dSPACE

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Behr-Hella Thermocontrol has set up a model-based
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A lot is written about corporate culture these days. In essence: It is the attitudes of management and employees, towards their work, each other, and the outside world, that determine the success of their company in the long term. Customers soon notice if staff are not really motivated, but merely submitting to pressure and instructions from above. At dSPACE, we cherish our corporate culture. We have always had an informal, family-like atmosphere, and are determined to preserve this despite rapid growth. Our efforts are obviously appreciated by our customers, who often give us positive feedback on topics connected with this very fact.

We wanted to find out more about what they thought, however, so we held our first systematic survey on satisfaction among our German customers. Over 90% of respondents scored our overall performance as being good or very good – the two highest scores. The more detailed items in the questionnaire were also given these two top scores in 80 to 90% of the responses, with Support and Sales heading the field. We were also curious to know how customers saw dSPACE's market position as compared with competitors. So we asked for their estimation of how innovative, reliable, flexible and cooperative we are. We can be more than content with the answers.

The survey results exceeded our expectations. But we have no intention of becoming complacent. We know we will always need a healthy measure of self-criticism, and that to meet our customers' requirements in the long term, we have to continue changing. So close communication between you and us is vital – to build trust between us, and provide a firm foundation for partnership.

Dr. Herbert Hanselmann
President and CEO

12 *Conti Temic develops diesel engine ECUs for DaimlerChrysler's commercial vehicles. Code generation is routinely performed by TargetLink, dSPACE's production code generator.*

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Developing and Testing Prosthetic Wrist Joint Designs

- **Work by the Centre for Orthopaedic Biomechanics at the University of Bath, UK**

- **Prosthetic wrist joint development for more successful wrist replacement surgery**

- **A wrist simulator, controlled using dSPACE Prototyper, is used for testing designs**

Successful replacement of the human wrist joint is a major challenge for modern orthopedic surgery. A multidisciplinary team of surgeons and engineers is working at the University of Bath to tackle some of the key issues in engineering a new wrist joint prosthesis. An important aspect of this work has been the development of a wrist simulator that can be used to test the functionality and performance of prosthetic wrist designs. The use of dSPACE Prototyper has enabled a control system for this wrist simulator to be created with minimum time and effort.

Wrist Simulator Design

The development of a machine that can be used to compare the performance of different prosthetic wrist designs under realistic loading conditions has been a challenging task. This simulator was required to reproduce typical motion and loading conditions of the human wrist while allowing measurement of the forces involved. Current wrist prosthesis designs are based on a refined ball-and-cup type joint. Dislocation of the joint under loading (for example produced by pushing oneself up out of a chair) can be a major problem following implantation and so one purpose of the simulator was to establish the factors that contribute to joint dislocation.

▲ *Wrist replacements that are currently in production.*

The Mark I version of the simulator has a modular construction with aluminum blocks used to represent the hand and forearm, in which the two halves of the prosthesis are fixed. Four cables, positioned to represent the main tendon groups within the wrist, are used to articulate the 'hand'. One end of each cable is wound on a shaft connected through a gearbox to a brushless servomotor, which is used to regulate cable motion and tension. The other end of each cable is attached to a load cell on the hand block so that cable tensions can be monitored and used for control feedback. Incremental encoders connected to the motor shafts provide the controller with motor position signals. The forearm block of the simulator is mounted on a six-axis force transducer, used to deduce instantaneous loading conditions.

All force and motor position signals are monitored by dSPACE Prototyper through the high-resolution A/D board and used by the control algorithm running on a dSPACE processor board. The output of this control system drives the motor power electronics and in effect determines the torque produced by the motors.

Control Algorithm Evolution

Due to the wider project objectives and timescales it was important to have the control system for the wrist simulator operational within weeks rather than months of the hardware being assembled. However, this meant that the control algorithm had to be developed without the luxury of a mathematical model of the system, which could have been used to synthesize algorithms and perform simulations.

