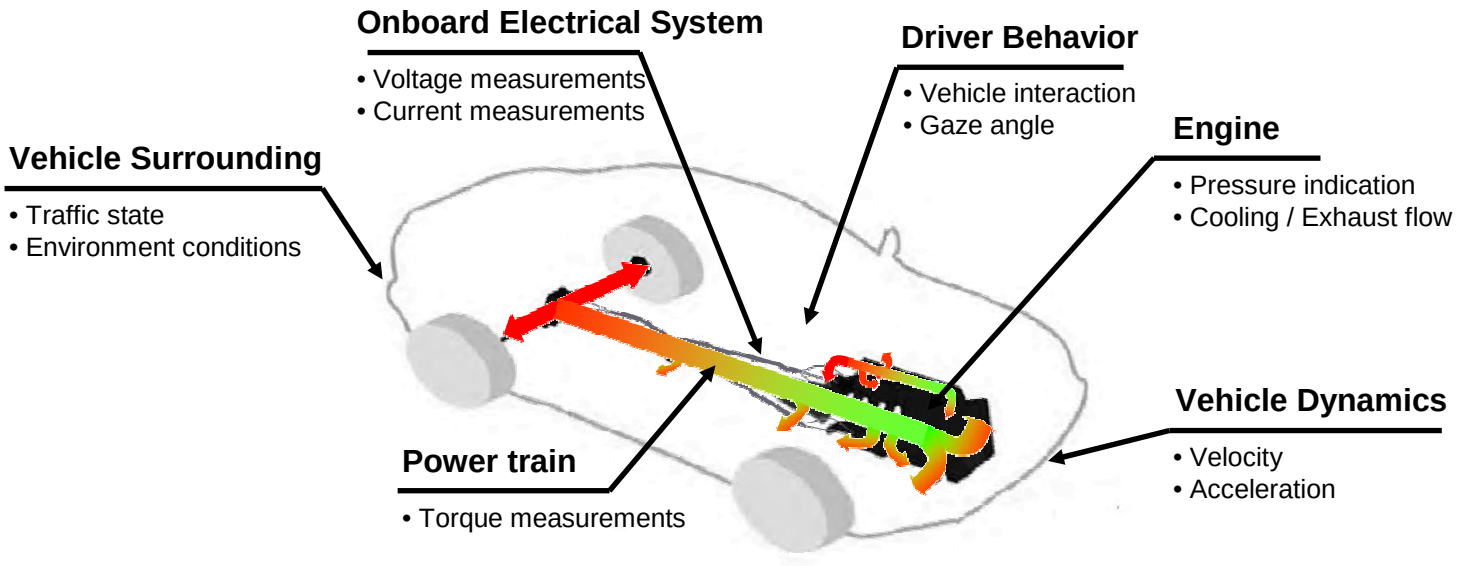
Aim: Building a research platform for the development of electronic control and driver assistance systems to reduce CO_2-emissions in motor vehicles

Universität Stuttgart

IVK

Power Flows during Real Driving

- Series-production vehicle rigged with measurement equipment
- Analysis of existing power sources and sinks and their origin

