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dSPACE MAGAZINE

1/2009

Maquet: Artificial respiration controlled by neural activity

Nord-Micro: Developing safety-critical systems for aircraft

Yokohama National University: Innovative vehicle dynamics control for electric cars


Giefersstraße
26
dSPACE
digital signal processing and
control engineering GmbH

Dr. Herbert Hanselmann
President

"The car industry's run by dinosaurs and machos. The dinosaurs can't wake up to new technologies, the others go on producing gas guzzlers. Either way, they're destroying the climate ..." That, at any rate, is an opinion frequently voiced in Germany and elsewhere.

But how many people know that road traffic in Europe amounts to just 12% of total CO_2 emissions, while power plants reach a hefty 43%, and even private homes come in at 14%? And hardly anyone knows it would be much cheaper to reduce CO_2 in power plants than in vehicles – where it's the most difficult. The development and production costs it involves are enormous. Electric cars may be a cherished objective, but it will be decades before such technologies have any measurable effect on the climate. You think wind power will go into your E-car? Electrons are neither green nor black and any increase in wind power could as well be used to reduce CO_2-emitting power generation for industry and households. Only when the last CO_2-emitting power plant is closed will electric energy be pure.

The current attacks on the industry are emotional, unfair, and most often not based on facts. In the past, car makers built vehicles that people wanted. Who can blame them for doing that and creating jobs in a market economy? And gas was cheap, in the US at least. German politicians claim that German and US carmakers slept while some international manufacturers invested and put "green cars" on the market. They should remember that no one wanted to buy the 3-liter version of the Volkswagen Lupo that came out in 1999. And who would have thought that over the last 10 years, General Motors has pumped a billion US dollars into developing fuel cell vehicles? And that they brought an electric car up to production level as early as 1996? No one wanted to buy that, either. For most vehicle types, the advantages of hybrids may well be meager – when hybrids have been compared with other efficient solutions and when their entire life cycle has been assessed, including battery manufacture and disposal. Especially when most driving is done outside towns, as is the case in Germany. Urban fuel consumption is hardly a major factor if only 10% of total kilometers are driven in towns, as is often the case with the now much-maligned large company cars. It always depends where your point of reference is.

Exaggerated political demands are damaging the entire industry. Even leasing companies have been hit, because it's impossible to estimate how vehicles will depreciate. No one knows how much CO_2 or anything else governments will permit in 5 years' time. Consumers prefer to wait and see what happens. And this is fatal, because in order to invest in new technologies, the car industry needs earnings, which were not exactly a hallmark of earlier small cars. Political actions that cause sales to fall dramatically can cause more damage than the effect of slightly more CO_2. Of course we have to press ahead with developing new drive technologies. But with a sense of proportion. Not with a sledgehammer!

Dr. Herbert Hanselmann
President

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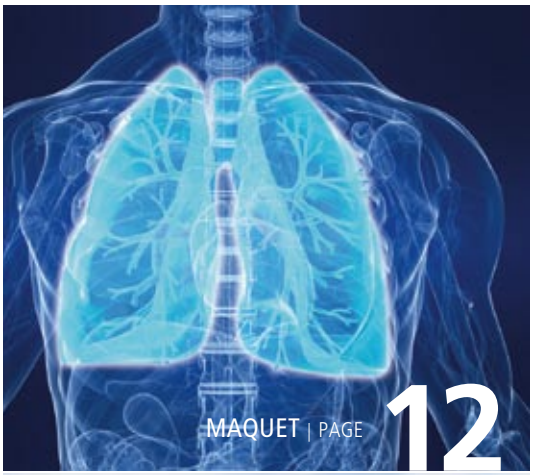

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IMPRINT

dSPACE MAGAZINE is published periodically by:

dSPACE GmbH · Technologiepark 25
33100 Paderborn · Germany
Tel.: +49 52 51 16 38-0
Fax: +49 52 51 6 65 29
dspace-magazine@dspace.com
www.dspace.com

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Responsible in terms of the press law:
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Authors: Ralf Lieberwirth, Sonja Lillwitz, Julia Reinbach, Nina Riedel, Dr. Gerhard Reiß
Co-Workers on This Issue: Alicia Alvin, Holger Krisp, Andre Rolfsmeier, Andreas Tenge

Editors and Translators:
Robert Bevington, Stefanie Bock,
Dr. Michelle Kloppenburg, Christine Smith
Design: Krall & Partner, Düsseldorf
Media Design (Layout) dSPACE: Tanja Raeisi, Sabine Stephan
Print: Merkur Druck, Detmold, Germany

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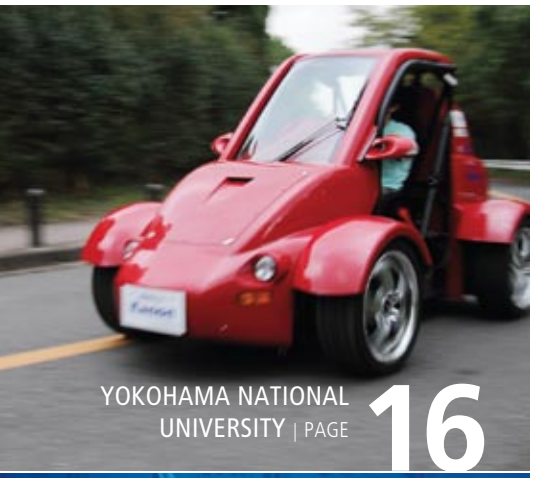

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Maximum Safety

Nord-Micro: TargetLink in many different aircraft types since 2000

In aircraft with pressurized cabins, special valves and control algorithms have to regulate the air pressure with maximum reliability. At high altitudes, the safety of the passengers and crew has top priority. Since 2000, Nord-Micro has been using TargetLink, the production code generator, to develop cabin pressure controls for a wide range of aircraft types. In Nord-Micro's development processes, the autocoded software effortlessly fulfills the strict requirements of aircraft manufacturers such as Boeing and Airbus, and also those of the FAA and EASA aviation authorities.

Cabin Pressure: Safety First

Automatic cabin pressure control in aircraft is one of the functionalities that passengers and crew hardly notice, except during descent and landing. Yet reliable cabin pressure control is of vital importance to the occupants of any plane. Above a certain altitude, they simply would not survive conditions outside the aircraft. So cabin pressure control is not only important for comfort, it is first and foremost a safety-critical functionality that must function without errors at all times. Errors in the control system or a system failure would make it necessary to immediately begin an emergency descent while the plane's occupants reached for their oxygen masks.

Some of the most vital mechanical components in a cabin pressure control system are the electronically controlled air outlet valves, which regulate circulation according to the fresh air intake and also control the cabin pressure via the waste air. These complex valves are precisely adapted to each specific aircraft type.

The software required for valve control is implemented on several electronic controllers. Each controller is connected via a special interface for signal conditioning (a remote data concentrator) to the aircraft data bus, which connects them all to the flight management system (FMS) (figure 1). Sensors in the cabin pick up the air pressure data and pass it to the responsible controllers, and the FMS provides the environment data.

The cabin pressure control system not only ensures that the air pressure stays within predefined limits, it also performs other tasks. These include regulating the pressure change rate, which affects the comfort of the passengers, and protecting the aircraft's outer skin against the damage that might be caused if the difference between external and internal pressure were too great.

Nord-Micro: Successfully Using TargetLink Since 2000

Nord-Micro has many years of experience in developing powerful, reliable cabin pressure control systems, especially for passenger planes seating more than 80. The company has been using TargetLink, dSPACE's production code generator, to develop and autocode controller software since the year 2000. Thus, numerous aircraft, from regional jets to the Airbus A380, have cabin pressure control systems on board that contain controller software developed and autocoded with TargetLink. The safety-critical software developed in this way meets the rigorous requirements defined by aircraft manufacturers and aviation authorities for software used in aircraft, including certification up to safety level A (figure 2). The main standard is DO-178B, which defines the requirements for software development in aviation. In more recent projects, Nord-Micro employed TargetLink as a design and coding tool, and also used TargetLink's extensive test support functionality to facilitate code reviews, module tests on the target, and tool integration with IBM® Rational® Test RealTime (RTR) for analyzing the required code coverage.

Tough Requirements from Aviation Authorities and Aircraft Manufacturers

Because the software developed by Nord-Micro is intended for use in a safety-critical system, TargetLink has to meet numerous requirements regarding the quality of the models and the generated code:

- *Support for Coding Guidelines*
  Nord-Micro and aircraft manufacturers all have coding guidelines aimed at fulfilling DO-178B. Practical experience has shown that TargetLink generates code that meets the specifications. For example, the tool meets the MISRA guidelines which were incorporated into Nord-Micro's in-house coding standard. Special requirements such as enforcing an explicit return statement in every function can also be fulfilled by compliance with a specific modeling style.

- *Code Readability*
  The code generated by TargetLink is clearly structured, and includes easy-to-understand comments and intuitive symbol names. Its good readability makes it considerably easier for Nord-Micro to carry out code reviews.

- *Requirements for Model-Based Design*
  Model-based design is not yet covered by the DO-178B standard. The European and American aviation authorities have therefore started to publish specifications for translating DO-178B requirements into requirements for model-based design. These specifications relate to issues such as meaningful names for signals in models and the modeling style that is used. Using TargetLink, these rigorous specifications are easy to implement.

- *Deterministic Code Generation*
  The efficiency of Nord-Micro's test efficiency benefits from deterministic code generation. This ensures that any changes made to a subfunction have only a local effect, and functionalities that were already tested are not affected by changes to other model segments. One way of doing this is by using an intelligent mechanism for numbering subsystems that restricts code changes to their own location.

- *High Code Efficiency*
  Even at optimization level 0, which is usually used for safety-critical aviation applications, the code generated by TargetLink is efficient enough for the controller to execute it in the required time.

> "TargetLink effortlessly fulfills the rigorous requirements for model-based development issued by European and American aviation authorities."
>
> *Andreas Alaoui, Nord-Micro*

Efficient Development Steps in TargetLink

In the development process at Nord-Micro, TargetLink is not only used for autocoding, but also in the following features and process steps (figure 3):

- ***Definition of Software Requirements***
  Nord-Micro handles the requirements in Telelogic® DOORS®, a requirements management tool, and links them to TargetLink models by means of the requirements management interface from The MathWorks. This ensures that all the work products created during the development process can be traced back to the software requirements.

- ***Model Design***
  For graphical modeling, Nord-Micro uses MATLAB/Simulink/Stateflow/TargetLink, and also a UML tool.

- ***Automatic Scaling***
  By using TargetLink's worst-case scaling analysis for fixed-point arithmetic, Nord-Micro has been able to eliminate numerous errors at an early stage, saving time and money compared with manual coding. TargetLink's worst-case autoscaling functionality has also assisted in the formal verification of Nord-Micro's system software.

- ***Documentation Generation***
  The documentation that TargetLink automatically produces is also a software design document, so Nord-Micro does not have to create one manually. Consistency with the generated code is always automatic. This saves Nord-Micro a considerable amount of work in carrying out the necessary design reviews.

- ***Code Reviews***
  The code reviews carried out at Nord-Micro are greatly simplified by the clear structure, naming,

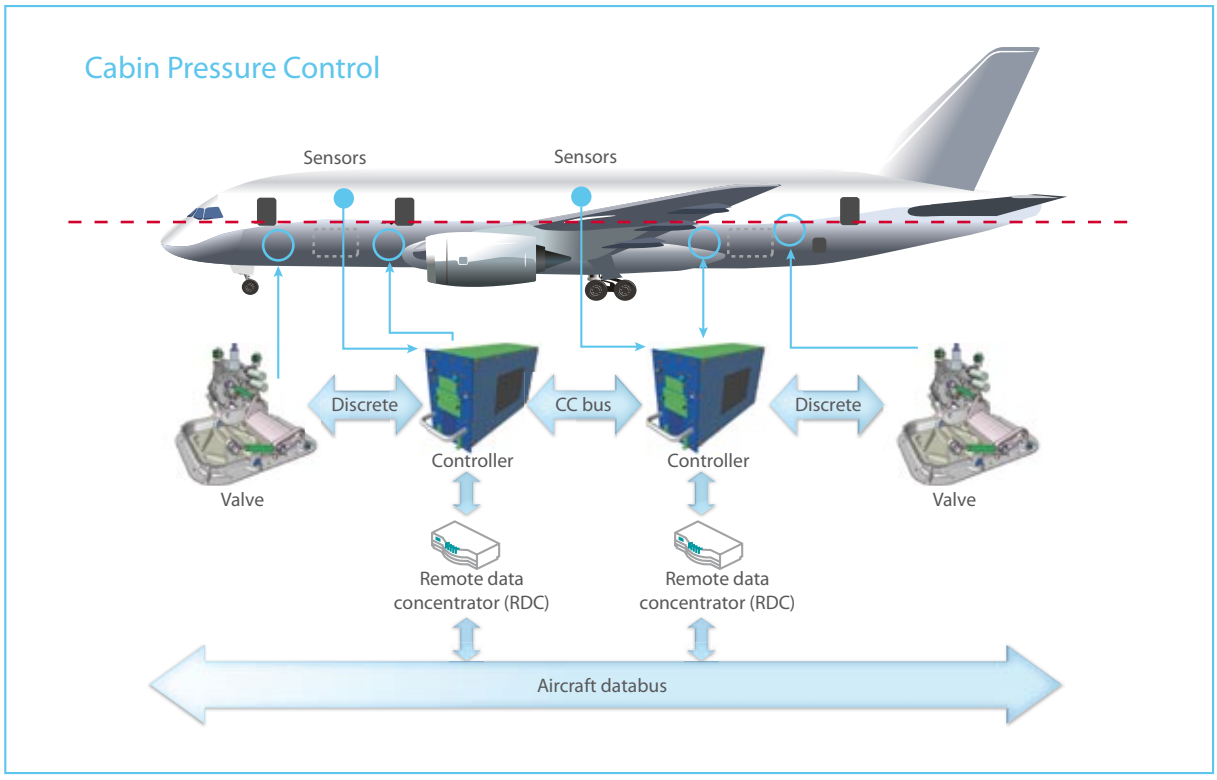


Figure 1: The controllers that control the valves are connected to the flight management system (FMS) via the aircraft's central databus.

and commenting of the generated code, and also by direct traceability between code and model.

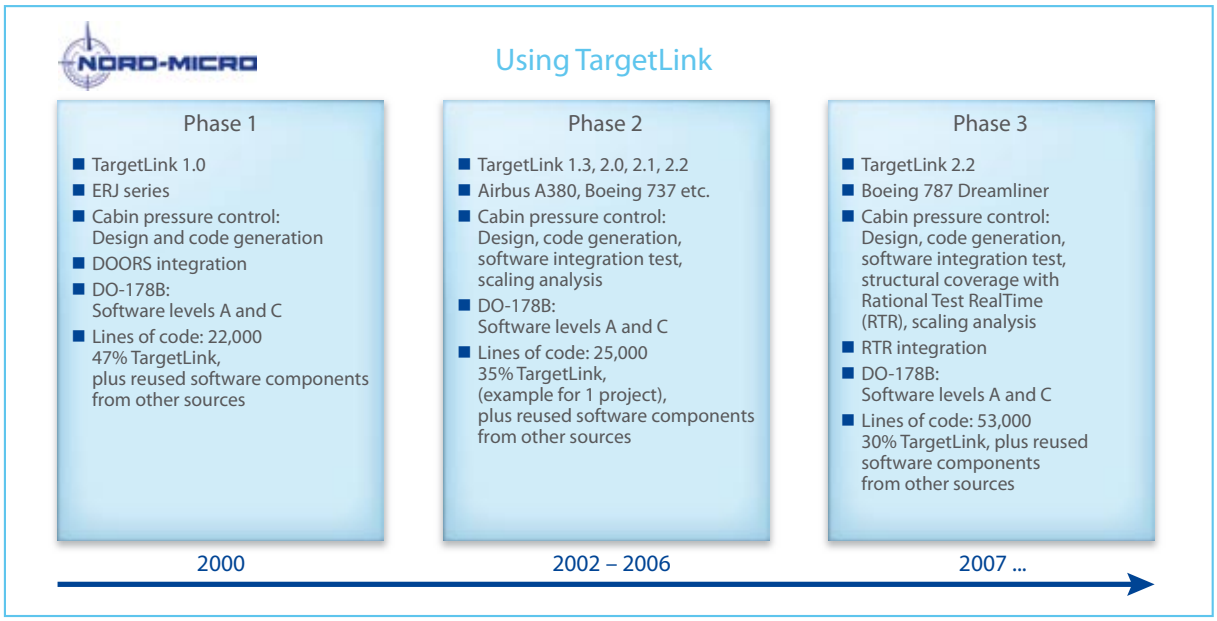
- *Software Integration Tests*
  Nord-Micro uses TargetLink for performing software integration tests (figure 2). The first step is to derive suitable test stimuli from the requirements. Then in TargetLink, the results of a model-in-the-loop simulation are compared with those from a processor-in-the-loop simulation for the test stimuli, using C167 and MPC5554 processors. The integration tests include an analysis of the structural code coverage performed thanks to tool integration between TargetLink and Rational Test RealTime. Nord-Micro can reduce the cost of module testing to the minimum by this means.

> "Using TargetLink, we have successfully carried out several software developments according to DO-178B that were certified for safety level A."
>
> *Andreas Alaoui, Nord-Micro*

Software Integration Tests with TargetLink and Rational Test RealTime

For one of the most recent projects, dSPACE and IBM Rational developed a tool integration between TargetLink and Rational Test RealTime (RTR) to streamline Nord-Micro's test process. First TargetLink code is suitably instrumented with RTR (preparing code for the test), and then RTR is used again to perform code coverage analyses. The integration between the two tools enables Nord-Micro to run the software integration tests on the target processor using TargetLink's simulation features and achieve the structural coverage required by DO-178B as early as the software integration level. This approach radically reduced the workload for module tests to 20% of its original value. As of Version 2.0, TargetLink also had functionalities for measuring structural coverage, but Nord-Micro required a formal tool qualification for structural coverage, which is already available with RTR

Figure 2: Production code generator TargetLink has been used successfully for many years to develop safety-critical software at Nord-Micro.



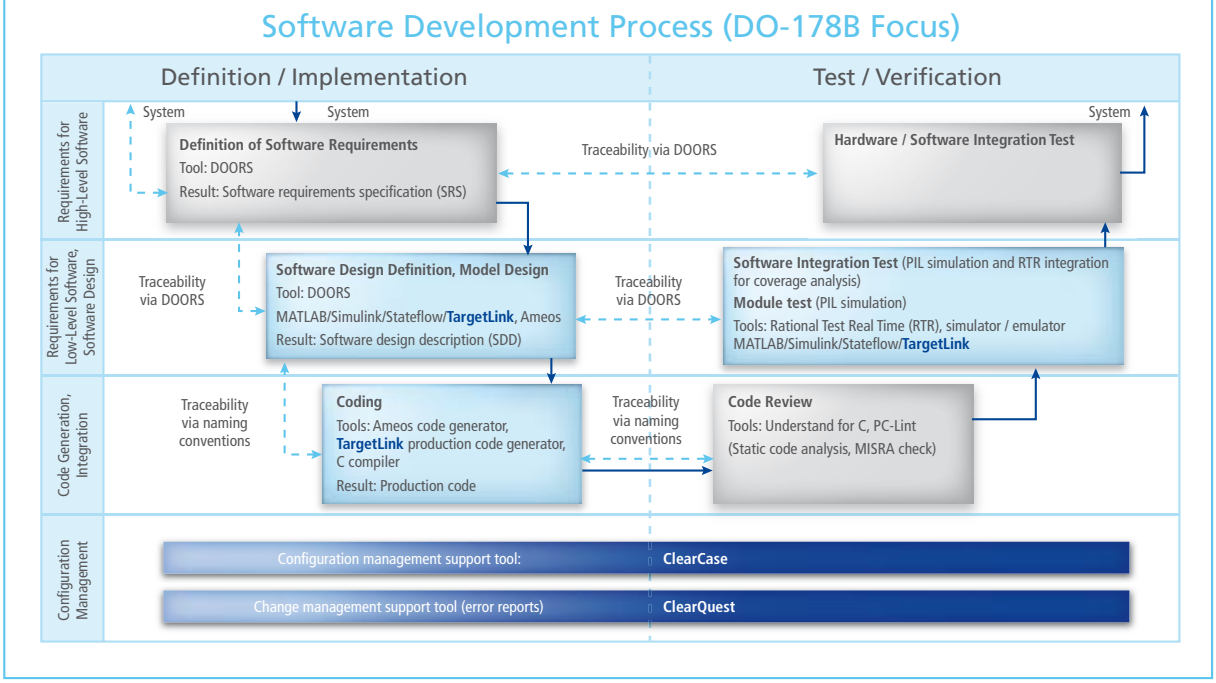


Figure 3: TargetLink in the development process at Nord-Micro.

in the form of a tool qualification kit. Nord-Micro is also using RTR for measuring structural coverage in the hardware/software integration test. For the software integration tests, Nord-Micro creates test data based on the requirements. Then model-in-the-loop simulation is used to test whether the model behaves in compliance with the requirements. If the result is positive, production code is generated and executed on the target, and the results of this are checked against the results of model-in-the-loop simulation. The next step is to generate instrumented production code so that the simulation results can be tested for consistency between instrumented and uninstrumented code. If the results of this are also identical, the required coverage can be verified by measuring the structural coverage on the basis of the instrumented TargetLink code and RTR to verify the required coverage. ■

Andreas Alaoui,
Manager Software Engineering,
Nord-Micro AG & Co OHG
Germany

Summary

The projects carried out between 2000 and today have shown us that TargetLink is an ideal development tool and production code generator for safety-critical aviation applications. Complete compliance with the rigorous requirements of aircraft manufacturers and aviation authorities was achieved by means of TargetLink, so code generated by TargetLink is now in use in numerous aircraft types. Amongst the qualities that we really appreciate are the good readability of the TargetLink code, traceability between the code and the model, and the determinism of code generation, which considerably reduces our test workload.