▲ *The wrist prosthesis simulator allows testing and visualization of new prosthesis designs.*
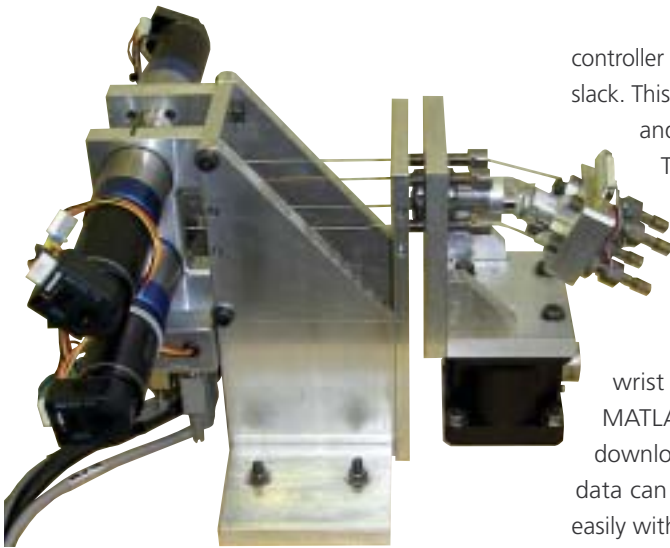
controller if the tendon cables become too tight or too slack. This is achieved using standard PD (proportional and derivative) feedback with high gain.

The controller is initialized manually using ControlDesk. Prosthesis test routines that involve prespecified wrist motions can then be run automatically using MATLAB® script files that utilize the MLIB interface library. The motion paths for the wrist are uploaded to the controller from the MATLAB workspace, while measured data is downloaded following each test. In this way test data can also be recorded, viewed and processed easily within the MATLAB environment.

Instead, the controller design process involved iterative development and testing on the hardware itself. Without the use of dSPACE Prototyper this would have been a very time-consuming and uncertain task.

The current system uses a closed-loop position controller based on an artificial neural network (ANN) algorithm. The external inputs to the algorithm are the time-varying position demand signals, in the form of wrist angular displacements. Additional control loops regulate the cable tensions by overriding the position

Outcomes and Outlook

The creation of the wrist simulator for functional testing and comparative assessment of wrist prostheses will allow significant progress to be made towards an optimum clinical design, without subjecting patients to unnecessary risks. Ongoing development of the wrist simulator itself is aimed towards more accurately replicating the behavior of muscles and soft tissues within the wrist and arm. Fast and efficient control system implementation and development, which are made possible through the use of dSPACE Prototyper, will be of key importance in achieving this goal.

Dr. Matthew Cole
Department of
Mechanical Engineering
www.bath.ac.uk/ortho-
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University of Bath
United Kingdom
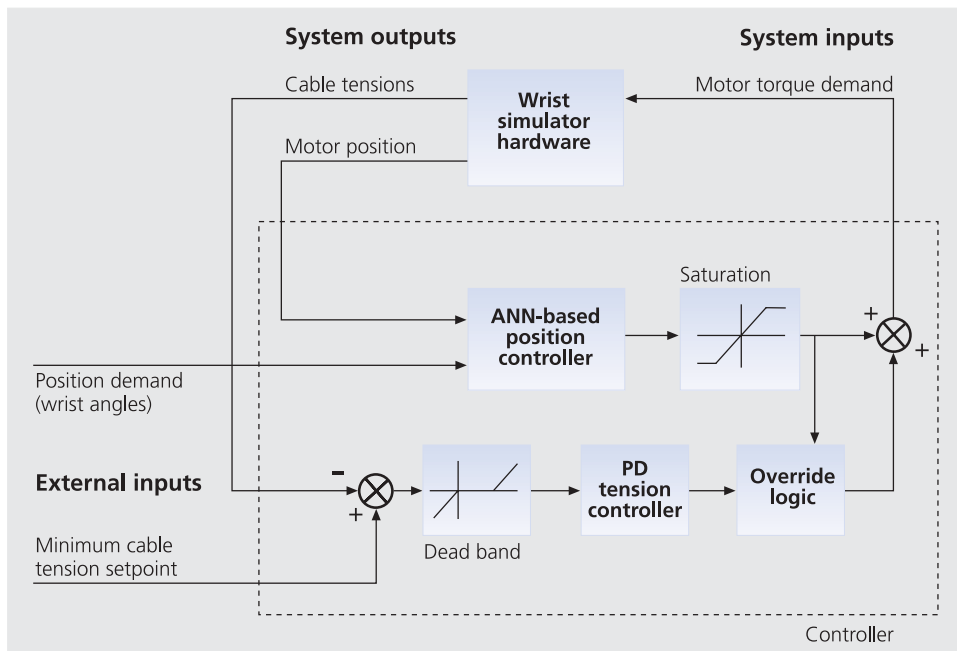
▲ *Block diagram of the closed-loop control system. The controller code runs on dSPACE control hardware.*

