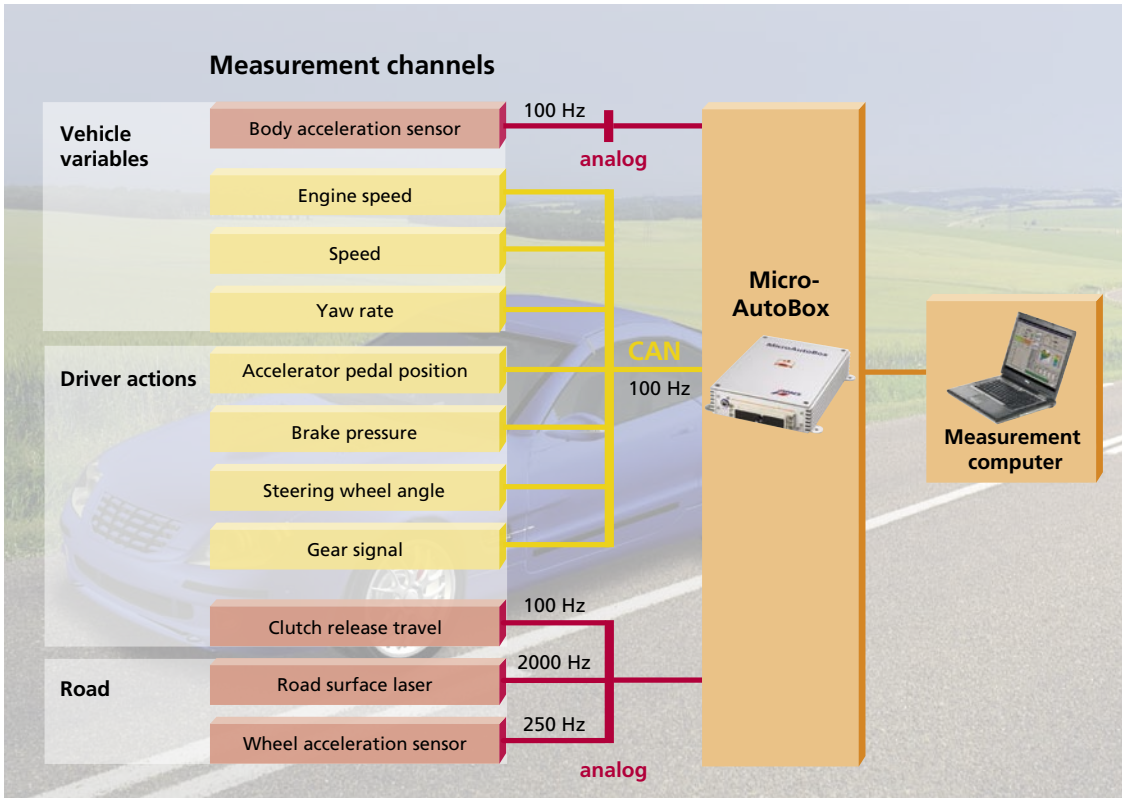
# Customer-Oriented Vehicle Measurements

- Recording driver behaviors
- Statistical data processing for simulating load spectra
- Endurance-test-capable measurement system MicroAutoBox

More and more, life cycle tests on vehicles and vehicle components are being moved forward to the simulation phase, rather than performing later hardware tests. Reliable information is needed for designing component strength, and this includes a precise knowledge of customer behavior. To obtain this information, the Institut für Fahrzeugtechnik (Institute of Automotive Engineering, IAE) at the Technische Universität Braunschweig, Germany, is using dSPACE MicroAutoBox to capture driver actions and driving environment parameters. Statistics derived from this measurement data make it possible to simulate customer-imposed stress at an early development stage.

The stress that inflicts maximum damage on a component and therefore causes minimum durability, called the representative load spectrum, is a key factor in many optimization objectives in vehicles. For example, requirements optimization and efficient vehicle testing are very closely connected with the load spectra that are used. With this in mind, we at the IAE have developed a method that lets us identify the representative load spectra by using a simulation environment. The advantage is that operating loads for the chassis, drivetrain, body, etc. are captured systematically. For the simulation, we draw on an extensive database of vehicle measurements, so we can include all the customer-relevant conditions that a vehicle is subject to, subdividing them systematically into driver, road and vehicle (what we call the DRV method).