Moreover, the flexible configurability of the source code enables us to integrate several TargetLink models into our real-time software without much difficulty. The source code is so efficient that our real-time requirement is always fulfilled. Integration with other development tools such as DOORS and Rational Test RealTime ran smoothly. Based on experience gathered so far, Nord-Micro will continue to use TargetLink for developing cabin pressure control systems in new aircraft in the future.

Breathe at ease

Neural impulse measurement makes artificial respiration more comfortable

Normally, when we want to breathe in, we just do it. But with artificial ventilation, how does the machine know how much air the patient needs, and when? Mechanical intervention can be stressful for the patient, and to minimize the discomfort, the machine must respond to the patient's breath initiation as early as possible.

How We Breathe

The act of breathing depends on rhythmic discharge from the respiratory center of the brain. This discharge travels along the phrenic nerve and excites the diaphragm muscle cells, so that the muscles contract and the diaphragm is lowered. As a result, the pressure in the airways drops, causing an inflow of air into the lungs.

Conventional Artificial Ventilation

Conventional mechanical ventilators sense a patient respiratory effort by either a drop in airway pressure or a reversal in flow. In other words, the last and most slow-reacting step in the chain of respiratory events is used to sense the patient's effort. The patient has to act before the ventilator joins in.

This is hard work, especially for weak patients. And because a conventional ventilator intervenes relatively late, a slight asynchrony can occur between human and machine. This may lead to patient discomfort and agitation. But using a ventilator that takes over the breathing activity completely should be avoided as long as possible to maintain the patient's breathing abilities and to promote spontaneous breathing.

NAVA (Neurally Adjusted Ventilatory Assist)

To improve artificial ventilation and to make the situation more comfortable for the patient, we at Maquet developed a new way of detecting patient breath initiation. Instead of measuring the airway pressure, we use an electrode array to capture the electrical activity of the diaphragm (figure 1). The raw electrical signal measured on the single electrodes is called EMG (**e**lectro**m**yo**g**raphy). Signal processing is performed on the EMG to obtain what we call the Edi signal, which contains only the signal related to the diaphragm. The Edi signal is transmitted to the ventilator and used to assist the patient's breathing. That way, the machine can react to the patient's wishes faster. As the ventilator and the diaphragm work with the same signal, their mechanical coupling is practically instantaneous.

The activation signal of the diaphragm is the earliest possible detectable signal we can use with today's technology (figure 2).

Testing NAVA

The key technology of NAVA is the signal processing performed on the EMG. To test the EMG algorithm and

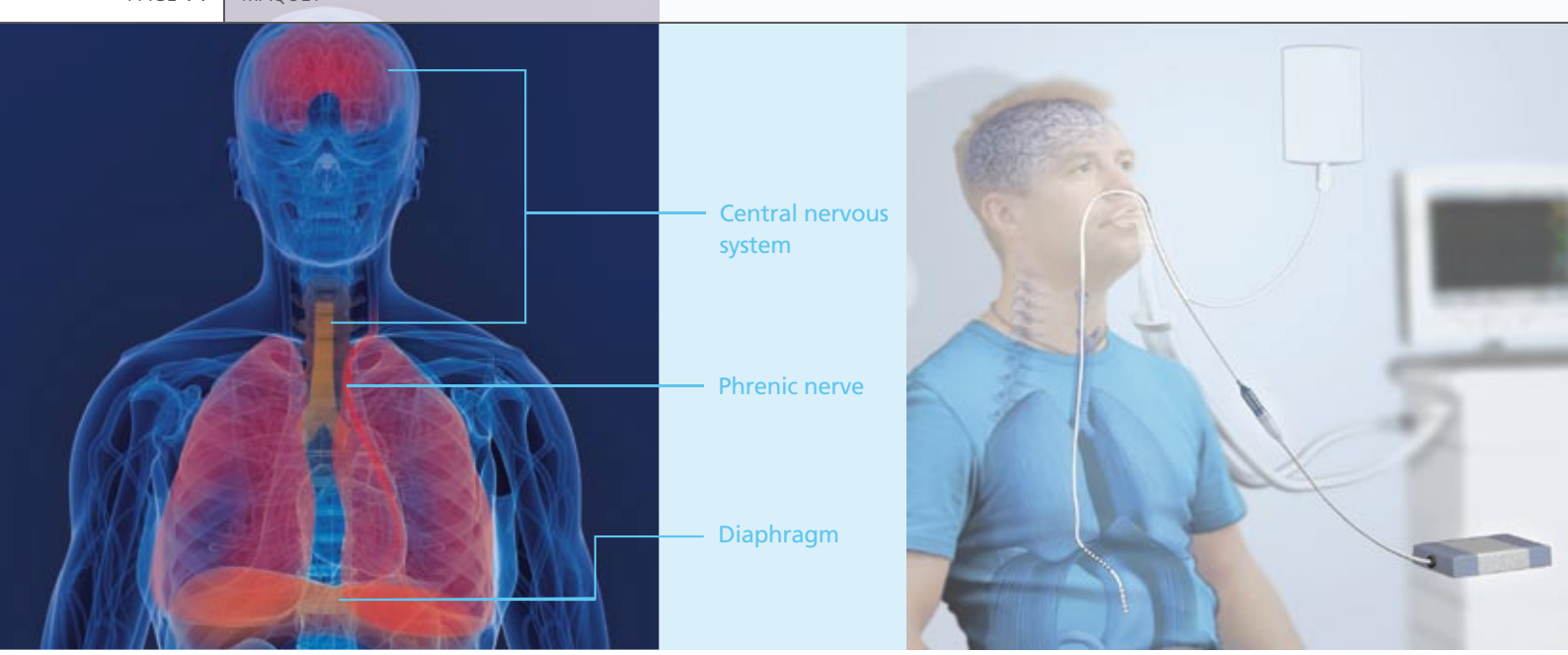


Figure 1: Attachment of the NAVA to the patient.

its interaction with the SERVO-i ventilator, we used a laboratory setup (figure 3) consisting of:

- A catheter that provides measured EMG signals, or a simulator that simulates the EMG signals as breathing impulses
- A dSPACE DS1005 PPC Board for processing the EMG signals
- The SERVO-i ventilator for controlling artificial respiration

> "With the dSPACE system, we easily set up a prototype to accelerate the development process."
>
> *Fredrik Jalde, Maquet Critical Care AB*

To stimulate the system, we can use four different inputs:

1. Real input from a patient or a volunteer: This is obtained by inserting a catheter in the esophagus to pick up the EMG signal from the diaphragm. As an alternative to inserting the catheter in a patient, we have a system with a water tube with two wires connected to an iPod. The iPod generates two stereo signals to the water tube to provide EMG and ECG signals.
2. Simulated input from a hardware simulator: A signal generator provides a sinus signal at about 200 Hz.
3. Simulated input from a software model: This was implemented as a Simulink model and can be controlled with dSPACE ControlDesk.
4. Files containing patient recordings: The files are read from the PC and transferred to the dSPACE hardware in real time via C-Lib functions. The files are selected in ControlDesk.

All the different input signals have in common that they contain information about the breathing – inhalation or exhalation – and the desired inhalation strength. The modular hardware from dSPACE, a DS2002 A/D-board, receives these signals. The DS1005 PPC Board is used for signal processing with the EGM algorithm to obtain the Edi signal. The SERVO-i receives the analog Edi signal from the DS2102 D/A board, and the signal is used as a trigger signal but also to support the patient by providing oxygen and air pressure in proportion to the amplitude of the Edi signal.

We used the dSPACE test and experiment software ControlDesk to create a graphical interface for our development and tests. This gave us an easy way to manage and manipulate the controller model, for example, to select the breathing mode and define the settings for it, and to choose between simulated and measured EMG signals.

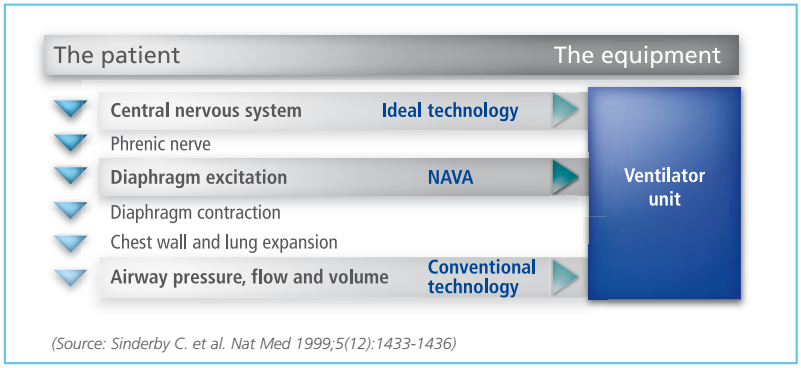


Figure 2: By using the electrical activity of the diaphragm, NAVA technology senses the earliest respiratory signal that can be detected.

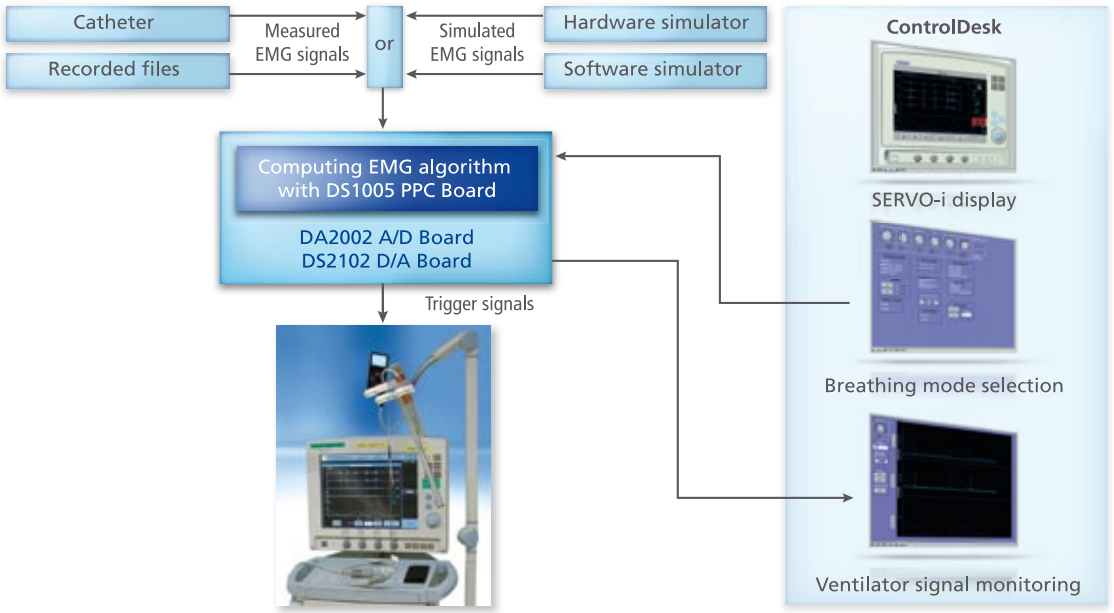


Figure 3: Schematic of the laboratory set-up for the NAVA development system.

We were also able to monitor the measured ventilator signals.

The most important use of the dSPACE system has been our work on the algorithms for signal processing for the EMG signal and setting up a prototype for testing without having to adapt the SERVO-i ventilator.

NAVA in Everyday Use

The NAVA technology, together with the Edi module and Edi catheter, is an addition to our SERVO-i ventilator. The user does not have to buy a complete new ventilator system. Moreover, and far more importantly, there are several benefits for the patients that have been experienced in daily work so far:

- Improved synchrony: In NAVA, the ventilator is cycled-on as soon as neural inspiration starts. Moreover, the level of assistance provided during inspiration is determined by the demand from the patient's own respiratory center. The same applies to the cycling-off phase: The ventilator cycles off inspiration the instant it is alerted to the onset of neural expiration. By utilizing the Edi signal, the maintenance of synchrony between the patient and the ventilator is improved.
- Lung protection: With NAVA, the patient's own respiratory demands determine the level of assistance. NAVA provides the ability to avoid over- and under-assisting the patient.
- Patient comfort: With NAVA, the respiratory muscles and the ventilator are driven by the same signal. The delivered assistance is matched to neural demands. This synchrony between patient and ventilator helps minimize patient discomfort and agitation, promoting spontaneous breathing.
- Decision support for unloading and extubation: The Edi signal can be used as an indicator to set the level of support given by the ventilator, and to optimize weaning. As the patient's condition improves, the Edi amplitude decreases, resulting in a reduction of ventilator-delivered pressure. This pressure drop is an indicator for deciding whether to wean the patient off artificial ventilation and extubate. ■

Fredrik Jalde
Control Engineer Mechatronics
Maquet Critical Care AB
Sweden

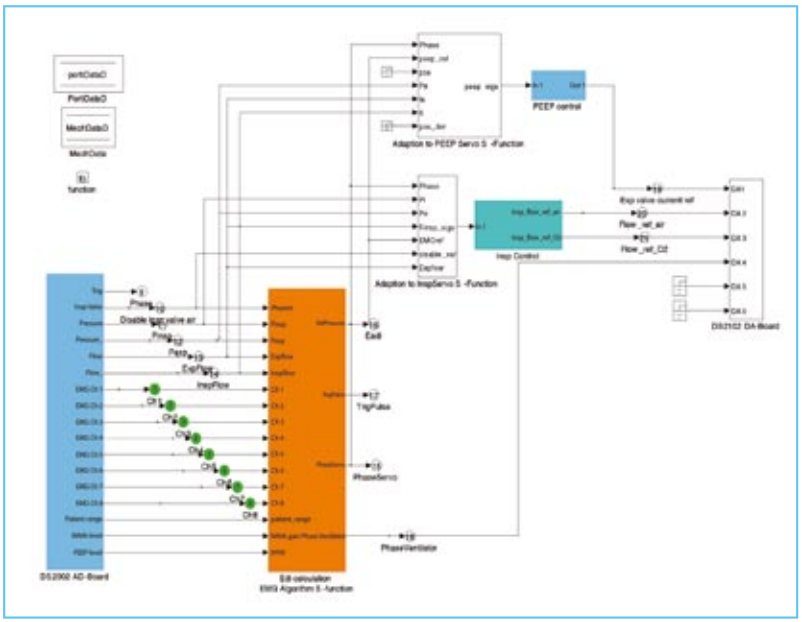
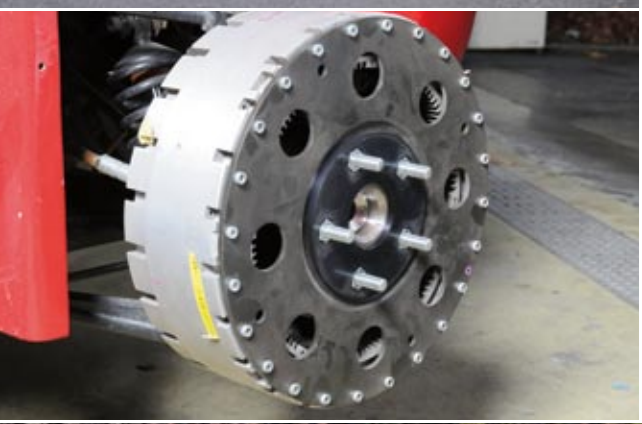


Figure 4: Simulink® model for EMG control of SERVO-i.

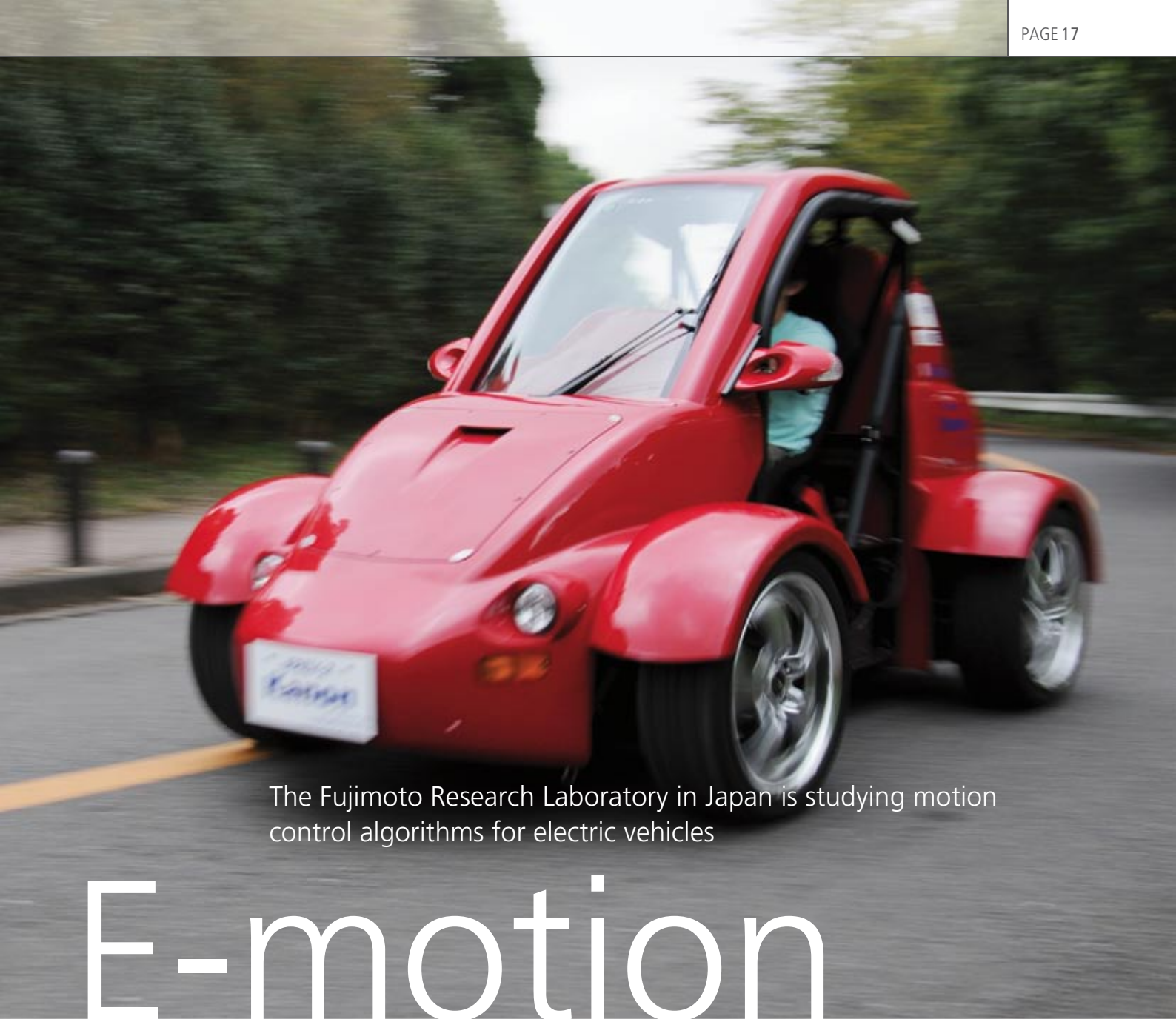


Research into developing electric vehicles has progressed over the last few years. These vehicles have the potential for completely new vehicle designs, and also different riding and handling characteristics. The in-wheel technology often used in this field requires dedicated control algorithms for convenient and efficient motion control.

Advantages of an EV

In recent years, heightened concern for energy and environmental issues has focused attention on electric vehicles (EVs), leading to a variety of research projects. The advantages of an EV are not restricted to problems such as CO_2 emissions, though. From the standpoint of vehicle motion control, an EV has three main advantages:

- Extremely fast torque response
- Accurate determination of generated torque
- Compact, lightweight motors can be incorporated inside each wheel to drive each one independently



The Fujimoto Research Laboratory in Japan is studying motion control algorithms for electric vehicles

E-motion

Research Focus at Fujimoto Research Laboratory

The Fujimoto Research Laboratory at Yokohama National University in Japan investigates electric vehicles, focusing particularly on methods of electric drive technology. The laboratory is working on a type of drive known as an in-wheel motor, and is also studying the safety aspects of electric vehicles on slippery road surfaces. Research is being conducted on attitude control methods that employ yaw rate control, using this yaw moment to prevent spinning and drifting when turning.

Development Objective: A Yaw-Stable Vehicle

An electric motor goes straight from zero to its maximum torque. Thus, uncontrolled torque requests can result in immediate loss of static friction, which results in vehicle oversteer during extreme cornering. To detect the beginnings of oversteer, the vehicle's yaw rate has to be determined. The yaw rate is the angular velocity with which a vehicle rotates around its vertical axis. If external effects push a yaw-stable vehicle off course, in the ideal case it returns to a straight path without the driver having to steer.