Whisper Mode for Helicopters

- **Noise Reduction with dSPACE Prototyper**
- **Helicopter noise reduced by 50%**
- **Major step towards production level**

Anyone who has ever been near to a helicopter when it was landing knows the phenomenon: On top of the "normal" helicopter noise, there is an unpleasant, rhythmic drone. Eurocopter Deutschland has implemented a control for noise reduction, in cooperation with the European Aeronautic Defence and Space Company (EADS), ZF Luftfahrttechnik (Aviation Technology) and the German Aerospace Center (DLR): With the help of dSPACE Prototyper, the rotor blades' angle of attack is modified to change the air flow, cutting the resultant noise by half.

Blade Vortices Cause Noise

The noise created on a helicopter's approach to landing is called blade vortex interaction (BVI) noise. Blade vortex interactions arise when the air vortex leaving one rotor blade collides with one of the following blades. Blade vortex interactions can occur in many flight situations, but they are particularly intense during descent at approx. 120 km/h and a flight path angle of 6-8 degrees. Under these conditions, a rotor blade can be completely submerged in the trail of the preceding blade, so that collides with the vortex along its entire length – the result is large pressure fluctuations that radiate as acoustic energy. In other flight situations, the vortices largely
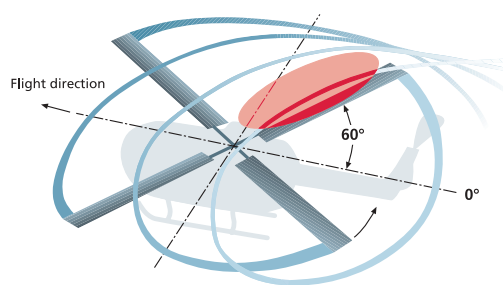
▲ *The rotor blades collide head-on with air vortices in the area marked red. This causes a large part of the aircraft noise.*
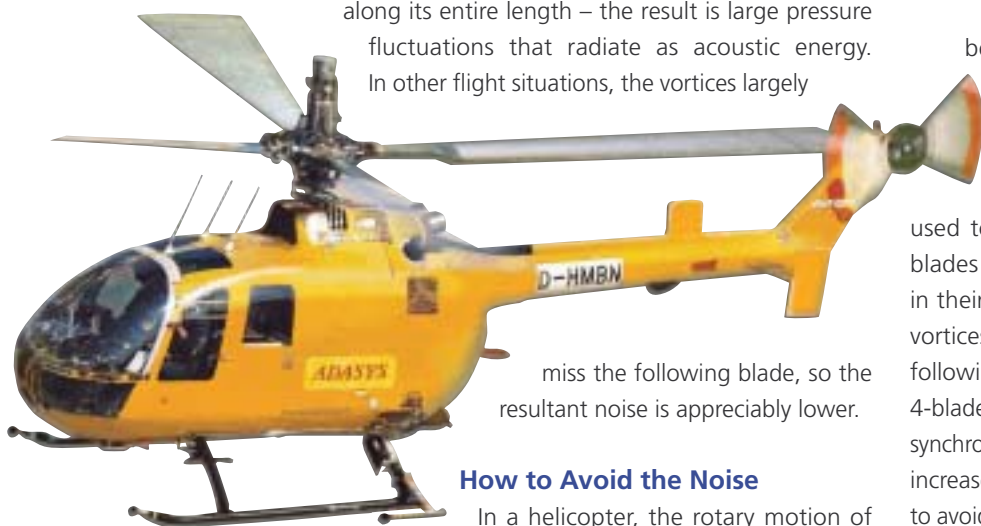
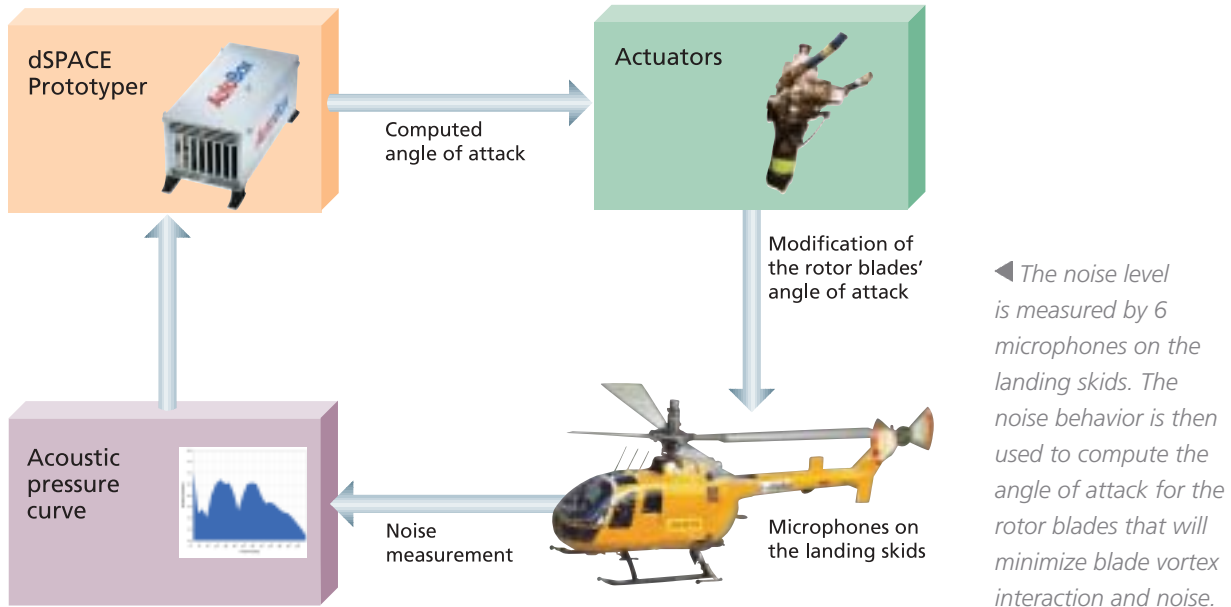▲ *Type BO 105 helicopter. Microphones for noise measurement are mounted on the landing skids.*