▼ *The MicroAutoBox records the measurement channels at different sampling rates.*

## Capturing Characteristic Driving Behavior

The dSPACE MicroAutoBox captures CAN variables such as the accelerator pedal position, steering wheel angle, gear, and brake pressure for various customer types, along with analog measured variables, such as the clutch release travel. At the same time, it records data on the state of the vehicle and the driving environment, so that driver actions can be correlated with particular vehicle and environment properties. As well as vehicle acceleration in three spatial directions,

velocity, and engine speed, the MicroAutoBox also captures, via laser measurement, the height of the road surface irregularities the vehicle drives over. Measuring both tracks provides data on the road surface, so that the stress on the chassis, body, and exhaust system can be assessed. The volume of collected data is manageable, as the individual measurement channels can be recorded at different sampling rates. Using Real-Time Interface from dSPACE, we created Simulink model subsystems for recording the driver's actions at 100 Hz, wheel carrier acceleration at 250 Hz, and road surface irregularities at 2000 Hz. The data was recorded via the experiment software ControlDesk.

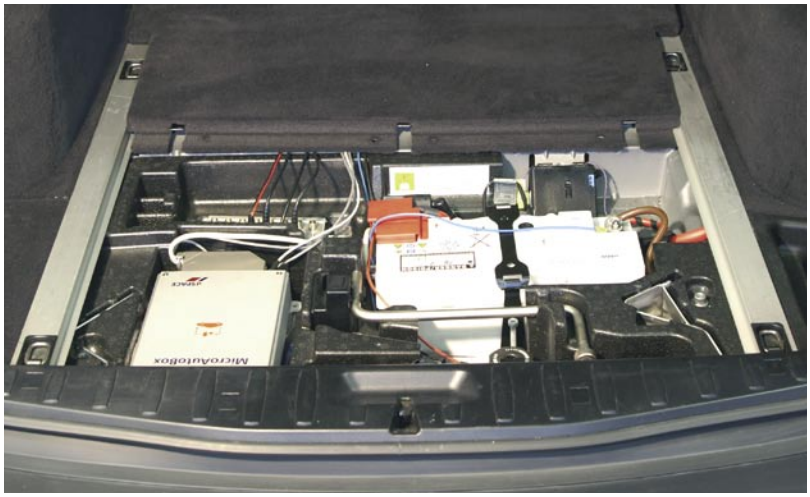
## Driver Statistics Used for Simulation

The obtained measurement values are the basis for simulating driver, vehicle, and road (DRV simulation). Individual driving maneuvers in the time histories are identified, and the significant parameters are collected in statistics. The simulation environment developed by the IAE reconstructs the driving maneuvers from these statistics and uses them to control a virtual vehicle.

*"Natural driver behavior is only possible if the test persons are unaware of the measurement equipment in the vehicle. The compact size of the dSPACE MicroAutoBox 1401 makes it ideal for concealed installation, without compromising its performance and versatility."*

***Hermann Kollmer, TU Braunschweig***

The primary criterion for reconstruction is the orientation speed profile (OSP). These driver statistics describe the vehicle speed at the end of an accelerating or braking maneuver as a function of current speed. They comprise data on the driver's desired speed, and also map the volume of traffic, traffic routing, speed limit, and other road characteristics. Combined with statistics on the accelerator pedal position, gear speed, and brake pressures, this allows customer use of a virtual vehicle to be simulated in simulation runs of any desired length. To determine the operating load spectra, the vehicle model contains detailed mapping of individual assemblies or components (such as the transmission, car body, chassis, or exhaust system) so that the forces occurring during vehicle operation can be calculated. The results of the simulation are operative load spectra for different customer types, which are weighted to obtain the representative load spectrum.



▲ *The entire measurement equipment fits in the trunk of an SUV.*

## Reliable Information

Our project partners are very satisfied with the results that they obtain from the simulation, since these give vehicle manufacturers and automotive suppliers reliable information on vehicle stress by customers at an early stage of development. This has a very positive effect on project costing and scheduling.

In future projects, customer-oriented vehicle measurements will be extended to countries with bad road conditions. And we will again count on MicroAutoBox, the reliable and endurance-test-capable measurement system.

*Hermann Kollmer*
*Andreas Janßen (research assistants)*
*Prof. Ferit Küçükay (Director)*
*Institute of Automotive Engineering*
*Technische Universität Braunschweig*
*Germany*

## Glossary

**Representative load spectrum** –
Causes the minimum permitted component life in customer vehicle use and is therefore the assessment criterion.

**OSP** –
Statistics for describing and reconstructing speed profiles.

**DRV method** –
Systematic approach for identifying driver, road (driving environment), and vehicle.