In-Wheel Motor Technology

The vehicle under investigation uses in-wheel motor technology, i.e., each wheel has its own electric motor and can be driven separately. A completely new type of yaw rate observer was developed especially

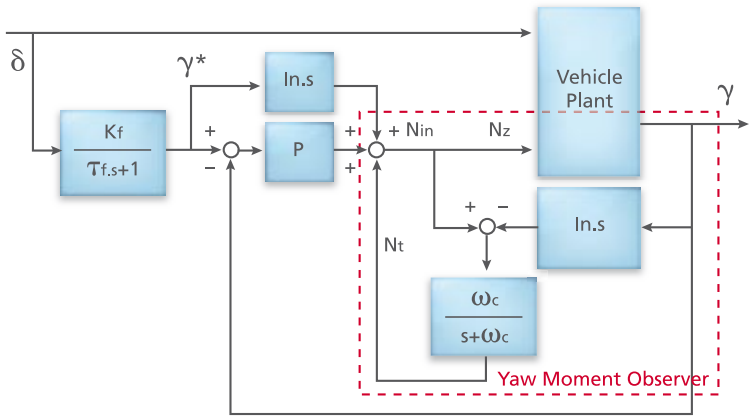


Figure 1: Block diagram of the vehicle stabilization control based on a yaw moment observer.

> "The dSPACE AutoBox is a very easy-to-handle control system, since it is extremely shock-proof and can be used in a voltage range from 8 to 60 V."
>
> *Shinsuke Sato, Graduate Student, Yokohama National University*

for this kind of drive. The yaw moment can be derived from the difference in drive force between the right and the left wheel, and then used as a control input for stability control of the vehicle (called direct yaw control or DYC for short).
The electric motors require dedicated control algorithms for practical, efficient motion control.

Two-Dimensional Vehicle Control

To control the yaw rate, the lateral force and the actual wheel speed have to be known. The lateral force is a nonlinear variable that is difficult to measure or estimate. The effects of the lateral force can therefore be determined as a disturbing torque. For yaw-rate-controlled vehicles, the equation of motion is as follows:

$$I\dot{\gamma} = (2l_f Y_f - 2l_r Y_r) + N_z$$

where $\dot{\gamma}$ is the yaw rate, Y_f and Y_r are the lateral forces, and N_z is the yaw moment used as the control input of the controller. It is derived from the drive force difference between the in-wheel motors of the right and left front wheels. The proposed control methods are used to configure a yaw moment observer, so that the disturbance moment can be suppressed and the yaw rate can be controlled.
Simulation results show that without the control, the vehicle skids considerably during extreme cornering (figure 3), and its behavior is unstable. Vehicles with yaw rate control are stable.
The results of test runs also show that without control, the yaw rate varies considerably and the vehicle is unstable, but with the control, the yaw rate levels out to a fixed value (figure 2).

These results show clearly that the proposed control method is very effective on slippery road surfaces and increases vehicle safety.

Test Drive with dSPACE AutoBox

To test the control algorithms in practical test drives, the FPEV 2-Kanon test vehicle was equipped with a dSPACE AutoBox containing a DS1103 Controller Board that was responsible for computing the algorithms.
A control system modeled with MATLAB®/Simulink® was loaded to the AutoBox. The AutoBox drives the electric motors via converters. The angular velocity, the torque, the acceleration and the yaw rate are available as analog signals.

Effectiveness of the dSPACE AutoBox

To make full use of the advantages of electric motors, the control algorithms have to be calculated

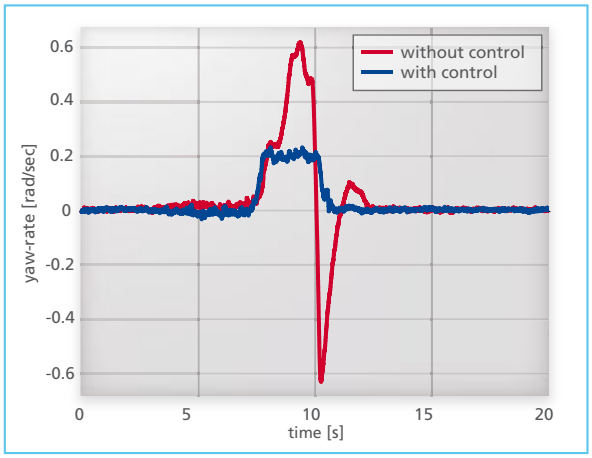


Figure 2: Test results on measured yaw rate. Without control, the yaw rate fluctuates strongly (red); with control, the yaw rate levels out to a fixed value (blue).

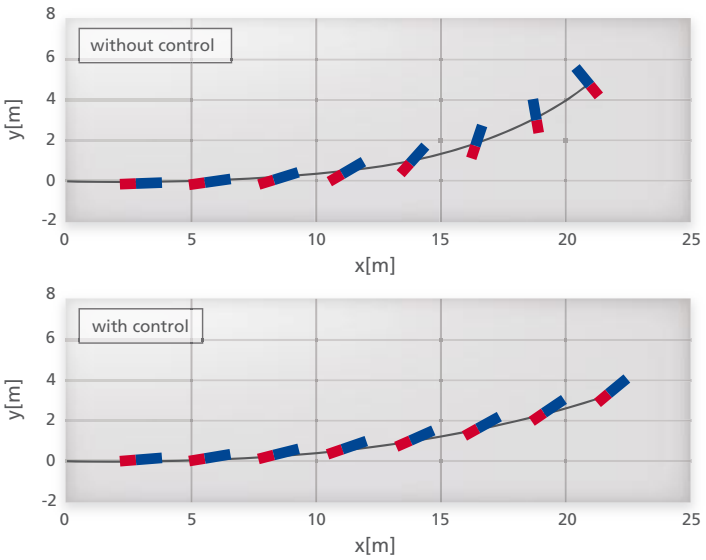


Figure 3: Simulated vehicle trajectories of a steering maneuver on a slippery surface. The vehicle rotates around its yaw axis (top). The vehicle is stable and does not skid (bottom).

Prof. Hiroshi Fujimoto in the development laboratory.

extremely fast. The short sample time of the DS1103 Controller Boards and its low latencies during I/O access meant that the algorithms could be executed in real time. Since the hardware has such extremely fast response times, the algorithms behaved as expected.

Conclusion and Outlook

The safety of an electric vehicle is greatly improved by the control methods that have been developed. They allow tires with low frictional losses to be used without compromising safety. The methods developed at the Fujimoto Research Laboratory result in lower electricity costs and a longer distance driven per battery charge.

The Fujimoto Research Laboratory is currently an active member of a research partnership between automobile manufacturers and suppliers, and will continue its research on powerful, reliable motion controls, including tests run under real-world conditions. The goal is to make these control methods available on the open market. ■

Prof. Hiroshi Fujimoto
Department of Electrical & Computer Engineering
Yokohama National University
Yokohama
Japan

> "As a result of adopting a dSPACE system, the joint tests performed with a company that we do collaborative research with went smoothly. Even without an extremely convenient tool like the dSPACE system, as an educational organization we have to provide training that enables students to build control systems."
>
> *Prof. Hiroshi Fujimoto, Yokohama National University*

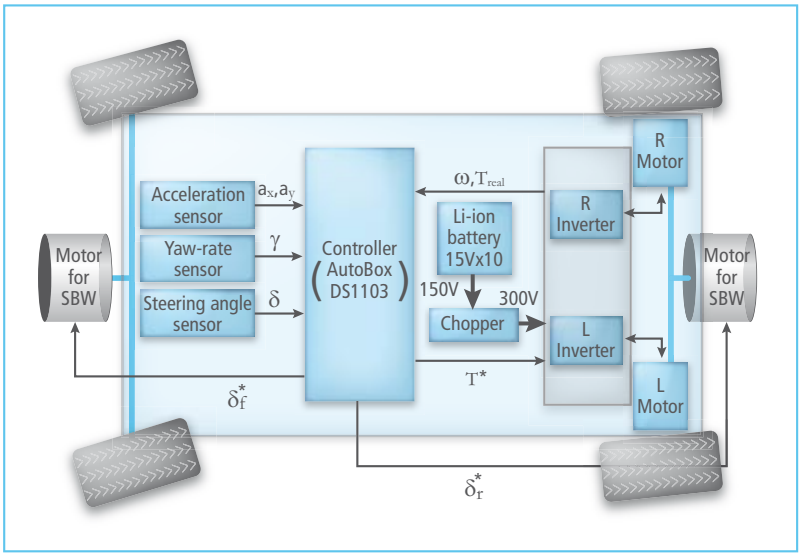
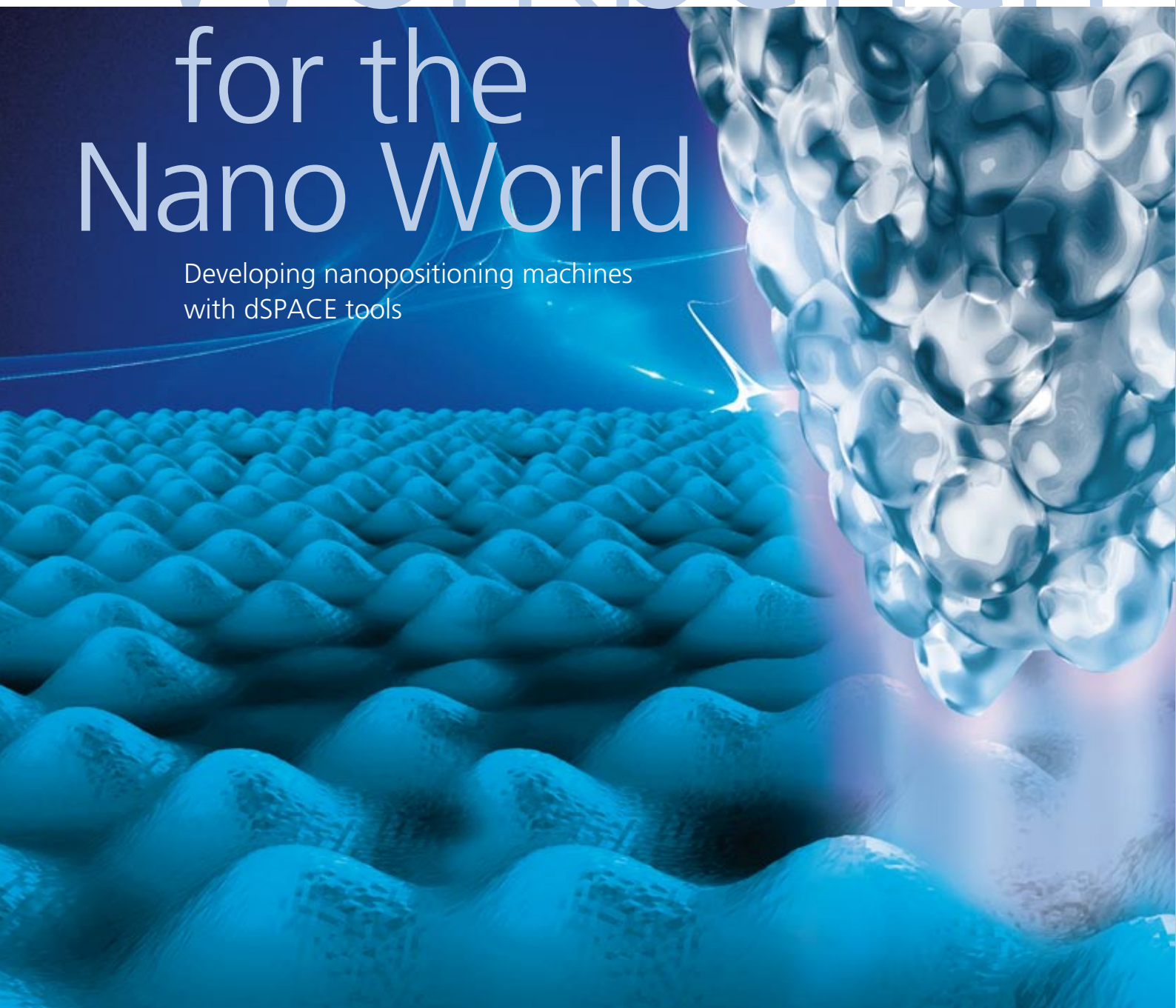
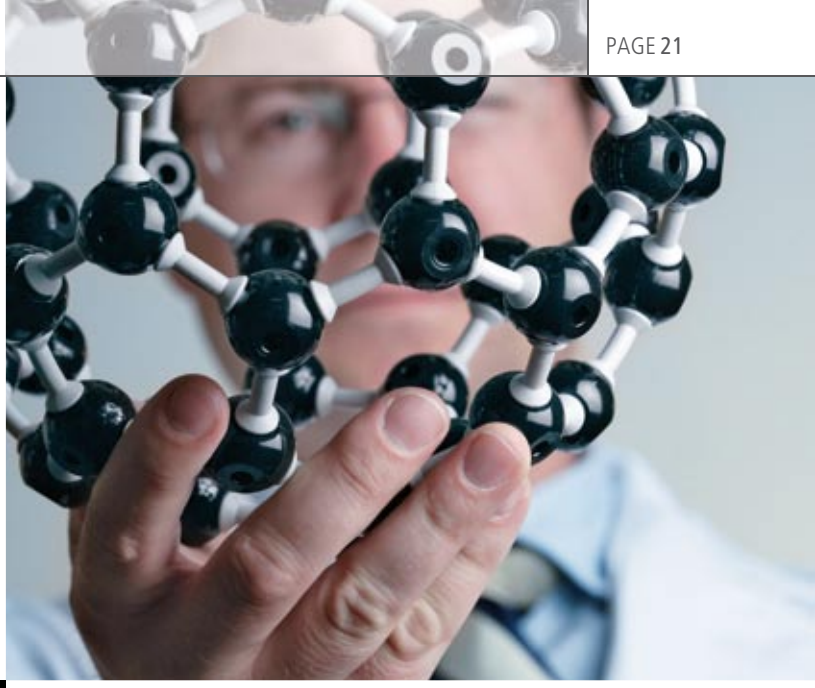


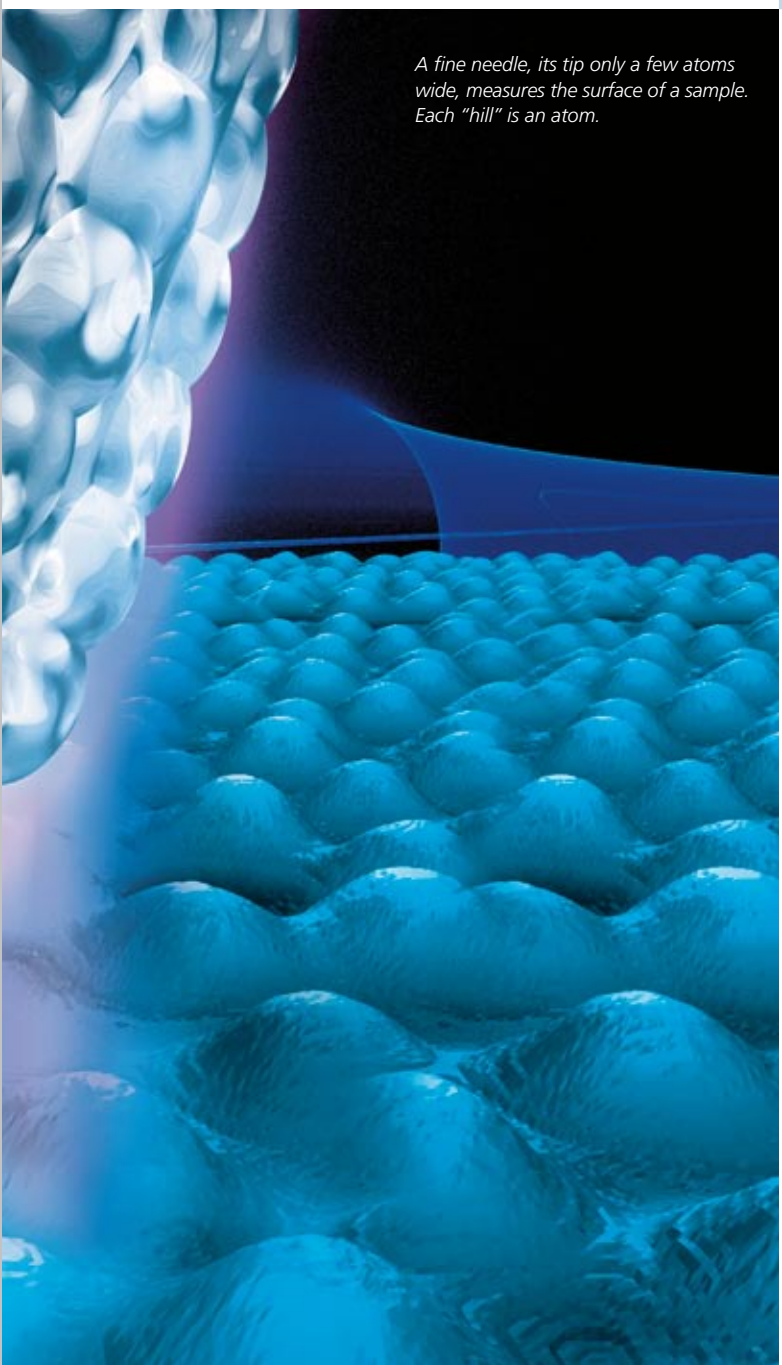
Figure 4: Configuration of the vehicle control system.

Workbench for the Nano World

Developing nanopositioning machines with dSPACE tools

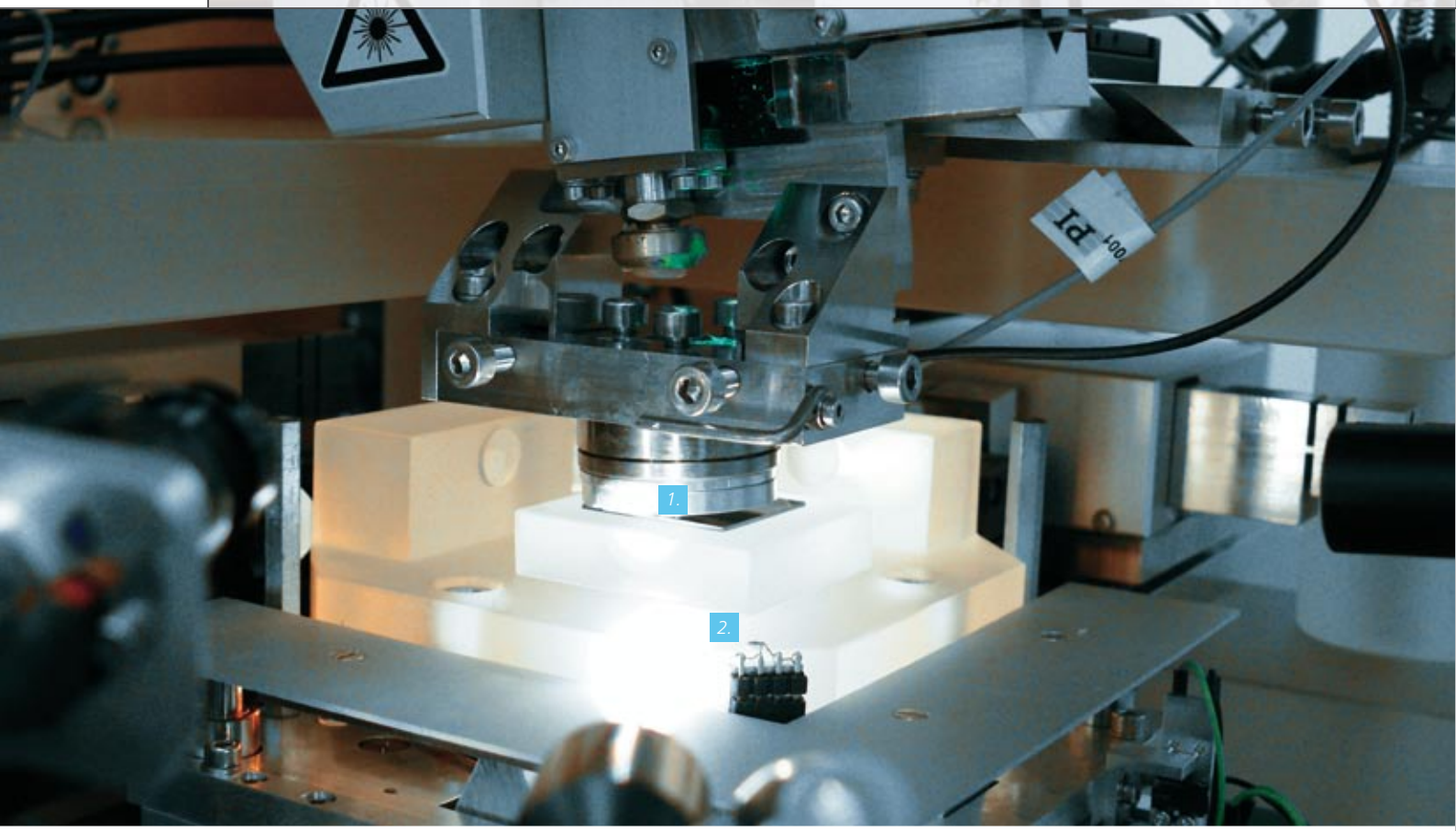






A fine needle, its tip only a few atoms wide, measures the surface of a sample. Each "hill" is an atom.

Just as Moore's Law predicts, the semiconductor industry is doubling the number of transistors per unit of area almost every two years. Processing such tiny structures requires precise positioning machines that move the processing tools to defined positions quickly and reproducibly. A team at the Technische Universität Ilmenau in Germany has designed a very versatile positioning machine for work in the nanometer range. The machine is controlled with the aid of dSPACE hardware and software.



The heart of the positioning machine is a movable positioning table with a probe fixed above it. This can be used for a wide range of different tasks in semiconductor technology, biotechnology, genetic engineering, micromechanics, etc.