miss the following blade, so the resultant noise is appreciably lower.

How to Avoid the Noise

In a helicopter, the rotary motion of the blades and the straight motion of the craft overlap, giving rise to a particular kind of air flow behavior. In the rear right quadrant of the rotor disk, there is a zone in which rotor blades and vortices move towards each other and collide head-on. The result is a high noise level. If a method could

be found to suppress the collisions between rotor blades and air vortices in this zone, a large part of the overall aircraft noise would be eliminated.

To achieve this, dSPACE Prototyper was used to modify the angle of attack of the rotor blades for fractions of a second at specific points in their rotation. This changes the direction of the vortices that are shed, which then largely miss the following rotor blade – minimizing the noise. On a 4-bladed helicopter, the angle of attack needs to be synchronously reduced for 2 blades and simultaneously increased for the other 2 blades. This is the only way to avoid additional pressure fluctuations. The pilot has the feeling that the helicopter is behaving normally, as it would without the additional rotor blade control. The modification to the angle of attack is only 1.4 degrees at a maximum – very little in comparison to the angles of up to 30 degrees that can occur in common flight maneuvers.

dSPACE Prototyper

Computed angle of attack

Actuators

Modification of the rotor blades' angle of attack

Acoustic pressure curve

Noise measurement

Microphones on the landing skids

◄ The noise level is measured by 6 microphones on the landing skids. The noise behavior is then used to compute the angle of attack for the rotor blades that will minimize blade vortex interaction and noise.

Using dSPACE Prototyper as a Silencer

To test the principal function of the individual rotor blade control, a type BO 105 helicopter was modified.

- A total of 6 microphones were mounted on the landing skids to measure noise behavior. The optimum rotor blade control for minimizing noise was then computed from the noise behavior.
- Instead of the usual rigid control rods on the rotor blades, an actuator was connected to each of the 4 blades, allowing additional adjustment to the angle of attack for each blade separately.
- Pressure sensors were mounted on the rotor blades to measure the sharp pressure fluctuations on impact with a vortex.

This imposes tough demands on the dSPACE hardware, as it is inundated by measurement signals coming from the microphones and blade pressure sensors, which it has to process fast and convert into a control signal for the rotor blades. The blades rotate at approx. 7 revolutions per second. The noise level on the landing skids, the pressure fluctuations on the rotor blades and other factors are measured 512 times per revolution. High sampling frequencies of up to 5 kHz are needed to compute useful control signals for the rotor blades. This is the reason we

chose dSPACE Prototyper. The entire experiment was configured with MATLAB®/Simulink® and monitored by means of ControlDesk.