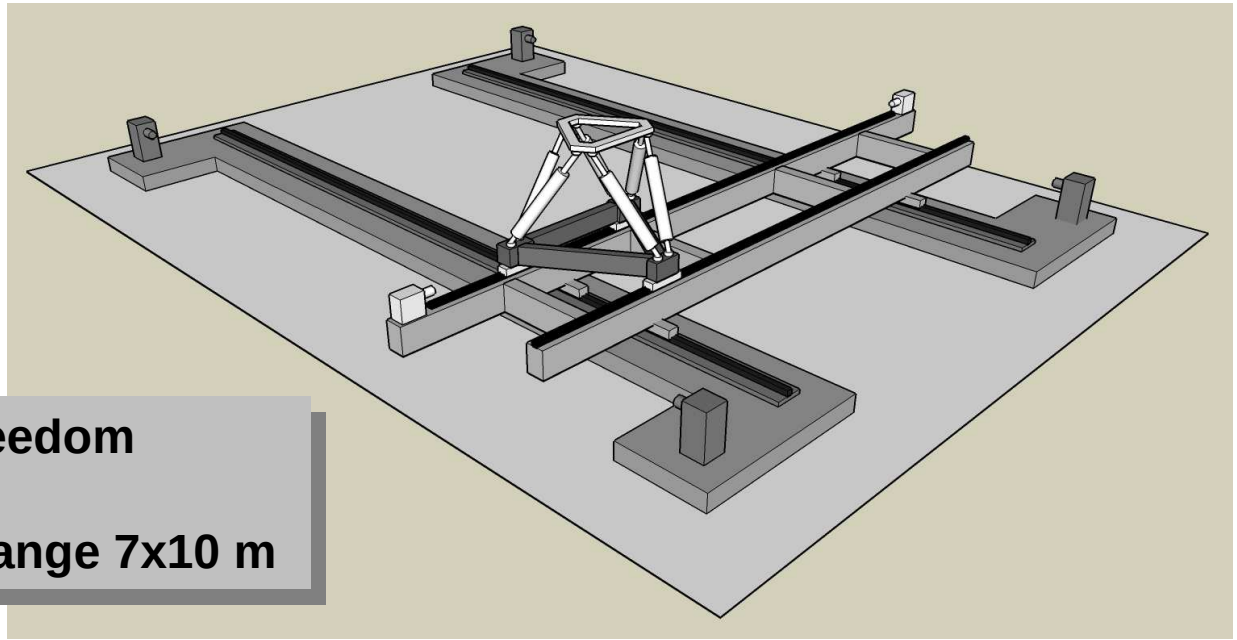


➔ Quantification of power flows and driving resistances for representative load and driver distributions

Stuttgart Driving Simulator

The Motion System: Enables realistic reproduction of longitudinal, lateral and rotational accelerations as experienced in a real vehicle

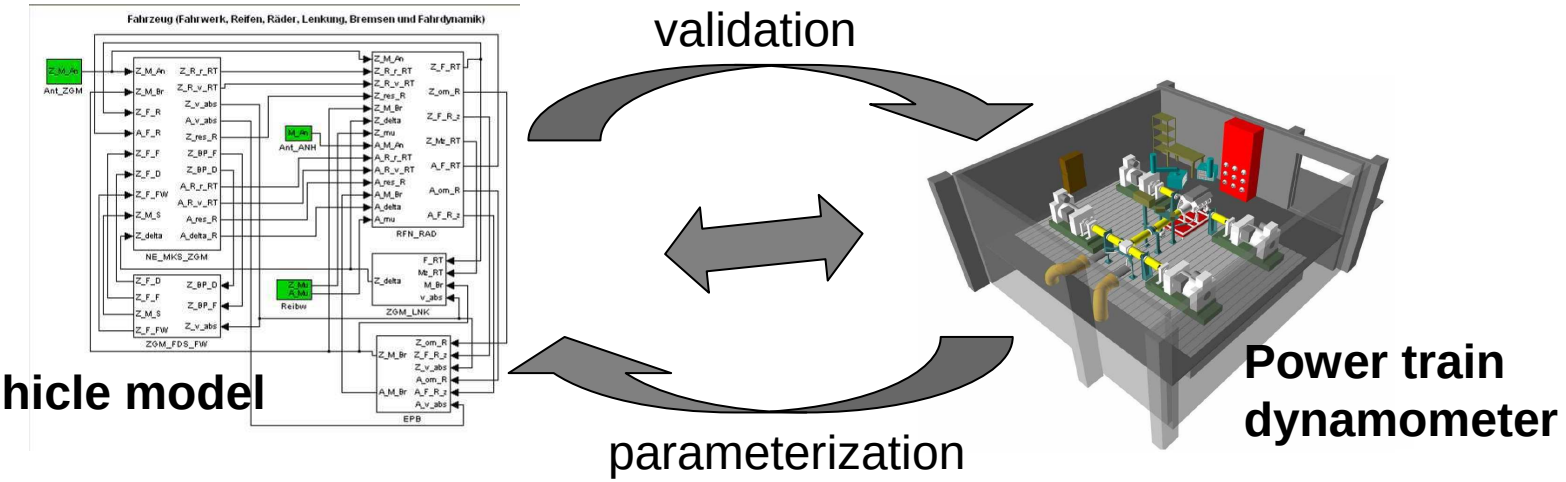
The Audio/Visual System: Enables realistic representation of vehicle, road, and traffic together with authentic engine, tire, and wind sounds.