1. probe
2. positioning table

From Semiconductors to Genetic Engineering

The typical uses of positioning machines include tasks in the semiconductor industry, such as inspecting wafers and photomasks or testing ICs. But they are also indispensable in other fields such as biotechnology, genetic engineering, micromechanics, and measuring and processing precision optical instruments. "In just a few years, positioning ranges of 450x450 mm will be required, along with positioning reproducibility in the sub-nanometer range and positioning speeds of 20-50 mm per second," says Prof. Eberhard Manske from Technische Universität Ilmenau. "In terms of human dimensions, this would mean you could locate and precisely reposition a tiny grain of sand in an area covering the whole of Russia and extending upward to the top of the stratosphere, 50 km from the Earth's surface."

> "The dSPACE hardware and software helped us achieve the high sampling rate needed for fast, nanometer-precise positioning."
>
> *Arvid Amthor, TU Ilmenau*

Atoms Become Visible

The positioning machine designed by Prof. Manske's team essentially consists of a movable positioning table that can be moved in all three spatial dimensions by means of linear motors. Its position and tilt are monitored by means of several optical distance gauges (laser interferometers). Above it is a rigidly mounted probe that scans the object mounted on the positioning table. The probe head can be fitted with various tools and sensors, such as an atomic force microscope, a kind of microscope with a fine needle whose tip consists of only a few atoms. The needle moves closely across the surface of the sample row by row in a grid. The forces that affect the needle depend on the surface structure of the sample, providing a method of measuring the sample's vertical profile that even shows individual atoms.

Handling Masses of Data

The positioning processes are controlled by a dSPACE system consisting of a DS1006 Processor Board and various I/O boards. One of the system's tasks is to read the position signals measured by the laser interferometers and compute the corresponding currents for controlling the linear motors. "For nanometer-precise positioning, the motor current has to be supplied with sufficient accuracy. We achieve this by means of

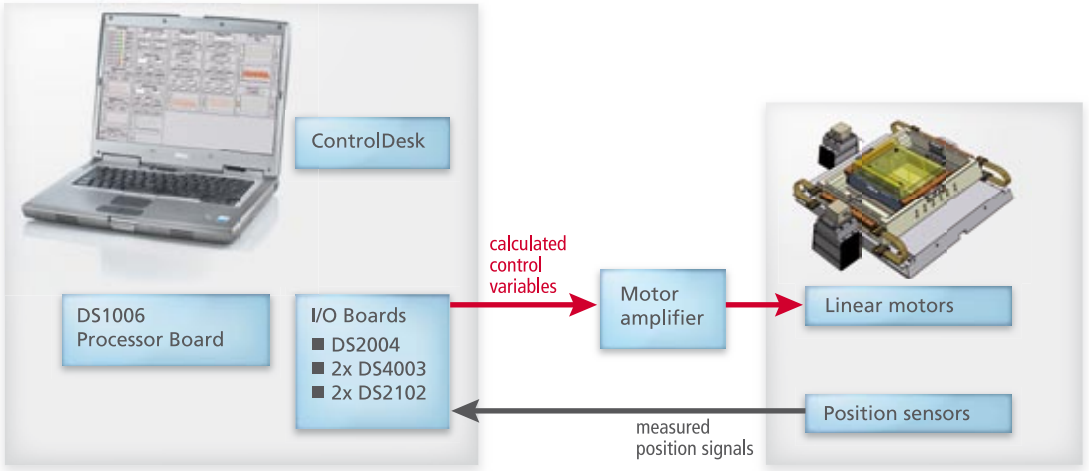


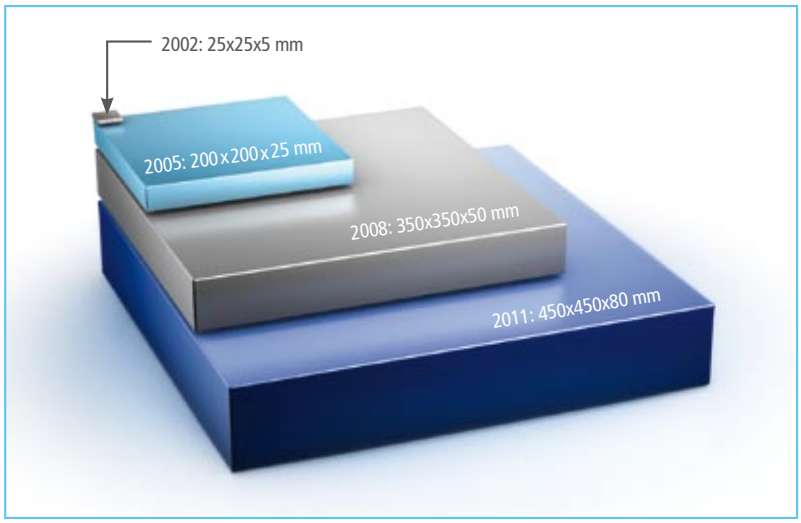
Diagram of the control. For fast, nanometer-precise positioning, the dSPACE system has to work at a high sampling rate of 10 kHz.

16-bit D/A conversion using dSPACE's D/A boards," explains Arvid Amthor, one of Prof. Manske's team. "The high sampling rate of 10 kHz is another major challenge. We move the positioning table at speeds of up to 30 mm/s, and 1 mm is 1,000,000 nm. This produces masses of data within a very short time, and that data has to be processed fast." All sequences are monitored by ControlDesk, the experiment software. The high positioning precision and speed require a complex, model-based, computation-intensive algorithm that is based on a dynamic sequence control. There are various disruptive effects to take into account, the main one being the nonlinear effect of friction, which dominates in the nanometer range and necessitates a lot of modeling work.

The Positioning Range Must Get Even Bigger

With a so-far unmatched positioning precision of 1 nm in a 200x200x25 mm large positioning range, the Technische Universität Ilmenau is currently the world's unchallenged leader in the nanopositioning field. In coming years, the main endeavor will be to enlarge the positioning range even further, with at least the same positioning precision and speed. "The machines will not be of any practical use unless positioning is fast enough," comments Prof. Manske.
As the first step toward this goal, the team plans to increase the positioning range to a volume of 350x350x50 mm. This requires further optimizations in measuring technology and data processing, as well as even more efficient modeling for correcting system and ambient disturbances. ■

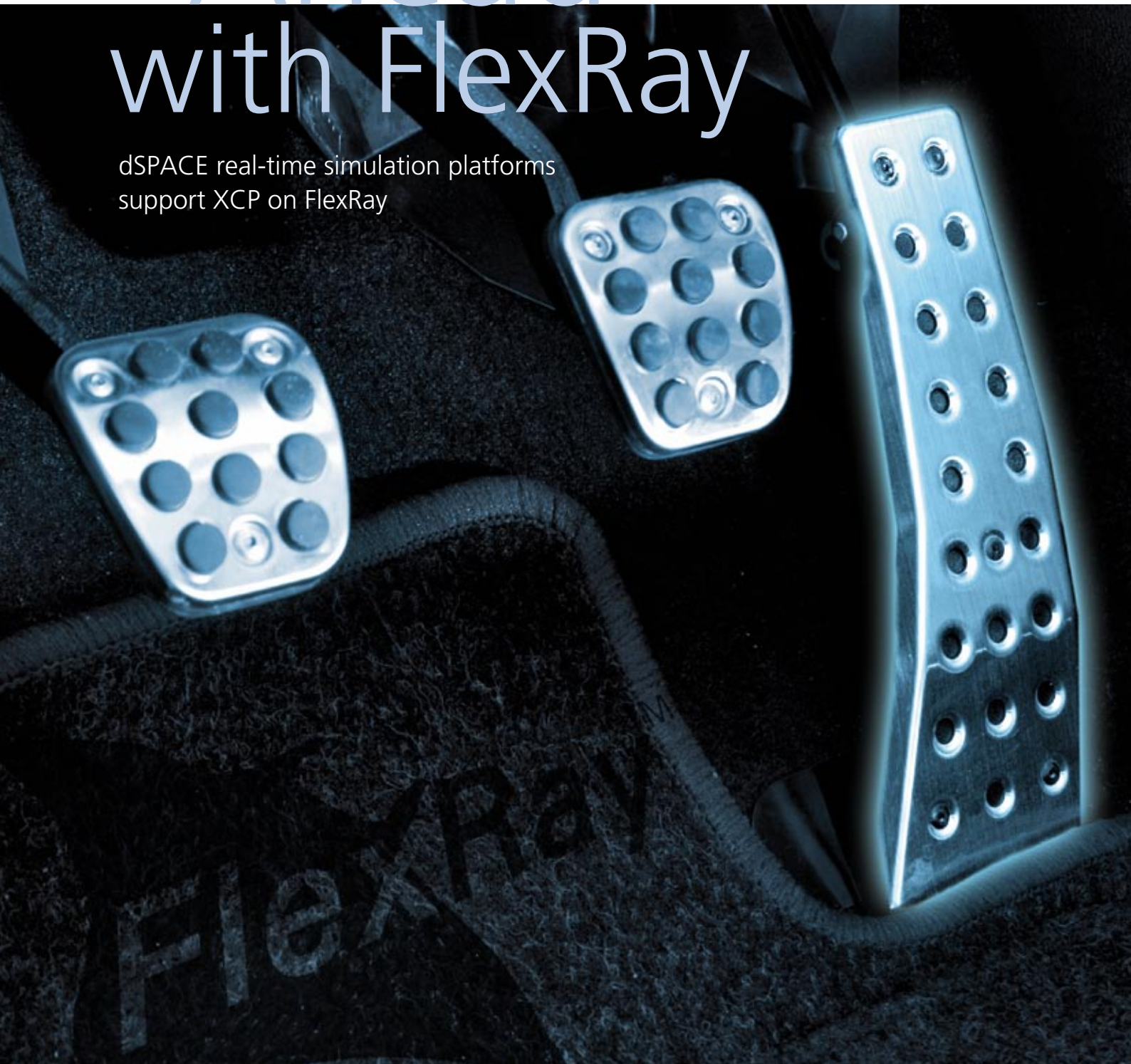
This article was written in cooperation with Prof. Eberhard Manske and Arvid Amthor, Technische Universität Ilmenau, Germany.

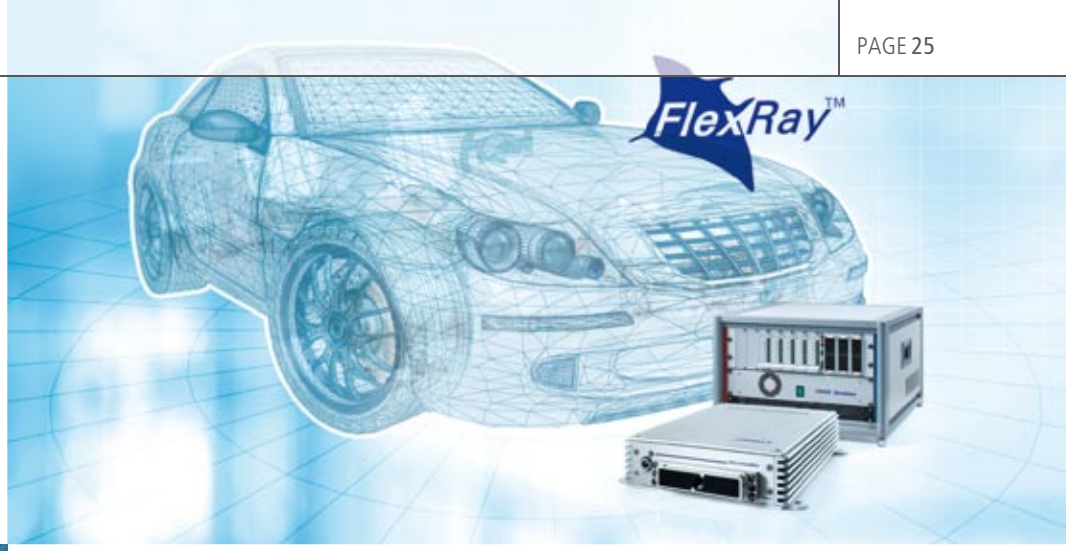


The positioning range of nanopositioning machines has multiplied since 2002. Even so, future tasks will require an even greater range, which can only be achieved by using complex, model-based control algorithms.

Full Speed Ahead with FlexRay

dSPACE real-time simulation platforms support XCP on FlexRay





ECU communication via FlexRay is becoming more and more essential. For the development and validation of automotive control systems, internal ECU variables have to be accessed via standardized protocols. dSPACE's real-time simulation platforms support the powerful XCP on FlexRay protocol. Typical application cases are function bypassing and ECU testing via hardware-in-the-loop simulation.

Requirements for Modern Bus Systems

When CAN-based bus architectures were developed for use in vehicles, the data traffic on automotive bus systems was only a small fraction of its present volume. LIN was developed as an especially inexpensive bus system, and with its low data transmission rate, it is good for application cases with small data volumes and comparatively long transmission times. CAN and LIN are increasingly coming up against their limits in modern vehicles. The FlexRay protocol is a viable way around this obstacle: It is faster (currently 10 Mbit/s; CAN provides a maximum of 1 Mbit/s, LIN a maximum of 20 Kbit/s) and also allows deterministic data transmission. 'Deterministic' means that time slots are executed in precisely defined sequences. Only one specific node is allowed to transmit in each slot. This ensures that important messages (to the steering system, the brakes, etc.) are executed within defined periods of time. Moreover, precise scheduling of data traffic also makes it easy to combine subsystems.

FlexRay in Production Development

More and more production projects are using the FlexRay bus. The execution of individual tasks in the ECUs can be synchronized via FlexRay. With deterministic data transmission via dedicated FlexRay slots, ECUs that were developed and tested by different suppliers can be networked to form an overall system (figure 1) without mutual effects. Calibrating and testing these ECUs is possible via the standard XCP interface – the universal measurement and calibration protocol published by ASAM. XCP is not only indepen-

dent of the physical data transport layer, it also takes the communication interfaces of today and tomorrow into account. As the FlexRay bus is installed in ever more vehicles, XCP on FlexRay is becoming more important.

RTI Bypass Blockset: Now with XCP on FlexRay

To equip ECU developers for meeting the challenges of future vehicle bus systems, dSPACE now supports communication between dSPACE real-time platforms and ECUs via XCP on FlexRay. In this scenario, the dSPACE system acts as the XCP master, while the ECUs are XCP slaves. This is made possible, for example, by the new XCP on FlexRay interface of dSPACE's RTI Bypass Blockset, a Simulink® blockset for dialog-based configuration of bypass interfaces and real-time ECU access. For bus configuration, the FlexRay interface of the RTI Bypass Blockset builds on the dSPACE FlexRay Configuration Tool. The FIBEX network description file is loaded to the dSPACE FlexRay Configuration Tool, and the XCP on FlexRay parts are configured in addition to the rest of the FlexRay communication. The result is an RTI FlexRay Blockset Library whose blocks can be added to the simulation model. The measurement and stimulus data needed for exchange with a specific ECU is configured in the second step, using the RTI Bypass Blockset. This is done by first reading the ASAP2 file containing the available ECU variables. Then RTI blocks are used to define measurement and stimulus access to the ECU (figure 2). With the RTI Bypass Blockset, up to four ECUs can be addressed in parallel via one FlexRay bus.

Flexible Configuration in the RTI Bypass Blockset

To define the XCP slots which are to be used with each ECU, the RTI Bypass Blockset provides dedicated configuration dialogs for matching the ECU-specific FlexRay communication options (FlexRay buffer) of each ECU to the FlexRay slots actually in use. Users can define the transmission bandwidth for communication with an individual ECU, and the points in time for data transmission within the FlexRay cycle any way they like (figure 3, figure 4). The XCP slots used for a specific data transmission can be either specified manually or assigned automatically by the RTI Bypass Blockset. If the precise positions of the XCP slots in the communication cycle in relation to the bypass hooks within the ECU tasks are known, it is possible to perform data capture or stimulation at defined points in time via XCP on FlexRay. If the positions of the XCP slots in relation to the bypass hooks are not known, automatic assignment can be used. Upcoming data packets are then transmitted with the next available XCP slot. Whichever mechanism is chosen, if XCP slots are used for more than one purpose

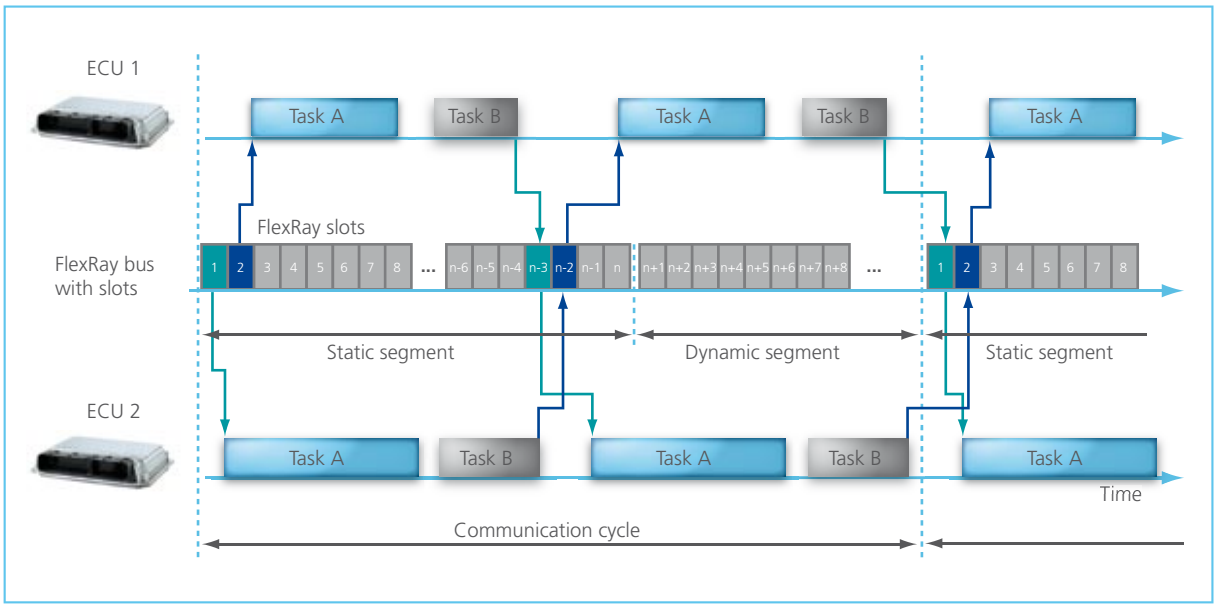


Figure 1: Synchronizing ECU tasks via assigned FlexRay slots. The overall system can be put together without the individual ECUs affecting one another.

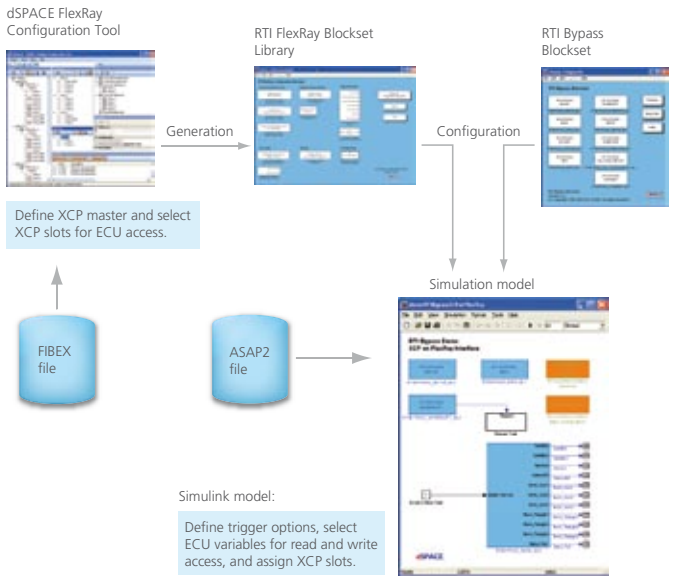


Figure 2: Configuration process with the dSPACE FlexRay Configuration Tool and the RTI Bypass Blockset.

(e.g., with one XCP slot communicating alternately with ECU 1 and ECU 2), the sequence of data to be transmitted by the simulation system can be prioritized. There are several ways to synchronize the real-time platforms with the ECU. One is to run calculations on the real-time platform synchronously to specific points in time within the FlexRay cycle, in which case execution is time-driven. Another way is to run calculations immediately after the associated data has been transmitted.

Application Case 1: Bypassing via XCP on FlexRay

In the field of function development, the RTI Bypass Blockset makes it possible to develop and test new ECU functions on a real-time simulation platform, with data exchange and synchronization to the ECU being performed via the existing FlexRay interface. To make data exchange possible, all the necessary data is transmitted to the development system via XCP service calls or bypass hooks, at defined positions in the ECU code. The development system then calculates the new function (bypass task) and returns the output data to the ECU, where it is placed in the ECU's memory with an XCP hook. This sequence can be carried out within one FlexRay cycle (function bypass without sample step delay). Because of the tight time correlation between task executions and FlexRay communication, bypass data is typically exchanged via the static part of the FlexRay

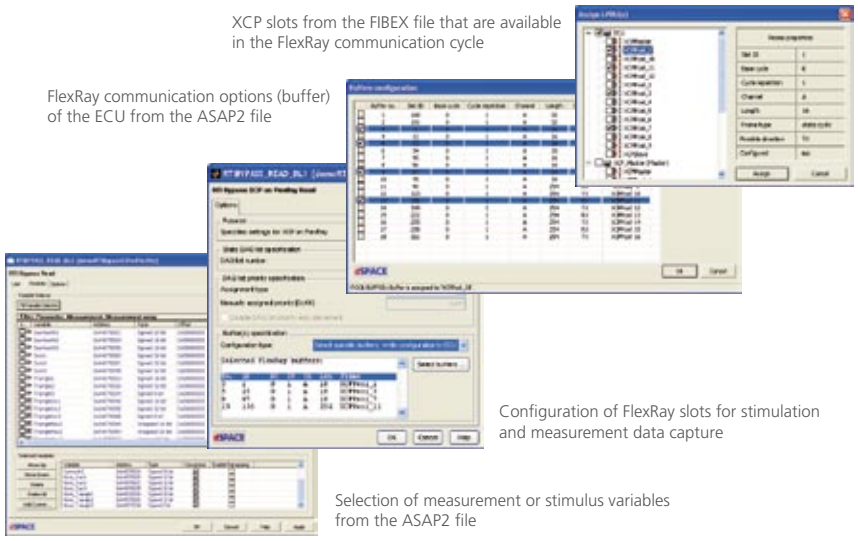


Figure 3: The RTI Bypass Blockset provides dedicated dialogs for manual configuration of the FlexRay slots used for XCP. As an alternative, the slots can also be assigned automatically.