Noise Cut by Half

During trial flights carried out in November 2001, a reduction in noise of 6.8 dB was achieved during descent using the setup described above, at a flight path angle of 6 degrees. This means that the noise as perceived at ground level was cut by half.

In addition to this noise control concept, a modern vibration control is also being tested in a new test setup. Both systems will then be adapted to the flap blade currently being developed at Eurocopter and tested. The flap blade has a new generation of actuator (with fast piezotechnology replacing slower hydraulics), and instead of moving the whole rotor blade, only the integrated flaps need to be adjusted in order to change the vortex. This is a significant step towards bringing these systems up to production level in the near future.

Dieter Roth
Eurocopter Deutschland GmbH
Germany

▲ Each of the 4 rotor blades has an actuator for modifying its angle.

Cool When It's Hot

▰ Behr-Hella
Thermocontrol:
Development
processes with
dSPACE tools

▰ Production code
generation with
TargetLink

▰ Verification and
integration tests with
dSPACE Simulator

Air-conditioning is now almost a standard feature in new vehicles. Improved comfort and the improved active safety that comes from a more pleasant driving environment are the main reasons why air-conditioning is so widespread. To tackle the ever-increasing workload involved in developing control strategies, Behr-Hella Thermocontrol has used dSPACE tools to set up a model-based development process that will allow more efficient work in many phases.

Modern, fully automatic air-conditioning systems are complex, with numerous control loops, sensors and actuators. Climate control is affected by a large number of thermodynamic systems and environmental conditions, such as humidity, sunshine and ventilation, and of course the temperature inside and outside the vehicle. Thus, new ECU hardware and software can only be tested completely in a real vehicle. However, prototypes of new vehicle models are rarely available, and the real loads have not yet been determined. So at Behr-Hella Thermocontrol, we have created a simulation environment that allows comprehensive testing off-vehicle.

dSPACE's TargetLink, which automatically generates production code from our Simulink models. Software-in-the-loop (SIL) with TargetLink enables us to detect and remedy any function or quantization errors at an early stage. TargetLink is now being used successfully in several ECUs.

Verification and Integration with dSPACE Simulator

Once the new ECU software is running on the target hardware, we use dSPACE Simulator in a second verification process: to test the interaction of hardware and software, with the real vehicle emulated by

Production Code Generation with TargetLink

We are using more and more MATLAB®/Simulink® to develop our ECUs. With appropriate system models, also available in MATLAB/ Simulink, we can simulate new software modules or functions in interaction with the associated subsystems. The plan is to run this initial verification phase without real-time hardware.
For new functions, there is a prototyping phase, where we are successfully using dSPACE's MicroAutoBox in advance development. Next we program the ECU software. We do this with
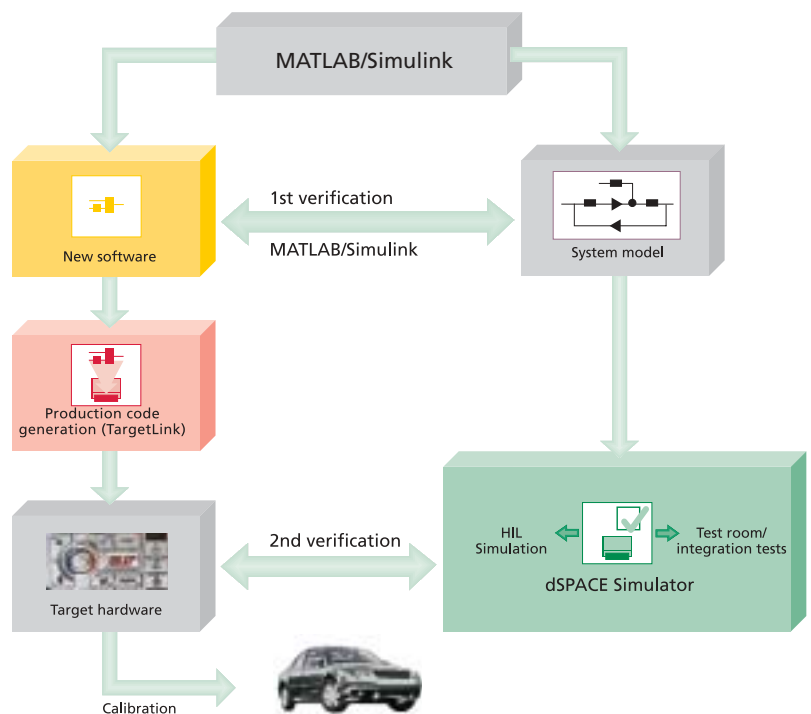
▲ Development process with dSPACE tools.