- **8 Degrees-of-Freedom**
- **Payload 4000 kg**
- **Linear Motion Range 7x10 m**

Real Component Testing

- Linkage of power train dynamometer with driving simulator
- Real components replacing simulations, e.g. engine and drive train, or on-board power system
- Simulation input ⇔ Dynamometer input
- Simulation output ⇔ Dynamometer output



Virtual Development – Application Examples

- Predictive driving
- CNG-Hybrid

Example 1: Predictive Driving

Learning as a human driver:

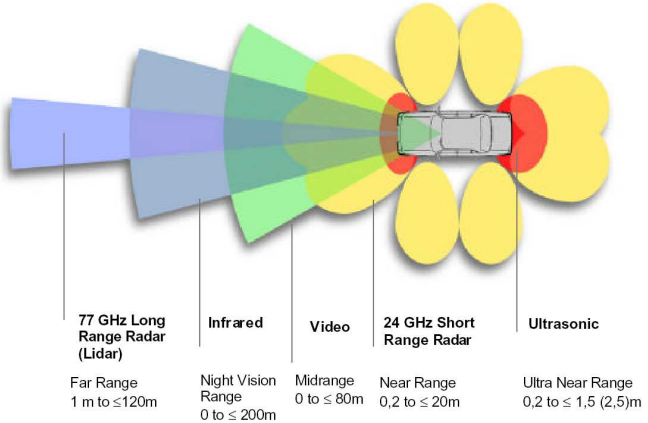
- Registration of the vehicle surroundings
- Remembrance of identified route characteristics

➔Allows early, manual intervention in vehicle control

Electronic learning:

- Evaluation of sensor data
- Storage of identified route characteristics

➔Enables early intervention in automatic control systems, e.g. engine or transmission



Scanning of vehicle surroundings
Source: Robert Bosch GmbH

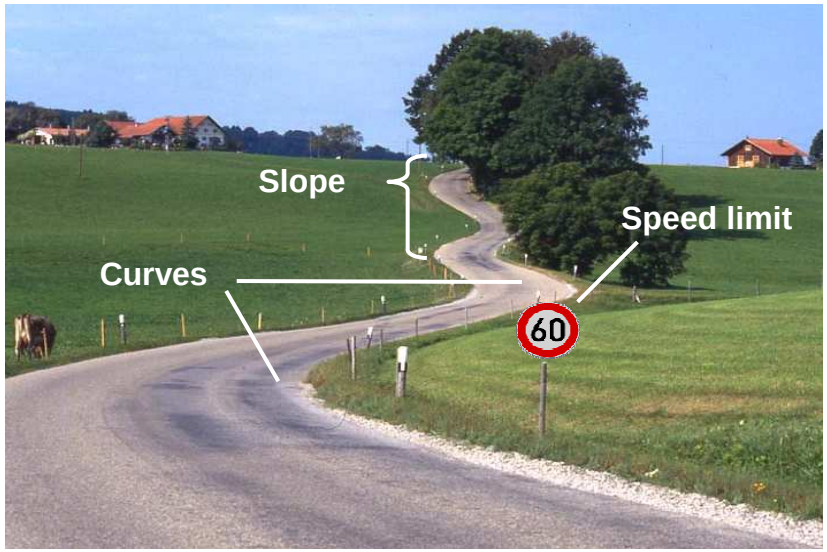
Concept Learning Vehicle

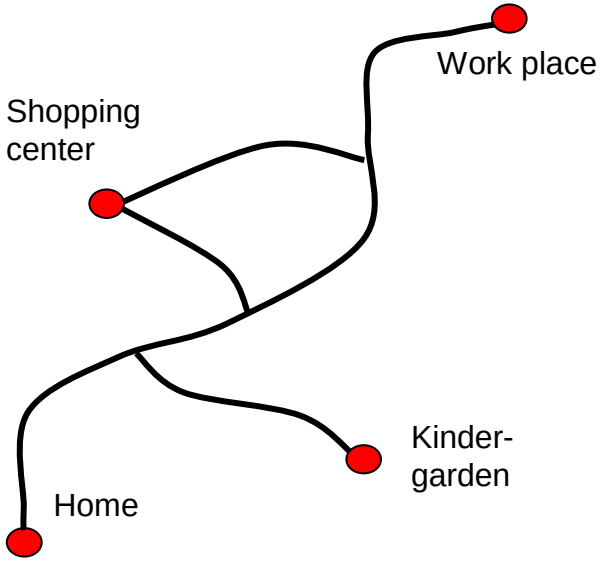
- Identification of route characteristics with basic sensor equipment
- Vehicles mostly driven on limited road network
- Benefits for predictive vehicle control

Trip purpose Germany:

Shopping	41%
Spare time activities	33%
Work/Education	26%

Source: DIW





„A System for the Provision and Management of Route Characteristic Information to facilitate Predictive Driving Strategies"
A. Carlsson, 2008, ISBN 978-3-8169-2912-3

Example 2: Hybrid Software Development

Hybrid coordinator for CNG hybrid vehicle was developed interactively in the existing FKFS simulator