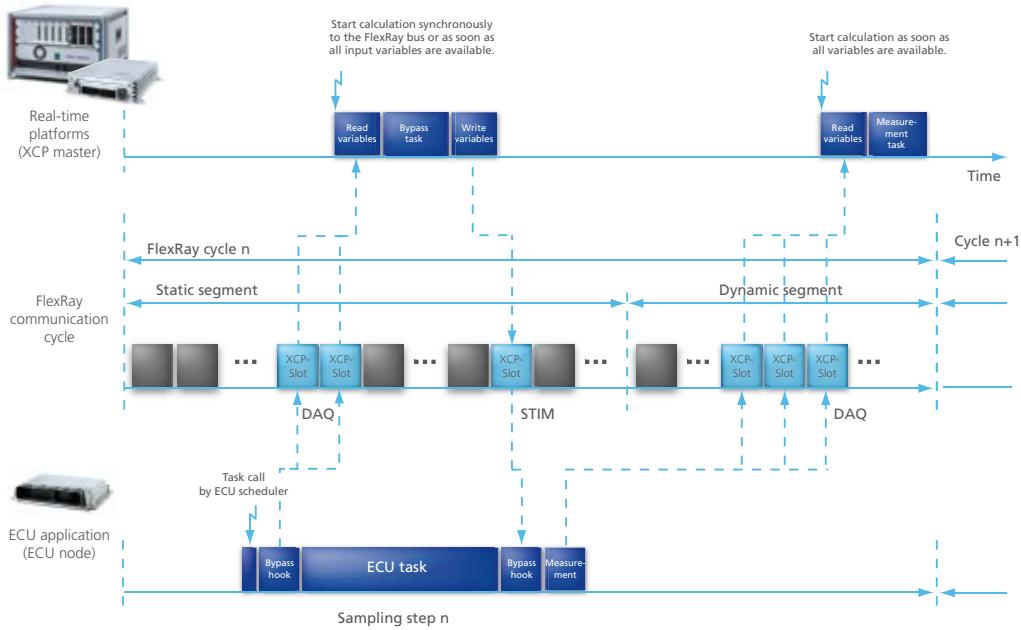


Figure 4: FlexRay communication sequence for a function bypass without sample step delay, and for a measurement data capture.

cycle. In applications with sample step delay, the ECU uses the bypass function outputs from the previous sampling step for its calculations. In scenarios like this, FlexRay communication can be performed in the dynamic segment of the FlexRay cycle.

Application Case 2: Data Capture in an HIL Scenario

Another typical XCP on FlexRay application for the RTI Bypass Blockset is monitoring the ECU's internal variables in a hardware-in-the-loop (HIL) scenario. The XCP service calls that are already available in the ECU at the end of each task are usually used for this. XCP communication is performed via the dynamic segment of the FlexRay cycle (figure 4). Thus, using the RTI Bypass Blocksets allows both simulation and ECU data to be recorded on precisely the same time basis. ■

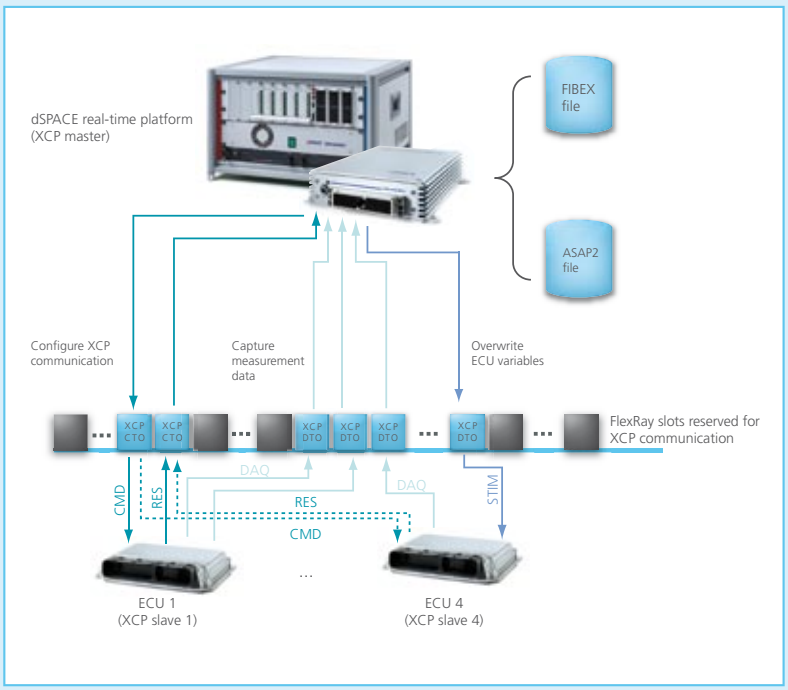


Figure 5: XCP on FlexRay communication: command transfer objects (CTO) are used for command-response sequences (CMD, RES), data transfer objects (DTO) for measurement and stimuli data (DAQ, STIM). dSPACE real-time platforms support parallel access on up to four XCP slaves per FlexRay bus.

XCP on FlexRay Technology

XCP: The Universal Measurement and Calibration Protocol

When an ECU is developed and validated, additional data has to be exchanged with it dynamically in parallel to the statically predefined bus communication. Typical appli-

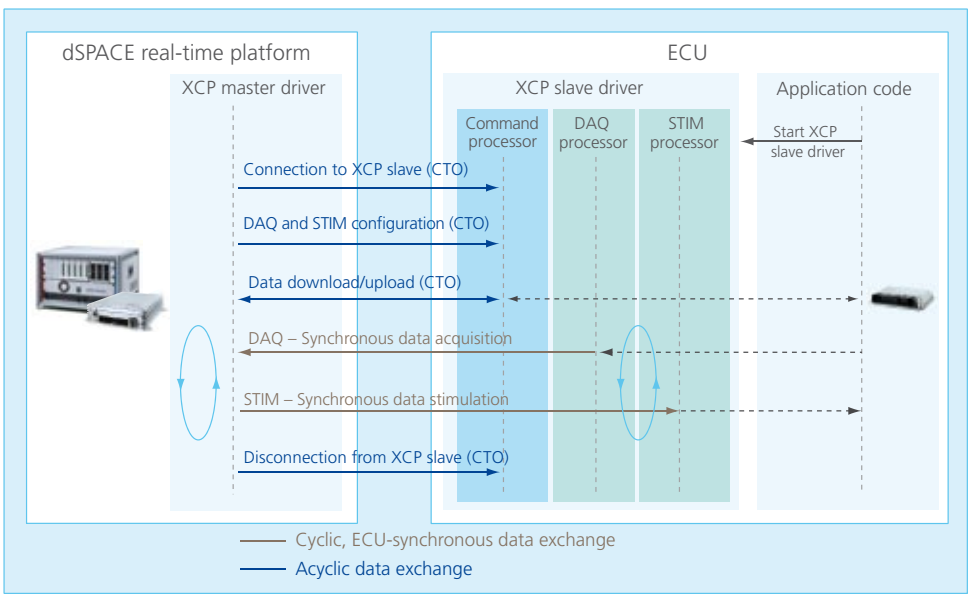


Figure 6: XCP communication sequences. The XCP slave driver consists of three components: a command processor, DAQ processor, and STIM processor.

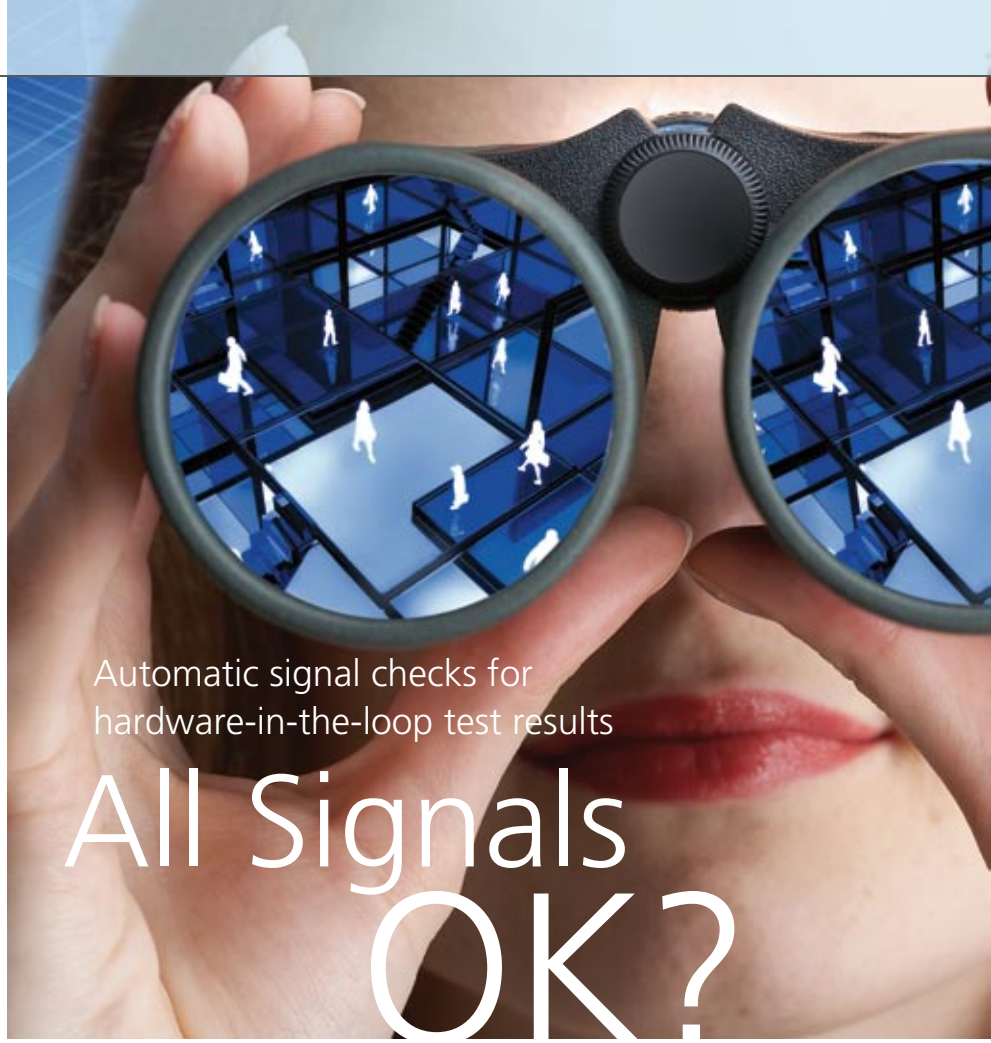
cations are adjusting control parameters in the ECU software (ECU calibration), ECU-synchronous data acquisition (DAQ) and cyclic overwriting of variables in the ECU RAM (STIM). The XCP protocol is tailor-made for these applications. It is based on a master-slave concept in which either a PC or the real-time simulation platform plays the part of the XCP master, and the ECUs act as the XCP slaves. The XCP driver software is usually a component in the production software inside the ECU. Starting from the XCP master, the XCP communication is configured by means of command-response sequences via XCP command transfer objects (CTO) during system run time. Noncyclic data exchange (download/upload), such as for calibration, is also performed via XCP command packets. When configuration has been completed, ECU-synchronous transmission of measurement and stimulus data is performed cyclically via dedicated XCP data transfer objects (DTO). The recipient does not have to respond to these, so they provide greater bandwidth (figure 6).

Fast and Flexible: XCP on FlexRay

One challenge with XCP on FlexRay is to integrate the typical XCP event-driven communication, e.g. as it appears with CAN, into the deterministic communication of the FlexRay bus. This is done by means of slots in the FlexRay communication cycle which are exclusively reserved for XCP communication and defined as XCP slots in the FIBEX network description file. Because the CTO packets contain slave-related node addresses, XCP communication with all ECUs via FlexRay basically requires only two single XCP slots for exchanging command-response sequences (CMD, RES). If more bandwidth is required, especially with regard to the cyclic transmission of measurement and stimulus data (DAQ, STIM), additional XCP slots can be added to the communication. XCP slots can basically be located in both the static and the dynamic segment of the FlexRay communication sequence. The majority of XCP slots are usually located in the dynamic segment, so that no bandwidth has to be allocated for measurement tasks statically. The static segment is usually reserved for deterministic communication. Assigning XCP slots in the FlexRay cycle means that the total bandwidth provided for XCP and the XCP communication timing both have to be taken into account when the bus is being planned. With some applications, up to around 30% of the FlexRay bus's possible bandwidth is made available for XCP communication.

Parallel Access to Several ECUs

For parallel access to several ECUs in a FlexRay network, arbitrary subsets of the XCP slots can be used for each ECU's communication. The result is dynamic partitioning of the total available bandwidth. The XCP slave configuration of each ECU is placed in the ASAP2 description file. It includes information on the ECU's internal FlexRay buffers that can be used for exchanging CTO and DTO packets, as either statically predefined or dynamically configured during run time (figure 5).



Automatic signal checks for hardware-in-the-loop test results

All Signals OK?

Thanks to the increasing automation of hardware-in-the-loop tests, more test cases can be run through in less time. But how do you keep track of whether the test results are satisfactory? This is where the Evaluation Library in AutomationDesk 2.2 comes in.

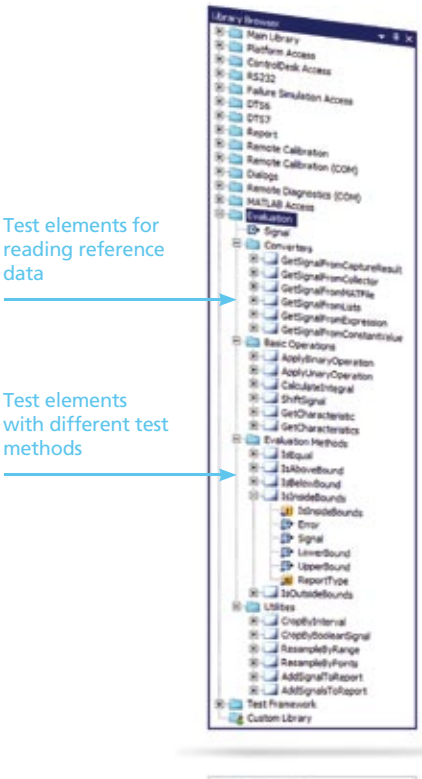


Figure 1: The library contains various evaluation elements that can be dragged to the test sequence.

AutomationDesk 2.2 now not only provides the Debugger for checking the tests (see dSPACE Magazine 2008-2). It also has another innovation: the Evaluation Library. This lets you compare the recorded test data with the reference data, making it easier to analyze and evaluate the test results.

Comparison with Reference Data

An automated hardware-in-the-loop (HIL) test gives testers a multitude of data and signal behaviors. But a successful test run does not necessarily mean that the signals are within the desired ranges. So the test results have to be checked.

AutomationDesk's Evaluation Library is used for this. It compares signals with their reference signals and assesses whether the signals in the test results are inside or outside the defined limits. This is a quick and simple way of evaluating test results.

Reference Signals from Numerous Sources

You can obtain reference signals for comparing and evaluating measured signals from a variety of sources. To choose the source, you can insert the appropriate test step from the library into the test sequence (figure 1).
The data can:

- Be described by listing sample points
- Come from previous measurements
- Consist of a constant signal
- Be defined by a mathematical expression

If the reference signal is defined manually, you can decide yourself how precise it is – by specifying either a large number of sample points or only a few. The in-between values are interpolated.
When regression tests are performed for new ECU versions, the ideal method is to compare the data with the results of previous measurements.

In this example, the comparison between the measured signal and the recorded signal reveals an upward deviation.

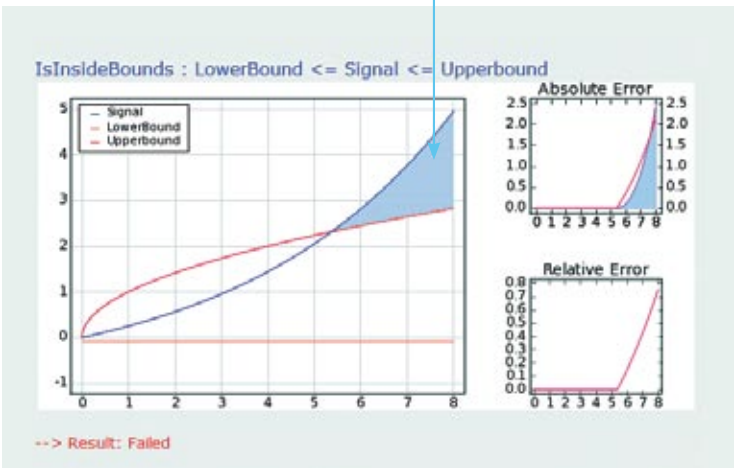


Figure 3: The automatically generated report includes a graph showing limit violations.

The tool that does it all. From test creation, to test execution, to test evaluation. AutomationDesk.

Signal Changes and Evaluation

When signals are compared and evaluated, the frequent method is to manipulate either the measured signal or the reference signal. This can involve the following operations:

- Using binary operations (add, multiply, less than, etc.)
- Calculating gradients and integrals to obtain further variables
- Moving signals along the x-axis to obtain a common start point or to cut off ranges that are not under investigation
- Resampling signals to calculate intermediate values, e.g., if the first signal outputs a value every millisecond, but the second signal only every 5 milliseconds. Different interpolation strategies can be selected.
- Calculating minimal/maximal values, minimal step size, etc.

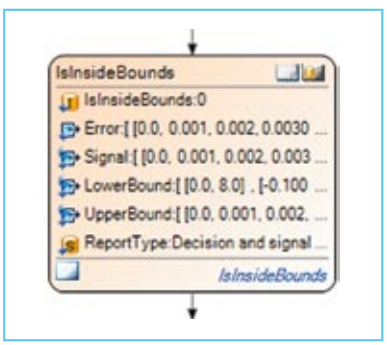


Figure 2: The upper and lower limits are defined by using test blocks in AutomationDesk.

The library contains ready-made methods for evaluating the signals. These methods check whether the signal is the same as the reference signal, whether it is above or below a defined limit, and whether it is inside or outside a range defined by two limits. You can add your own, self-defined methods to your libraries (figure 2).

Automatic Report Generation

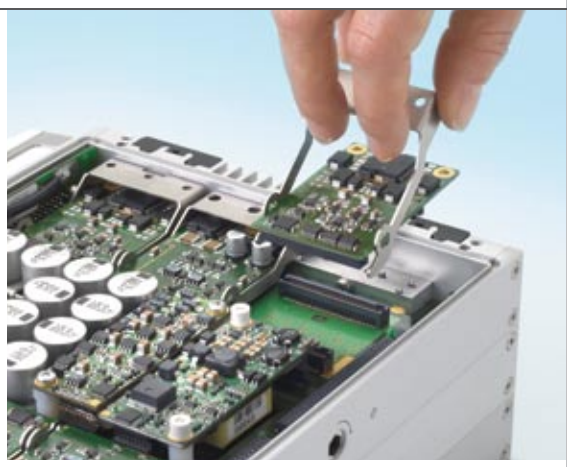
When the evaluation has been completed, it is automatically summarized in a report (figure 3). This contains a graph of the measured signals, the reference signal, and limit violations.

With the Evaluation Library in AutomationDesk 2.2, complex evaluations of recorded data can be produced quickly and simply. This reduces the time required for test creation. And automatic report generation means that tests are well-documented. ■

RapidPro: Connection Guaranteed

A continuously growing selection of interface modules for connecting sensors and actuators directly to dSPACE prototyping systems

dSPACE's RapidPro is a highly flexible, yet compact system for connecting sensors and actuators. First launched in 2005, the portfolio of signal conditioning and power stage modules has been expanded ever since, so that today there is a comprehensive range of modules for very different applications. This out-of-the-box approach means that dSPACE customers can avoid expensive in-house developments. And the range is still growing.



Smaller than a playing card: a 1-slot RapidPro module. The modules are easy to configure and quick to replace when requirements change.

The RapidPro Concept: Flexibility is Key

Compactness, flexibility, and off-the-shelf availability: These are the key concepts of dSPACE's RapidPro hardware, introduced in 2005. Since then numerous customers have been using the system to implement the sensor and actuator connections for their prototyping systems. The key to success is the enormous range of hardware- and software-configurable RapidPro modules, which can be plugged on simply, and quickly replaced whenever required. Each module provides a particular signal conditioning or power stage functionality. The standard components can be combined to form an individual system that is easy to modify whenever project requirements change. This has been a great labor-saver for numerous customers, since the only alternative to the convenient RapidPro concept is often to develop special circuits themselves – involving higher costs, more time, and greater project risks. Quite often this task was delegated to service providers with the necessary specialized knowledge. When the project was completed, the system was exactly in tune with the project requirements. There was no flexibility, however, so new requirements that arose during the project could not be met completely. In addition, it was often not possible to reuse the system in new development projects with modified sensor-actuator environments.
The solution is RapidPro: an elegant, flexible, compact system with a proven track record in numerous customer projects, which is continuously being extended by new modules for current applications.