models. This is hardware-in-the-loop simulation (HIL), and it enables any errors to be detected and corrected early on. dSPACE Simulator and the models also enable us to perform hardware/software integration tests in the test room. Ideally, in future we will need the real vehicle only for final tuning.

Our dSPACE Simulator is based on standard, modular dSPACE hardware: the DS1005 PPC Board for real-time computation and several A/D, D/A and digital I/O boards. In addition, we use several DS4302 CAN Interface Boards to simulate the CAN communication in the vehicle.

There is a controllable power supply and a universal connector system, and we have also integrated two in-house developments: a power module with four current sinks and four power switches, and a board that meets our special requirements regarding signal conditioning. Using this system, we have created a uniform hardware platform for testing our air-conditioning control units.

Intelligent Use of Models

All models are based on MATLAB/Simulink. We do the modeling ourselves. We have the great advantage of being able to draw on Behr's know-how in


▲ Air-conditioning ECUs from Behr-Hella Thermocontrol – developed with dSPACE tools.

thermodynamics and fluid dynamics. Moreover, we can easily integrate many of our customers' models such as look-up tables and specifications to the benefit of both of us.

We perform virtual test drives with our simulation environment. Typically, the process begins with a test drive in a real vehicle, during which we capture measurement values such as outside temperature, solar intensity, vehicle speed, engine speed and engine temperature. These measurement values form the basis for realistic simulation and are later fed into the simulation by means of ControlDesk Test Automation, dSPACE's software for test automation. We can "reconstruct" the test drives that were actually made in real time, using dSPACE Simulator.

The results of our work with dSPACE tools are very encouraging. SIL and HIL simulations, and virtual test drives with dSPACE Simulator, mean we can achieve comprehensive and practical verification, especially after software or hardware modifications are made. This gives us improved product quality. We plan to make more intensive use of dSPACE tools for prototyping and automatic production code generation. Our objective in HIL simulation is to model an entire vehicle from the point of view of climate control, and to develop fully automatic integration tests on the basis of dSPACE Simulator. As beta testers in this field, we have already had an opportunity to use AutomationDesk, a new dSPACE tool that promises great potential.
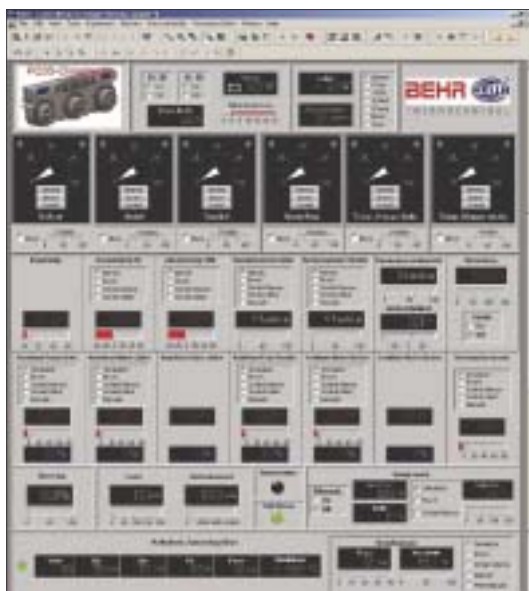
▲ ControlDesk and the upcoming AutomationDesk are central tools for automatic testing.

Dr. Ralph Trapp
Behr-Hella Thermocontrol GmbH
Germany

DaimlerChrysler Relies on TargetLink for Engine Controls

- **TargetLink for new engine control functions**

- **Easy integration into the existing development environment**

- **Greater transparency throughout the whole development process**

To benefit from process standardization in the powertrain development of electronic control units, the Engine Control department at DaimlerChrysler has switched completely to automatic code generation for the function and software development of in-house functionalities. TargetLink passed exhaustive testing and proved its abilities as a production code generator. This is partly thanks to its technical features and to the ease with which it could be adapted to our requirements and integrated into our existing development environment. Another major factor in choosing TargetLink was the extensive and dedicated technical support given to us by dSPACE.