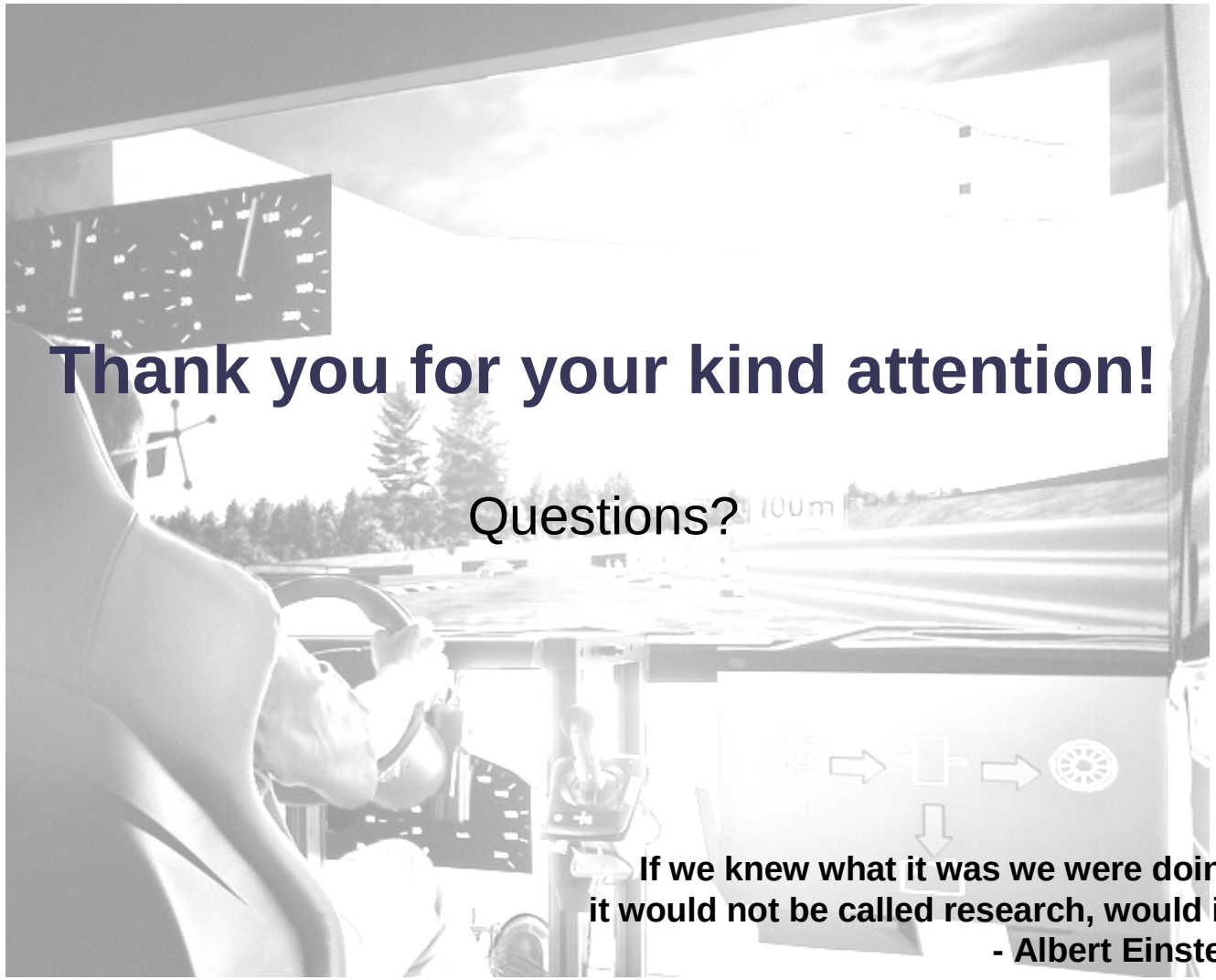
Details: see next presentation

Expected Results

- Better understanding of driver influences on fuel consumption
- Better understanding of acceptance issues of various assistance systems
- Better understanding of the dynamic relationship between control strategies and power train components
- Faster development cycles through quicker feedback on developed systems
- Better understanding of influences of driving comfort and pleasure on fuel consumption

Outlook

- First test drives with measurement vehicle and representative drivers pending
- Implementation of alternative power train configurations in existing vehicle dynamic models
- Development and implementation of predictive strategies for reduction of CO_2-emissions



Thank you for your kind attention!

Questions?

If we knew what it was we were doing,
it would not be called research, would it?
- Albert Einstein