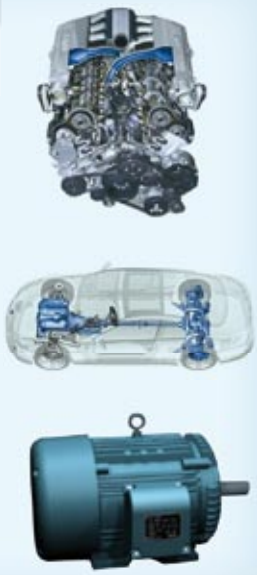
RapidPro Modules: Constantly Expanding Portfolio

RapidPro covers many automotive application areas because its modules can be combined flexibly to match the available installation space. In addition to multi-purpose module functionalities such as analog in/out, digital in/out and sensor supply, application-specific modules are also available. For example, for engine management there are special modules to capture the camshaft position and crankshaft position, to connect the lambda probes and knock sensors, and to generate the injection pulses and ignition pulses (see table). For applications in electrical drives and valves, there are half-bridge and full-bridge modules which can deliver peak currents of up to 60 A. In cases where required functionalities differ from standard functionalities, dSPACE offers an engineering service for customer-specific requirements. The latest additions to the portfolio are modules for connection to Denso lambda probes and for the fast, digital control of actuators. A module for universal control of brushless electric motors is under development and will be available within 2009.

Easy Module Configuration

The broad range of sensor interfaces and actuator interfaces demands a high level of flexibility during signal adaptation. This is achieved by a wide selection of specific signal conditioning modules and power stage modules. Due to the comprehensive configurability of the hardware and software, these modules can also be adapted to the necessary interfaces. Elements such as filters, voltage dividers, and pull-up/down resistors can be inserted on the modules wherever required. Settings such as the voltage ranges, signal inversion, and special behavior modes can be made easily via the software. Module-specific diagnostic messages and

RapidPro Modules: Signal Conditioning and Power Stages	Application Examples				
	Engine Management	Transmission	Chassis	Body	Electric Motors and Valves
SC-SENS 4/1 sensor connection	X	X	X	X	X
SC-AI 4/1 analog inputs	X	X	X	X	
SC-AI 10/1 analog inputs	X	X	X	X	
SC-DI 8/1 digital inputs	X	X	X	X	X
SC-CCDI 6/1 crankshaft/camshaft position capture	X				
SC-DO 8/1 digital outputs	X		X	X	
SC-DO 8/2 digital outputs push/pull	X		X	X	X
SC-EGOS 2/1 Bosch lambda probe connection	X				
SC-UHEGO 2/1 DENSO lambda probe connection	X				
SC-KNOCK 4/1 knock sensor connection	X				
SC-TC 8/1 thermoelement sensor connection	X				
PS-FBD 2/1 full-bridge driver	X	X	X	X	X
PS-LSD 6/1 low-side driver	X	X	X	X	
PS-HSD 6/1 high-side driver	X	X			
PS-HCFBD 1/1 high-current, full-bridge driver		X		X	X
PS-HCHBD 1/1 high-current, half-bridge driver	X	X	X		X
PS-DINJ 2/1 direct injection	X				



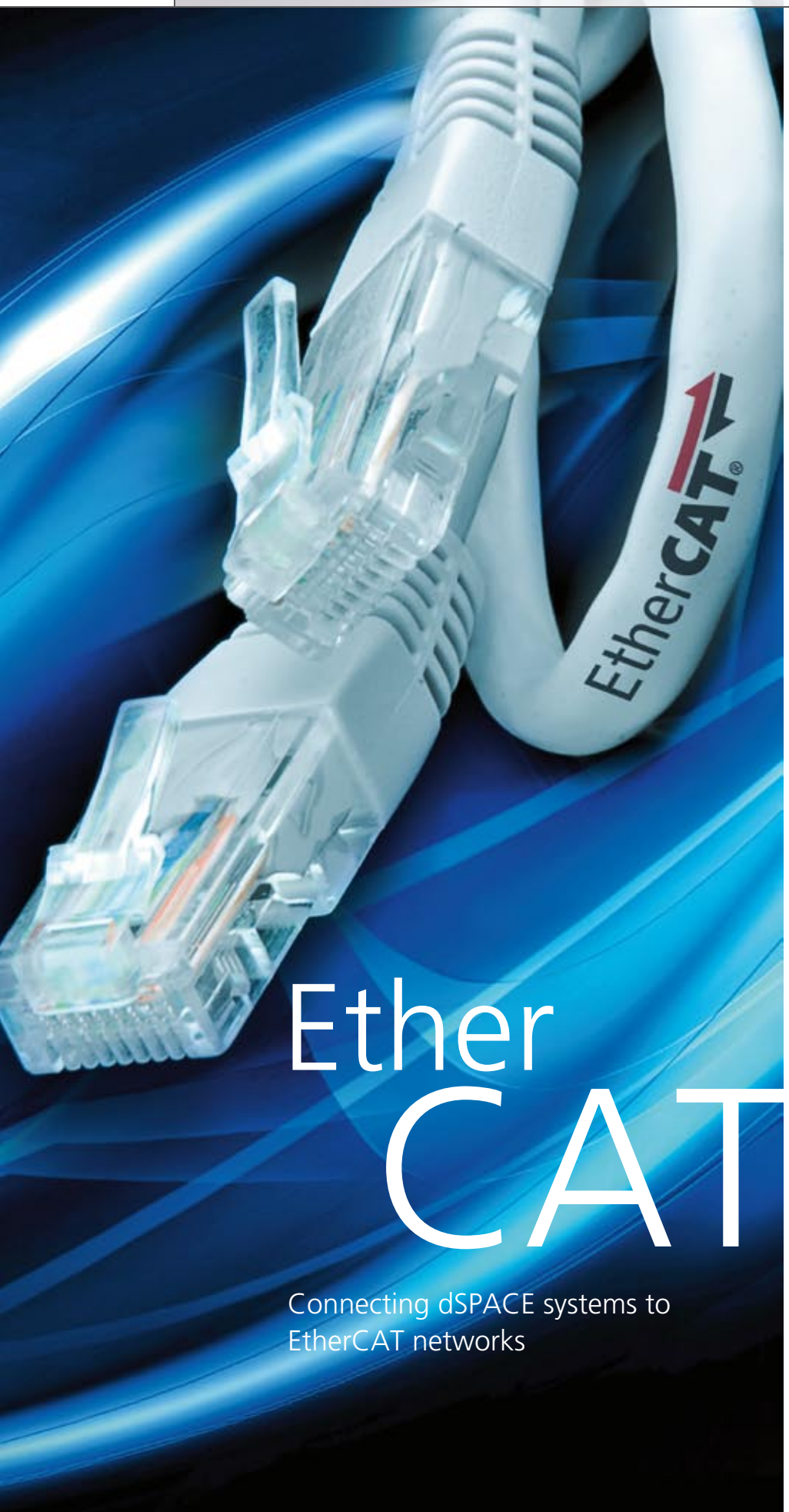
The RapidPro hardware is equipped for a wide variety of applications.

error messages are output, and the pinout list is generated as an aid for configuring the cable harness.

Looking Ahead

The RapidPro module for universal control of brushless electric motors currently under development will be launched in 2009 to provide special support for electrifying auxiliary aggregates such as oil pumps and water pumps via brushless DC motors. Further RapidPro modules are planned. ■

RapidPro has an extremely compact, highly scalable enclosure design that provides the optimum dimensions for any application size.



EtherCAT

Connecting dSPACE systems to EtherCAT networks

EtherCAT is an Ethernet-based field bus with many uses. One of them is as a communication system for applications in industrial automation. The new EtherCAT Slave Interface integrates dSPACE systems into EtherCAT networks.

Application Area

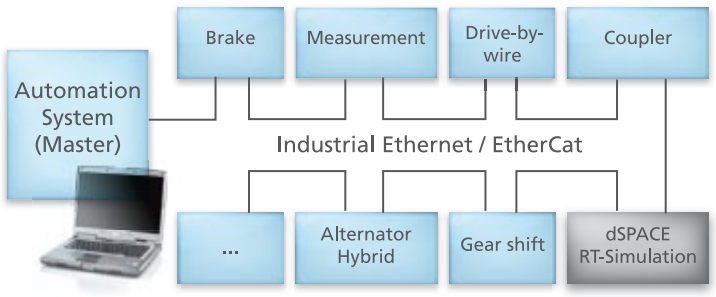
EtherCAT is an open protocol that is particularly suitable for implementing real-time applications in industrial automation. The protocol supports numerous network topologies such as line, tree, ring, star and combinations of these. The new EtherCAT Slave Interface has been specially designed to integrate a dSPACE system into an EtherCAT network as a slave. A typical application is an engine test bench with an integrated dSPACE System.

Hardware Concept

The EtherCAT Slave Interface is based on the DS5202 FPGA Base Board, the EV1039 piggy-back module, and either one or two Beckhoff FB1111-0140 EtherCAT controller boards. The DS5202 acts as the interface between the PHS bus and the dual-port memory (DPMEM) on the modules. The DPMEM is also addressed by the bus. To ensure data consistency, the EtherCAT Slave Controller performs synchronization.

Software Concept

The EtherCAT Slave Interface is configured by means of an M script that defines the object directory of the



Example of an engine test bench whose components are connected via an EtherCAT network.

Glossary

Ethernet –
Fast, cable-bound data network

Field bus –
Industrial communication system for connecting a large number of devices, actuators, and sensors

Mailbox –
Memory for CANopen messages

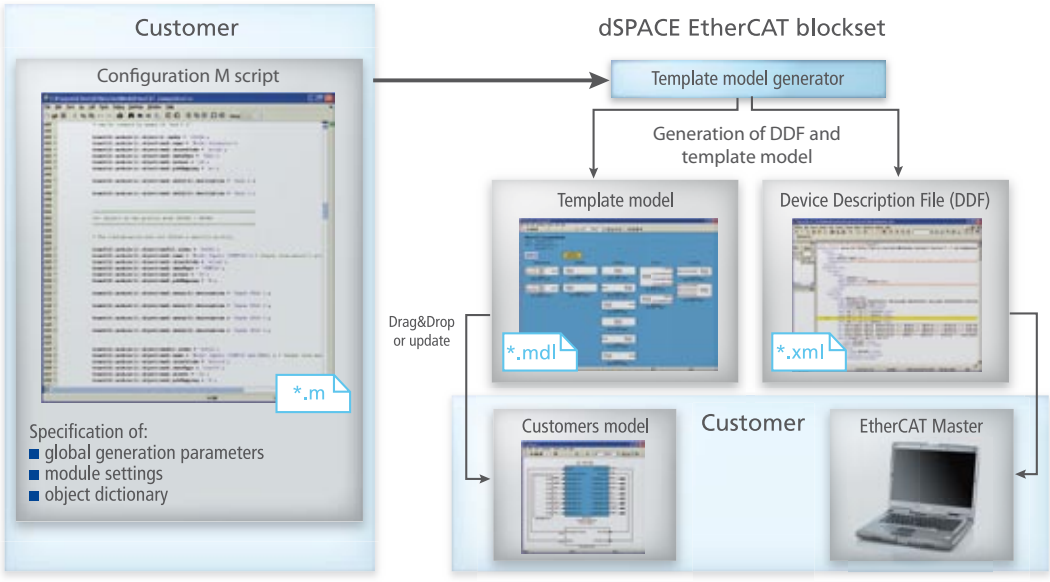
slave and some global settings. A Simulink template model and the device description file (DDF) are then created from these with the aid of an associated generator. The blocks in the template model are completely preconfigured and can be dragged straight to the function model for insertion. This method ensures consistency between the application on the dSPACE system and the DDF that is made available to the EtherCAT master.

Interaction and Communication

The EtherCAT Slave Interface supports the following methods for interaction and communication, and also provides the necessary Simulink blocks:

- State machine
- Interrupts
- CANopen over EtherCAT (CoE)
- Cyclic communication (RX, TX)

The state machine block processes the master's request to transition to a new state. It checks the validity of the requested transition and performs the associated actions.
The interrupt block passes EtherCAT interrupts to the function model so that actions can be activated synchronously. Interrupts can be selected and masked without the template model having to be regenerated.
The solution also supports acyclic communication with CANopen over EtherCAT. The object directory can be read from within the master, and individual entries can also be written. CANopen transfers can be executed in a background task. The mailbox provides 512 bytes for each direction and supports segmented transfers. A callback mechanism can be used to serve master accesses to the object directory with user C code. Six sync managers are available for cyclic communication. This means that different cycle times can be implemented to optimize the bus load. The configuration of the process data communication is static during run time. ■



Starting with an M script, the communication blocks and EtherCAT device description file are created.

Discover Real-Time Testing

The real-time testing toolbox for a wide range of application fields

Real-Time Testing is the ideal companion to the AutomationDesk test automation tool. For over two years, customers have been impressed by its value. The method allows the clock-synchronous execution of real-time test scripts and the Simulink simulation model.

The real-time test scripts are executed on a Python interpreter that is integrated into the real-time application. The interpreter can load various scripts during model run time and execute them independently of the PC without recompiling. Python is an easy-to-learn standard language for creating an understandable, flexibly extensible description of test scenarios that can be reproduced with precise timing. The scripts can detect all changes to model variables and react to them in real time in the same simulation step.

Cover More Test Scenarios

The first version of Real-Time Testing, for the DS1006 Processor Board, came out at the end of 2006. DS1005 support was added a few months later. These classic HIL platforms are supported as single- and multiprocessor systems. Then many of our customers asked for portation to MicroAutoBox. We responded to this need by providing AutomationDesk 2.2, which was launched in late 2008. Real-Time Testing can now also be used on the MicroAutoBox, for example, for RCP and for in-vehicle scenarios.

Real-Time Testing: Create precisely reproducible test scenarios with Python.

Stimulate More Data with Precise Timing

Numerous customers use Python real-time scripts to perform precisely timed stimulus generation for predefined signal behaviors. Recorded measurement data can be replayed via an intelligent load mechanism, in which the Python real-time script references a recorded file (MAT file) on the PC's hard disk. The script links data vectors in the file to the target parameters in the model. If the real-time test requires data to be replayed exactly 50 ms after a specific CAN message is received, for example, a simple replay command in the Python script triggers real-time-capable data transport from the PC to the real-time hardware in time for that to happen. The automatic load mechanism supports the replay of large data volumes, such as test drive log files several hundred MB in size. Several replay processes can run simultaneously, and they can all be controlled independently of one another. In a multiprocessor system, it is even possible to stimulate on several subnodes time-synchronously.

Generate More Traffic on the CAN Bus

For programming CAN restbus simulation, Real-Time Testing is conveniently integrated with the RTI CAN MultiMessage Blockset. The blockset contains an option for preparing CAN access for Real-Time Testing, so that the real-time scripts can send and receive CAN messages with freely definable CAN IDs and contents (see "All you CAN test" in dSPACE Magazine 01/2008). "This mechanism is so powerful that we also use it for replaying recorded bus traffic in ControlDesk," says Product Manager Holger Krisp. With Real-Time Testing, it is very easy to implement dynamic stress tests that continuously push the CAN bus to its transmission limits by feeding in interference messages. This procedure verifies whether the connected ECUs function correctly even in this extreme situation.

More Flexibility in Multiprocessor Systems

Today, HIL integration tests are executed on multiprocessor (MP) systems where submodels for the engine, transmission, restbus simulation, etc., are distributed across several processor boards to ensure real-time capability. To implement real-time scripts independently of the structure of the HIL model, Real-Time Testing provides transparent variable access in the MP system. The communication channels needed between the processor boards are set up dynamically by the Python test scripts during model run time, instead of being created statically in advance by the modeler. Local and remote variables can both be accessed during testing: It is sufficient to specify the unique MP variable path.

Do More with Real-Time Testing

Customers are already using Real-Time Testing in very diverse ways: for real-time stimulus generation, real-time observers, online time measurement in a millisecond raster, dynamic restbus simulation, and even complex integration tests – there's almost no limit to the possible uses. "dSPACE will continue putting new things into the Real-Time Testing toolbox in the future to open up new applications fields, such as direct ECU access from real-time tests via XCP on CAN," says Holger Krisp. ■

All's Well That Tests Well

Well-organized tests make sure your simulator really works for you

A testmanager's nightmare: The hardware-in-the-loop (HIL) simulators are up and running, but do not reduce the workload as hoped. So does all of that test hardware really do any good? To make sure it does, a sound strategy and good organization are needed. dSPACE not only offers tailor-made HIL simulators and the AutomationDesk test automation software. We can also provide support for setting up large, complex test environments, making sure that HIL simulators run efficiently in the long term.

HIL Simulation in the Automotive Industry

Only a few years ago, hardware-in-the-loop (HIL) simulation was just another test method for single ECUs or ECU networks. Today, it is an integral part of the software release process. HIL simulators test every system size from single components to extremely large networked systems. They cover all domains, including the engine, transmission, vehicle dynamics, chassis, infotainment, and comfort.

The usefulness of HIL simulation is no longer in question. But to run the test systems efficiently in terms of time and cost, the test strategy and test organization have to be planned carefully.

Long-Term Efficiency

The large numbers of new functions to be tested, the growing complexity of ECUs, and last but not least, the confusing number of variants all add up to an enormous quantity of test cases. Test automation is the method of choice for handling them. Test automation means test sequences can be defined once and then run automatically, overnight or on weekends. As users design more and more tests, they can build up a valuable library from which further new tests and test variants can be created. The objective is to continue using elements from the library for subsequent vehicle generations, if possible without modifications. So test automation must be viewed as a long-term task that will even outlive the simulator on which it was first implemented.

> Test automation is a long-term task that will even outlive the simulator on which it was first implemented.

Starting Out Right

A test automation tool provides support for test implementation and test execution. It is not a substitute for actual test development: the test developers still have to do this themselves. But it can help users to organize their work well from the outset, and to build a library for handling their basic function blocks. AutomationDesk, the test automation software from dSPACE, makes the task of constructing test cases a lot easier. Tests are created in graphical form, and the resulting basic blocks can be simply saved to libraries and then reused (figure 1).

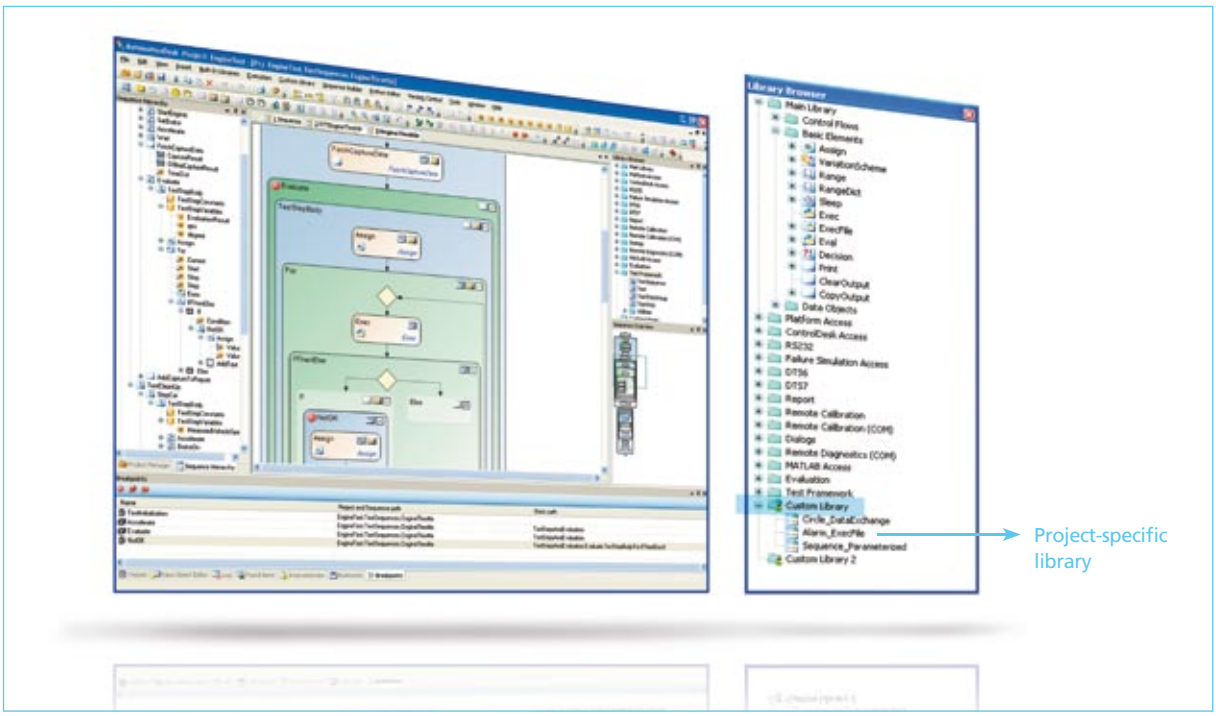
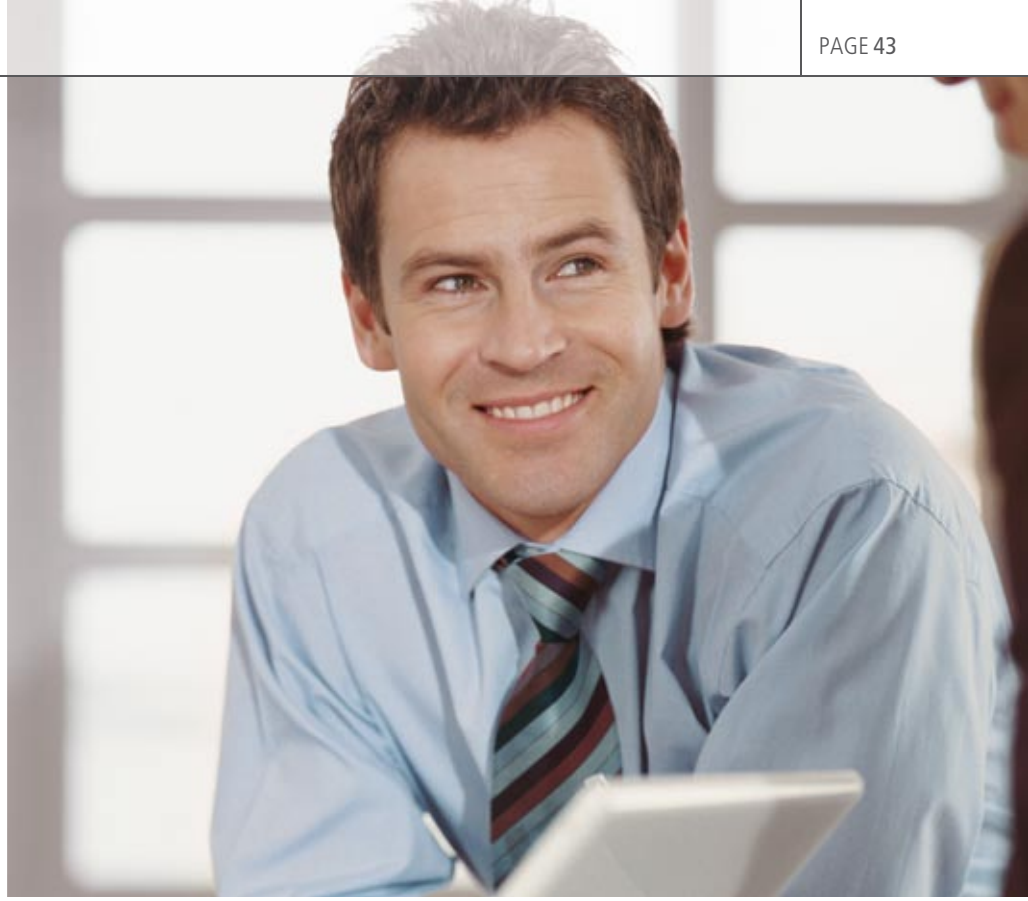


Figure 1: AutomationDesk supports the creation of project-specific libraries, for example, with Custom Libraries. The individual elements from the test cases can be added to the library by drag & drop.



Planning for Change

Some aspects can easily be overlooked, especially when test automation software is used for the first time. One of them is the fact that there may be additional vehicle series in the future, and the HIL systems may grow in size. The test cases have to be planned to allow for this. Even the test team itself might grow, and the test group structure has to accommodate that growth.

Reusing Test Cases

When testing begins, the focus is often on getting test results fast, without taking the time to set up a library. This makes it far more difficult to reuse tests later. Yet most HIL tests are so complex and elaborate that they cannot be handled and reused unless they are clearly organized.

Reuse means more than just using test sequences again in different test sets (for example, in regression testing). That type of reuse is easy to implement and involves very little work. Other types are more complex, involving the inclusion of similar components or even completely new ones.

1. Reusing a generic test for structurally similar test cases (for example, a single generic power window test for all windows, instead of four tests for four windows)
2. Reusing basic blocks on the same simulator for different test areas and issues
3. Reusing basic blocks and tests on different simulators, but for the same vehicle
4. Reusing basic blocks and tests for a new vehicle on the same simulator or a new simulator

The goal is to avoid redundancy in the library so that it is easier to maintain, and to use basic blocks that are as generic as possible to allow multiple reuse (figure 2). Generic, nonredundant basic blocks, combined with a suitable library concept, are the precondition for reusing test cases. If the test cases have to be adapted, such as when sensors have been modified, changes have to be made in only a very few places. The test cases that are derived are runnable almost immediately. If tests are created but there is no library concept, all the tests

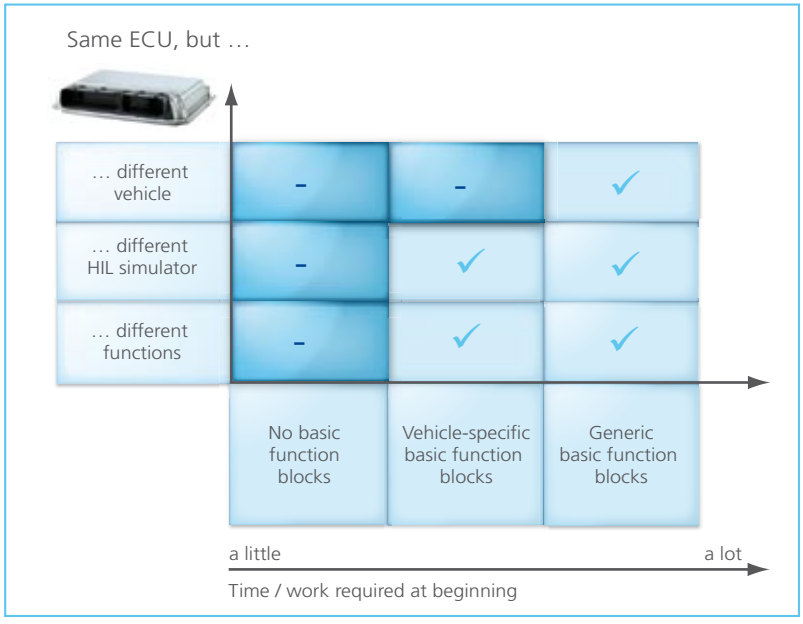
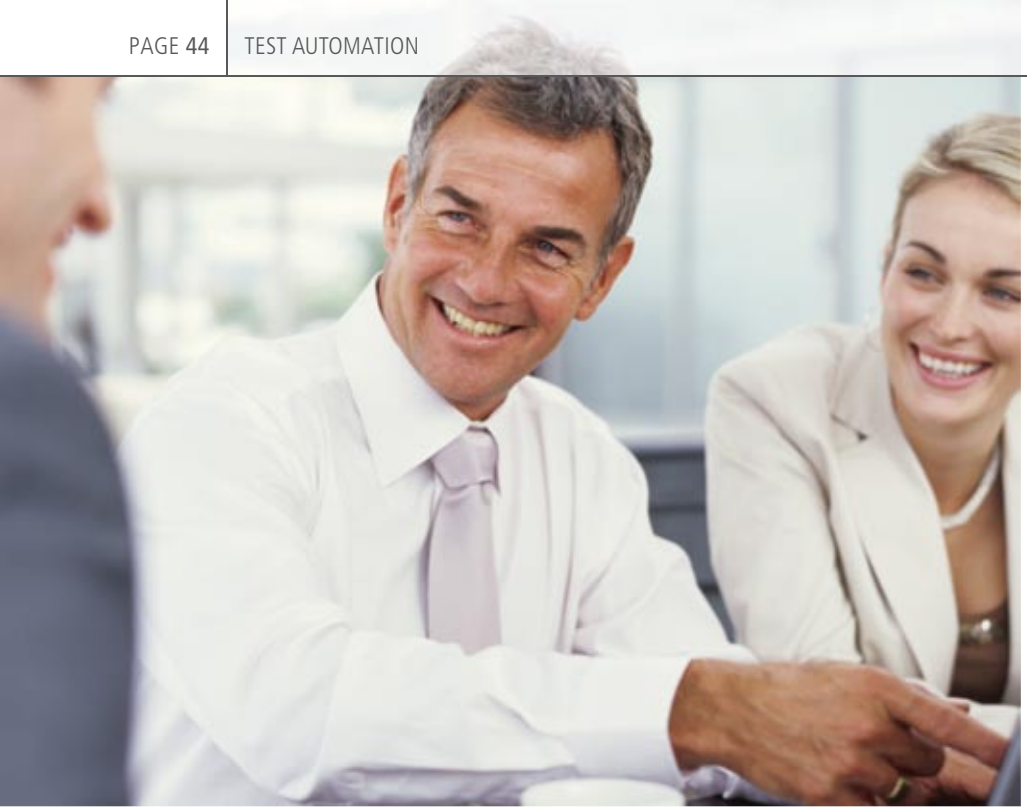


Figure 2: The initial effort invested in creating generic basic blocks simplifies test reuse later on in the process.



> A well-trained test team that is familiar with the test system is vital for the system's successful future use.

have to be reworked every time there is a change, such as when a new HIL simulator is used (figure 4). Introducing a sustainable test strategy may involve a relatively high initial workload, but the resulting libraries are the foundation for using simulators efficiently in the long term.

Quality ...

Creating, managing, and organizing test cases are not simple tasks to be performed on the side, even if there is software support. Test creation has many parallels with software development, where architecture and versioning are key elements. The quality of the work performed at the beginning largely determines how well tests can be reused later, and with how much effort. A well-trained test team that is familiar with the test system is vital for the system's future successful use.

... Means Certainty

When tests are run on a HIL simulator, developers have to be certain that errors found in a test run are really in the ECU code, and not in the tests themselves. So the first step is to specify, implement, and thoroughly test the basic blocks. Like software development, basic block development uses quality procedures such as clear function specifications, reviews, and official releases. The very first test cases are created in this way and then gradually extended. The extensions also undergo approval tests and release procedures. This provides the assurance that any errors that are found are in the ECU functions themselves, and the responsible ECU developers can classify the HIL simulation results as reliable (figure 3).

dSPACE Training and Engineering

A HIL simulator plus its associated software is a major initial investment. But this has to be seen in the right perspective: Even without a simulator, it costs a lot to run a test team over the years.
This makes it all the more important

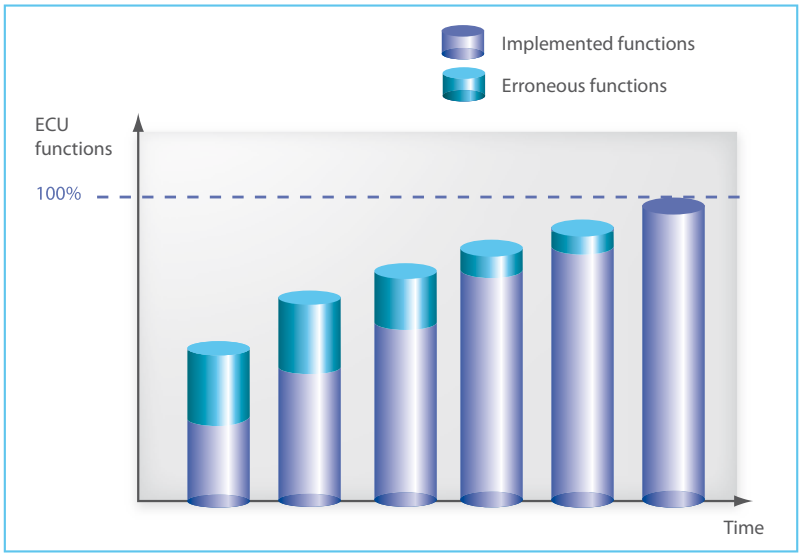


Figure 3: Using HIL simulation and test automation continuously enhances the quality of ECU functions.

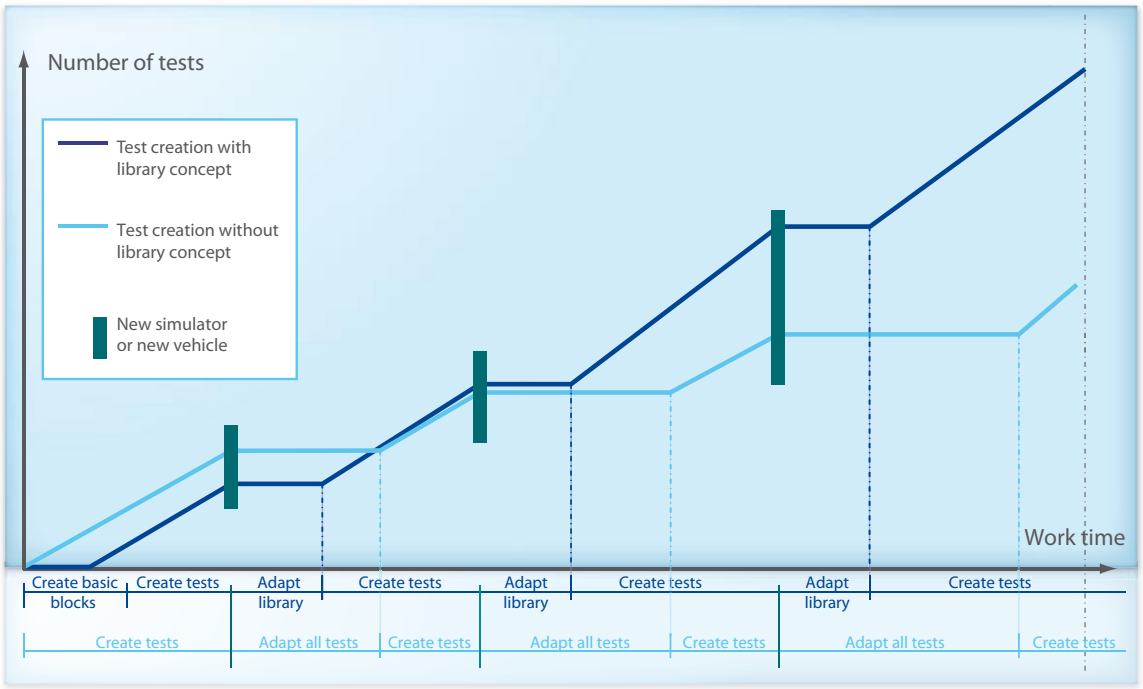


Figure 4: When a library concept is used, only the basic library blocks have to be adapted when a new simulator or a new vehicle is introduced.

to prepare test developers and managers thoroughly for working with the test software, enabling them to use it efficiently. dSPACE offers special training courses on AutomationDesk and on working with HIL simulators. The courses can be held on customers' premises if required, and can address specific requirements and needs.

For some years now, dSPACE has also been providing support for implementing test tasks. Engineering services for test automation start-up mean that users benefit from the dSPACE engineers' knowledge of the hardware and software, and from the project experience they have accumulated. The services include:

- Test processes
- Tests
- Project implementation
- Resident engineers
- Creating the test template
- Creating the library concept
- Example test implementation
- Data and result management
- Integrating third-party software
- Connecting the test software to existing tools

The knowledge and experience that dSPACE gains from engineering projects are used for further product developments, so that the products are always in tune with user requirements. Our products are market-driven, and we are actively involved in setting the trends, such as standardization formats. At the same time, users profit from our extensive experience when they set up their test environments. ■

Summary

- Test automation is indispensable to HIL simulation
- A well-structured library concept facilitates test reuse
- The initial effort pays off in the long term

Do-It-Yourself Formula One

International student teams build their own racing cars for Formula Student at the Hockenheimring

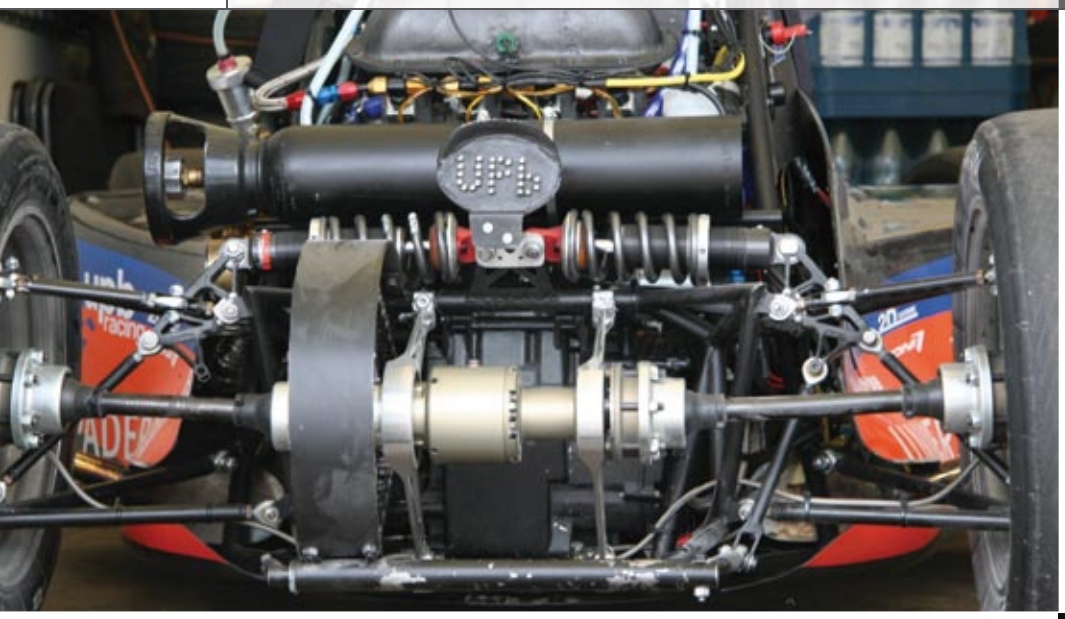
The UPBracing prototype racing at high speed.

The tilt table test: Will all four wheels stay on the ground, and will no liquid leak out?

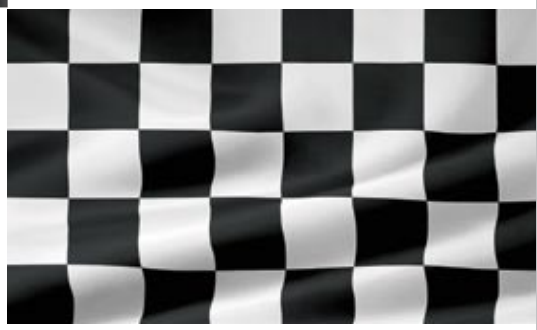
Each year, for a few days in August, students from all over the world meet at the Hockenheimring in Germany to race their self-designed, self-built cars on this traditional Formula One track. But with Formula Student, it's not just the team with the fastest vehicle that wins. The students also have to excel in production design, implementation practices, marketing activities, and other disciplines.

A Taste of Science and Technology

Students like Florian Meier and Ulrich Jahnke from the University of Paderborn, Germany, are already working on their third racing car for the competition – in addition to their university studies. Two years ago, when they decided to compete in Formula Student, they had no idea how the project would affect their careers. The idea behind the Formula Student competition is that an automobile manufacturer commissions the students to build a prototype for amateur racing drivers, designed for the production of several hundred vehicles a year. The vehicle must be inexpensive, reliable, and easy to run. It must also perform well in terms of accelerating, braking, and handling. Its market value is enhanced by other factors such as aesthetics, comfort, and the use of conventional, mass-produced parts.
Moreover, it has to pass several



The rear of the racing car – the result of intensive assembly work.



official roadworthiness tests before being allowed on the racetrack. The best vehicle is chosen by a jury of experts from motorsports and the automotive industry (OEMs and suppliers). The jury appraises each design, each cost sheet, and each sales presentation, and compares them with those of competing teams. The UPBracing Team from Paderborn is currently developing its third model for Formula Student. The students are changing the basic frame of their racing car's body and optimizing the components.
The Association of German Engineers (VDI) started running Formula Student Germany in 2006 to show interested companies the quality of young engineers. The competition aims to give students a taste of scientific and technological issues through sports, and hopefully to attract much-needed people into engineering. dSPACE is sponsoring the UPBracing Team in the endeavor to get young people interested in technical and scientific subjects at university level.

Like a Small, Independent Company

Ulrich and Florian and their team are devising their own marketing campaigns, and once every six weeks they publish a newsletter reporting on upcoming events. Ulrich's marketing team has thought up a program of incentives to ensure that all team members stick to the schedule. Everyone who completes their concepts, ideas, and activities punctually receives small advertising gifts. For larger projects, they sometimes get a new UPBracing jacket. Each team has to present itself like a small, independent company.
The team has even assigned sports students the task of devising the ideal work-out for the driver, to ensure optimum fitness for the gruelling race.

Interdisciplinary Cooperation

The project gives students from various subjects practical experience and also an insight into other fields and scientific disciplines. The business side of the UPBracing Team is taken care of by the IT, accountancy, press relations and marketing groups. On the technical side, there are groups working on the chassis, the body, the engine, the drivetrain, and the brakes. The students communicate via an internal forum on the UPBracing website or directly by e-mail and telephone.

Each group holds regular weekly meetings. Florian and Ulrich say that one of the things they have learned is how to organize themselves. For example, to avoid spending too much on travel, the team member who lives closest to the location where something needs doing is the one who goes and does it. The UPBracing team has 35-40 active members, eight of them women. Florian sometimes finds it difficult to acquire new members. When students graduate and move away, they have to explain to younger students who are interested in Formula Student that participation in the project is voluntary and very time-consuming. The students' response to Formula Student is enthusiastic despite this.

Last year, 64 student teams from Germany and other countries took their racing vehicles to the Hockenheimring to compete for victory in the eight disciplines of Formula Student Germany 2008. The organizers say that the advertised places had all been taken within six minutes on the first day of registration. 35 German universities and 29 international teams participated, including ones from the USA, Australia, Canada, and Japan. Florian and Ulrich say you

have to enjoy designing and building things and be prepared to invest time. And they add that you learn an enormous amount that will be useful in your future career. "The major strengths that are really needed in motorsports are quality, flexibility, speed and innovation. Formula Student offers upcoming generations of engineers an opportunity to prove their interdisciplinary skills, their commitment to teamwork, and the know-how for understanding complex issues. These are the very requirements that we want our young graduate employees to meet," says Thomas Casey, CEO of HEGGEMANN autosport.

The students already had numerous contacts with potential employers and have become very self-confident in their dealings with the CEOs of major companies. They feel they are being taken seriously and are proud of their project. This opinion is shared by Hubertus Benteler from the Benteler Group, the main sponsor for the UPBracing team: "The success of a company always partly depends on its employees' dedication, their team spirit, and their ability to think outside the box," he says. "Someone taking part in Formula Student has proven that he or she has understood what it's all about, from the idea and the financing through to the production of a product. We're happy to invest in people like that, because they get things moving!"

More than 70 International Teams Who Help Each Other

In addition to networking with potential employers, students also sharpen their social skills by working in a team. Formula Student therefore includes a Fairness Award. With

Expert Opinions

"Interdisciplinary skills, commitment to teamwork, and the know-how for understanding complex issues are the very requirements that we want our young graduate employees to meet," says Thomas Casey, CEO of HEGGEMANN autosport. HEGGEMANN specializes in high-performance engineering. The company is an expert in all aspects of vehicles and as a supplier covers all the classic production and service domains involved in motorsports.

Hubertus Benteler from Benteler AG adds: "The success of a company always depends in part on its employees' dedication, their team spirit, and their ability to think outside the box." The Benteler Group is one of the world's largest independent automotive suppliers and is internationally active in automotive technology, steel/tubing and commercial business.

The UPBracing team from the University of Paderborn.

more than 70 international teams, the competition organizers place great importance on mutual help. There is great solidarity between the teams competing on the track. Obviously, everyone wants to win and hopes their car will be the fastest, but despite this, people help each other wherever they can. One example of this was when the car made by the University of Bayreuth had a faulty brake pedal which meant that the team would not be able to go to the starting line. The UPBracing team from Paderborn searched through its inventory and provided the parts for the brake pedal. The Delft/Holland team even turns up to each race with a complete truck full of equipment so they can help teams who get stuck. That earned them the Team Supporter Award. Ulrich and Florian are obviously hoping that their racing car will be the fastest at Formula Student 2009, and that the University of Paderborn will continue to back their project. Other international teams have large assembly shops to work in. The UPBracing Team will soon have more space too. Talks with the University of Paderborn about relocating from their 38-m² room to a proper workshop facility are already underway. ■

The Vehicle's Technical Data

Acceleration: From 0 to 100 km/h in 4.4 seconds
Top speed: 180 km/h
Power: 72 HP
Weight: 250 kg

Noise test: One of four official roadworthiness tests that the car had to pass to be allowed on the track.

Interview

Florian Meier, 23, studies Commercial Engineering, and Ulrich Jahnke, 25, studies Engineering Informatics. Both are active members of the UPB-racing team at the University of Paderborn.

You joined the Formula Student project two years ago. What motivated you?
Florian: We can actually put some of the things into action that the University just gives us the theory for. Our team produces real results. Who would have thought so: We made a racing car all by ourselves, and we're driving it on a real Formula One track!

What was the biggest challenge?
Ulrich: At the beginning, it was difficult to find sponsors, because of course no one had heard of the project. Now we've actually managed to build our own racing car for Formula Student, and this year Hubertus Benteler from Benteler AG visited Silverstone personally to see our ambition for himself.

What are you learning from the project?
Florian: Good teamwork – you're not struggling for personal success like at the university, you're working towards a shared goal, and you really have to get along with all the members of the project.

Ulrich: Personally, I learn more from the project than I do from all the lectures dealing with a specific subject. When I've been involved in developing a component myself, I don't have to do any studying when I sit an exam on the subject later!

How have you benefited from teamwork?
Florian: I communicate much better than I used to. I think the amount of talking I do everyday has increased from 5,000 to 15,000 words. I even had to change my cell phone contract, so I now have 1000 free minutes. *(laughs)*

How did you acquire the know-how?
Florian: First we studied a lot of background literature. Then we sat down at the computer and took the plunge – with our brains on overdrive until the component we were aiming at came into being, at least visually. The whole team is constantly passing on knowledge, and new members also bring in new ideas.

Are there also difficulties?
Ulrich: It would be good if the university would recognize our work by giving us credits. Even so, by investing time in the project you learn an enormous amount for the future and for starting out on a career.

Were you able to use your contacts with companies yet?
Florian: The project is a good advertisement for us. Some team members have received definite offers for internships for producing examination theses. And we're really self-confident now. Self-marketing is a big thing for us – suddenly I'm giving lectures in front of all the engineers at our sponsors! *(tugs at his shirt and grins)*

What was your best moment so far with Formula Student?
Florian: One time the top team from Stuttgart was in the lead in a race, the car kept gaining in one lap after another, then suddenly a chain broke and the car just stopped dead not far from the finishing line. The audience was horrified. Then someone stood up and started clapping, and the entire audience joined in – it really gave me goose bumps.

ANACOM

New Distributor Brings dSPACE Closer to Brazilian Customers

Since November 2008, Brazilian companies interested in dSPACE products have a new partner: ANACOM Eletrônica Ltda. The company has over twenty years' experience in distributing development tools, and provides engineering services and training for its customers. Rafael Sorice, Sales & Marketing Manager, and Luigi Lauro, Project Manager for Services & Training, give insights into the company.

How was ANACOM founded?
Rafael Sorice: Carlos E. Lion, an electrical engineer with broad experience in aerospace and the computer industry, founded the company in 1989. He is now ANACOM'S President and CEO.

How has the company evolved since then?
Rafael Sorice: We began by developing custom electronic products, which we completely manufactured on our own, from designing the circuit board to generating the microcontroller code. We also marketed CAE/CAD tools for the electronics industry. We continuously expanded our distribution services. Five years ago, in response to high demand, we started providing project engineering and training. This is how we grew from 3 employees at the beginning to 70 employees now. We aim to expand service and consultation activities in the near future, until they make up 50% of our turnover. We give our customers individual support, and to be closer to more of them, we opened an office in Chile five years ago. Further offices in Peru and Columbia are planned.

What kind of companies come to ANACOM?
Luigi Lauro: We work in the automotive, aerospace, and military sectors, and for companies who require custom electronics or product training. Our customers include automotive OEMs like General Motors, Volkswagen, Volkswagen Truck, FIAT; suppliers like Delphi, Magneti Marelli and BOSCH; and the world's third largest aircraft manufacturer, Embraer.

What products do you have in your portfolio?
Luigi Lauro: We offer solutions for developing embedded systems and for automation technology (electronic design automation, EDA). We work very closely with major tool suppliers. So we're particularly pleased to have acquired dSPACE as a partner.

What services do you offer your customers?
Luigi Lauro: Our engineering team gives our customers total support, from the beginning of a project to its successful implementation. For example, we developed an automated control system for a refinery, supporting the project from the initial design, through the entire hardware and software development process, to final completion.

Why did you choose dSPACE?
Luigi Lauro: dSPACE is the right partner for us to forge closer links with the automobile industry. We talked to dSPACE customers in Brazil, who

Luigi Lauro and Rafael Sorice, from ANACOM's management team.

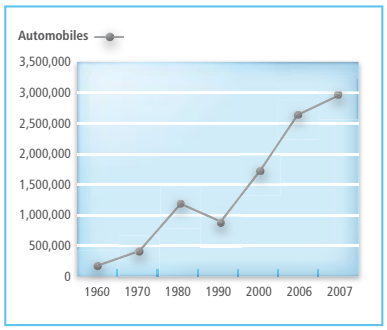
gave us impressive answers when we asked how dSPACE solutions support them in their work. We had comprehensive HIL training at dSPACE's headquarters in Paderborn, where we saw the benefits of this technology for ourselves.

How do you see Brazil's economic future?

Rafael Sorice: The Brazilian economy has developed extremely positively. Trade surpluses and reduced vulnerability to external shocks, low inflation, improved public finance, a reduced risk premium, accelerating economic growth that generates jobs, and institutional reforms – these have all been achieved in the last five years.

Economic stability and inflation control are greatly reducing poverty. The percentage of foreign capital in national investments has risen notably. Brazil is the world's tenth largest economy, with a gross domestic product of approx. US$ 1,400 billion in 2007. Major OEMs such as Volkswagen, General Motors, PSA, FIAT, SCANIA, Mercedes-Benz Trucks, Volkswagen Trucks, Toyota and Honda chose Brazil as the location for their South American research and development facilities.

We're convinced that Brazil's economy will go on booming!



Automobile production in Brazil.

What does the automobile market look like in Brazil, and are there any technological specialties?

Rafael Sorice: Two major innovations are the ethanol and flexi fuel systems. Some suppliers are already on the third generation of their systems.

The Brazilian automobile market is booming, and OEMs are launching more new cars: Last year there were over fifty new models and accessories. This had never happened before.

Local engineering is very alive, creative, competent, and very cost-effective. This explains the numerous technological development centers, all working on solutions to meet the domestic demand. We see that a lot more electronic components will be incorporated into cars, and there is great potential in ECU development.

Brazil is in a new situation: Formerly, cars were launched in the US and Europe and arrived here years later. Now OEMs will be much quicker to present innovations in Brazil. One particular challenge is the high tax that Brazilians pay on cars, about 36% of the final value. We expect this will change, because it is a barrier to introducing new technologies.

What are dSPACE's chances on the Brazilian market?

Rafael Sorice: dSPACE has excellent chances of expanding its market share here. Time and costs are the major difficulties facing ECU testers, and HIL simulation will definitely fill a gap. Experimental engineering now plays a vital role in Brazil, and more investments in modern laboratories and specialized people are needed. ANACOM is ready to meet this need, and will support its customers with advice and technical training.

Thank you for talking with us.

Profile of Brasil

Population: ca. 190 million (2008)
Gross domestic product (GDP): US$ 1,400 billion (2007)
GDP composition: 64% services, 30% industrial production, 6% agriculture
Automobile production (2007): 2,797,321 passenger cars, 175,501 commercial vehicles (source: VDA)
Automobile market: With approx. 14% growth in total automobile production, Brazil was the fastest growing automobile market after China in 2007. Brazil is also the largest market for ethanol products. Approx. 70% of the cars in Brazil are prepared for flexi fuel operation, which switches between gasoline and ethanol combustion.

www.anacom.com.br

North American User Conference 2008

In-Vehicle Electronic Content on the Rise

Wajiha Chahine, Software Testing Supervisor at Ford Motor Company, and Mina Khoee-Fard, Engineering Group Manager at General Motors, answer questions from the audience. Mina Khoee-Fard gave the keynote speech at the HIL session.

Automakers are constantly challenged to roll out new, innovative features that will make vehicles more appealing, safe, reliable and efficient. But with every new add-on, OEMs have to address the issue of growing technical complexity.

While the management of electrics/electronics (E/E) complexity represents a real challenge to the automotive industry, the growth of electronics in vehicles isn't expected to slow down any time soon. This was the common message shared at the dSPACE North American User Conference held in Michigan September 23-25, 2008. More than 170 attendees from automotive OEMs, Tier Ones, tool suppliers, and the aerospace/defense, off-highway/commercial and academic communities participated in the conference.

Panel Discussion

During an executive management panel discussion themed on major management challenges related to embedded software development, representatives concurred that the

Dr. Herbert Hanselmann, CEO, dSPACE; Jim Brogoitti, Manager, Core Systems and Software Engineering Electronics and Safety, Delphi; Alan Amici, Director of Vehicle Development, Chrysler LLC; Christopher Davey, Senior Technical Leader - Software & Control Systems Engineering, Ford Motor Co.; Kent Helfrich, Director of Software Engineering, General Motors Powertrain (left to right).

> "The conference brought high value to my colleagues and me in terms of the breadth of experience presented by a variety of users, in the detail introduced in the workshops, and in the observations of the panelists."
>
> *Ken Leininger, In-Vehicle Tools PDT Leader, Controls Engineering Tools Group, GM*

need for safer, more fuel-efficient and environmentally friendly vehicles is leading the automotive industry to incorporate more electronic content into the vehicle.
Kent Helfrich, Director of Software Engineering, General Motors Powertrain, said powertrain software for the GM global product portfolio is projected to ramp up significantly. Helfrich presented a timeline chart for the period of 1999 to 2014. From 1999 until around 2003, he noted a decline in the complexity of the embedded software product line within General Motors Powertrain as the company converged its powertrain portfolio. Since 2003, he said the complexity of GM's powertrain embedded software product line has been on the rise and will not flatten out until the middle of the next decade. "This is a great time to be a powertrain controls engineer in GM," Helfrich said. "All our advanced propulsion technologies will be enabled by embedded control systems. We are writing history as we bring these technologies to market."

Audience Feedback

Audience members concurred that similar trends are occurring at their companies. As part of an electronic survey that was conducted during the opening day of the User Conference, attendees were asked to provide their opinions on when electronics in automobiles will stop growing. 83% responded that it will be 10 or more years before the use of in-vehicle electronics comes close to peaking. What are the reasons for this continued growth?

Critical for Safety, Reliability and Functionality Requirements

One of the main influential factors is the across-the-board realization that embedded electronics and mechatronics are critical to meeting growing safety, reliability and functionality requirements, not to mention the numerous "must-have" comfort and convenience features that are demanded by today's car buyers. Moreover, the development of advanced propulsion and control technologies – such as hybrid-electric, fuel cell and autonomous vehicles – are introducing more ECUs to the vehicle.
Another major factor is the roll-out of standards such as AUTOSAR (AUTomotive Open System ARchitecture) and FlexRay. While these specifications are more widely known in Europe than in the United States, they deliver strong incentives for OEMs, suppliers and tool developers seeking to manage growing electrics/electronics (E/E) complexity.
During the opening keynote speech delivered by Dr. Herbert Hanselmann, the dSPACE CEO and founder gave insight on the dSPACE tool chain and new products that are emerging to address industry needs for embedded controls development. He said dSPACE is addressing the E/E complexity issue with the roll-out of its new architecture design tool – SystemDesk. SystemDesk helps software developers to plan, implement and integrate complex system architectures and distributed electronic control systems that are AUTOSAR-compliant.

Presentations from Automotive, Aerospace and Academic Industries

User application experiences are the traditional focal point of dSPACE User Conferences. The North American conference featured 19 presentations – 14 delivered by dSPACE tool users from the automotive, aerospace and academic industries and 5 given by dSPACE technical

Dr. Herbert Hanselmann, CEO, dSPACE; Kevin Kott, President of dSPACE Inc. (left to right).

Wajiha Chahine, Software Testing Supervisor, Ford Motor Co.; Mina Khoee-Fard, Engineering Group Manager, Global Systems Engineering, Advanced Development and Validation, GM; Rohinikumar Adivi, Engineering Project Team Lead, Caterpillar Inc.; and, Peter Hartman, Senior Manager, Powertrain Controls, Chrysler LLC. (left to right).

experts. Topics ranged from model-based design and production code generation to verification and validation strategies. Presenting companies included: Argonne National Laboratory, Bombardier Transportation, BOSCH Motorsports, Caterpillar Inc., ChallengeX/EcoCAR: The NeXt Challenge; Chrysler LLC, Delphi, FEV Inc., Ford Motor Co., GM, and MPC Products.

> "Many times, during economic cut backs, the verification phase is the first part of a project that funding gets cut. This conference showed both its importance and what everyone else is attempting to do in this area. Hence, great conference, and keep it up."
>
> *Ronald Fassnacht, Supervisor Powertrain HIL Team, Chrysler LLC*

HIL Technology Day

The second day of the User Conference was dedicated to a series of presentations on hardware-in-the-loop (HIL) technology. Mina Khoee-Fard, Engineering Group Manager, Global Systems Engineering, Advanced Development and Validation, GM, kicked off the HIL session with a keynote speech on GM's global HIL initiative and the role of HIL in the electrical and electronics software verification process for integration testing. She highlighted the strategic approach behind global HIL application in the E/E area and the harmonized processes and methods for enabling usage of HIL systems in 10 major vehicle engineering centers in GM. The keynote speech also touched upon the challenges of global E/E architecture, its implications on HIL application strategy, and the approach taken for addressing these challenges.

Product Workshops

On the final day of the conference, dSPACE technical experts hosted a series of 1-1/2 hour workshops. The sessions gave conference attendees an opportunity to hear more in-depth discussions related to dSPACE solutions for model-based design, AUTOSAR, CalDesk, autocoding with TargetLink, Automotive Simulation Models (ASM) and HIL test systems.

On behalf of dSPACE, we sincerely appreciate the high level of participation and contribution provided by our panelists, guest presenters and exhibitors. We hope conference attendees gained valuable information and insight on the pace of the constant change occurring within the embedded controls industry. ■

For more information on upcoming dSPACE events, visit our Web site at www.dspace.com

CalDesk: FlexRay Support

ECUs can be accessed via XCP on FlexRay with Version 2.1 of CalDesk, the universal measurement, calibration and diagnostics software. Another new feature is that data recording can be continued automatically, without user interaction, after the ECU's voltage supply was switched off and then on again during a running measurement (for example, manually during ECU calibration in the vehicle, or automatically via the HIL simulator during ECU tests). CalDesk has numerous functional extensions and many new comfort features, such as rearranging and reconfiguring plotter axes simply by dragging and dropping them.

Automation Interface for the RTI Bypass Blockset

The newest version of the RTI Bypass Blockset offers comprehensive automation capabilities via a MATLAB® m-API. For example, via a script, users can automatically exchange ASAP2 variable description files and variables for write/read access to the electronic control unit (ECU), or implement dedicated control dialogs for certain user groups. dSPACE will soon also offer the option to exchange measurement and stimulus variables dynamically, without recompiling the simulation model.

The RTI Bypass Blockset allows dialog-based configuration of ECU accesses and bypass applications in Simulink®. A uniform user interface enables real-time communication between the dSPACE simulation platforms and ECUs via CCP, XCP (CAN, Ethernet, FlexRay), on-chip debug ports (JTAG, Nexus, AUD/NBD, …) and DPMEM PODs.

Top HIL Topics

Something new happened at the 8th "Haus der Technik" conference on hardware-in-the-loop simulation in Kassel, Germany: For the first time ever, ETAS and dSPACE extended a joint invitation to their users and customers to come and compare notes. Around 80 guests got together on September 16-17, 2008 for discussions and talks on their projects and experiences. The topics ranged from HIL simulation and using models to test automation.
Partner companies of ETAS and dSPACE used the exhibition space to present innovations and talk to conference attendees in person. dSPACE presented a hardware-in-the-loop simulator for electric drives including load simulation.
The guests spent the first evening on a river boat on the river Fulda, where a hilarious onboard bowling match really broke the ice. The participants were full of praise for the event, and both hosts saw it as a complete success.

Professor Michael Popp (Bionorica AG), Frank Ferchau (FERCHAU Engineering GmbH), Professor Götz W. Werner (dm-drogerie markt GmbH + Co. KG), Dr. Herbert Hanselmann (dSPACE GmbH), Alexander Rösner, Klaas Kersting (Gameforge AG) (left to right)

Dr. Herbert Hanselmann is "Entrepreneur Of The Year 2008"

And the winner is ... Dr. Herbert Hanselmann. Dr. Hanselmann was quite excited about being presented with the prestigious "Entrepreneur Of The Year 2008" award by Ernst & Young in the Alte Oper in Frankfurt, Germany, in early October. "It's great to receive this award. It recognizes our sustainable, successful business endeavors and our commitment to thinking outside the box. I hope it also makes our employees feel a bit proud too. Without their motivation and their achievements, there might be an entrepreneur, but there wouldn't be an entrepreneur of the year," said Dr. Herbert Hanselmann.
Ernst & Young presents the annual business award in 50 countries all over the world. The title is awarded to entrepreneurs who excel at growing and sustaining market-leading businesses in their respective fields. Dr. Hanselmann received the award in the category Information and Communication Technology/Media. "The award winners are market leaders with double-digit growth rates and numerous new products. That's what impressed the jury," states Wolfgang Glauner, organizer for the award competition at Ernst & Young. "The winners' recipe for success includes an immense capacity for innovation, which is why they focus so strongly on further training for their staff."

Pelestorms' Lego Robot Leads European Competition

At the First LEGO® League's robot design tournament held in Zürich in December 2008, a total of 24 international teams competed for the Central European title in various categories. The Pelestorms from Pelizaeus school in Paderborn, Germany, won first place in Robot Design and took fourth place in the overall competition. Now they're off to Copenhagen to compete against the world's best in the Open European Championship in May 2009. In this international competition, young engineers between the ages of 10 and 16 build Lego robots and program them to perform specific tasks dealing with "Climate Connections". The jury of experts not only looks at how the robot is designed, but also judges the young researchers' presentation and teamwork. The young people have to come up with creative solutions to complex tasks. dSPACE is sponsoring the Pelestorms and supporting them with background knowledge. It's all part of dSPACE's ProMINT Initiative, which was founded to inspire students to take up Mathematics, Informatics, Natural Science and Technology – and to boost the numbers of young people entering engineering professions.

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formula student germany

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DYNAMICS EH REGENSBURG

Encouraging the will to win: Talent meets technology

The future belongs to innovation. So at dSPACE, we're helping young researchers get their ideas on the road. Here's just one example: Formula Student Germany, a race in which student teams build racing cars and compete against teams from across the globe. dSPACE products such as MicroAutoBox and TargetLink are giving Formula Student teams an edge in design, performance, economic planning and reasoning. And providing them with an opportunity to use real world technologies to speed them on their way. As a company with its eye on the future, dSPACE is opening doors to young talent. And giving them their first successful hands-on experience. Good luck to all the teams!

Embedded Success dSPACE