▲ *Hartmut Weckenmann*

The more complex the interplay of ECU functions and different ECUs becomes in today's automotive electronics, the higher the level of specialist knowledge possessed by individual employees and teams. This means that a mass of internal know-how is available, but also that the exchange of models and model components between specialists from different areas is becoming increasingly difficult.

Standardization for Greater Transparency

One of DaimlerChrysler's major objectives in ECU development is to streamline the cooperation between different development areas. We place great importance on constantly improving and simplifying the exchange of models between individual developers and teams by means of standardized development processes. We have been using TargetLink, dSPACE's production code generator, since 2001, and it plays a major role in our standardization efforts, as code generated automatically by TargetLink avoids the individual differences inherent in handcoding and thus eliminates the majority of possible error sources. This ensures maximum transparency throughout the entire in-house process. The Powertrain Electronics section at DaimlerChrysler currently has 25 TargetLink licenses in the area of ECU development.

Function Development with TargetLink

As the basis for code generation, DaimlerChrysler provided a special Simulink block library for automotive applications, and dSPACE adapted this to TargetLink. The function developers implement the models in TargetLink, at our request supported on site by dSPACE from the Project Center in Stuttgart. This cuts traveling times and ensures a fast response when we have queries. dSPACE support includes individual adaptations and developments in the areas of autoscaling and support of model-based tests (code coverage). The Engine Control department is now performing further development and the development of new functions exclusively on the basis of TargetLink. Moreover, code generated automatically using TargetLink is also being integrated into existing projects. The target processor for the production code is the MPC555 from Motorola. Three partial projects have so far been implemented successfully with TargetLink.
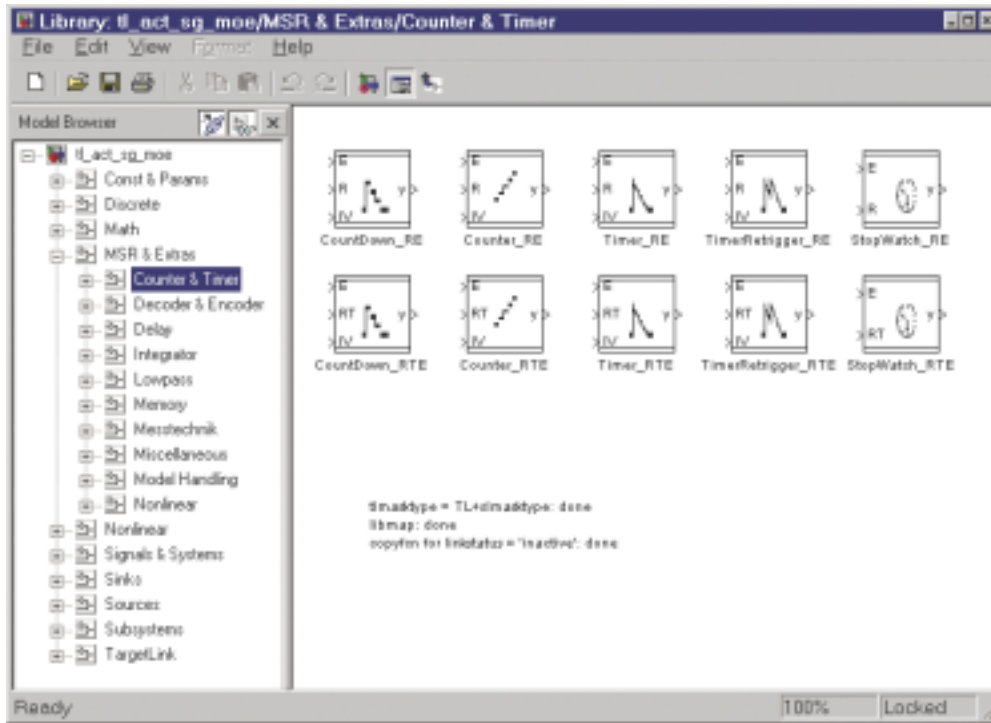
▲ *DaimlerChrysler's special Simulink block library for automotive applications*

Same Code for Same Model Components
The Powertrain Control department sees the great advantage of automatic code generation with TargetLink, compared to the procedures previously used, in the consistency of the generated code with the model, and in having the same code for comparable model components. This allows functions that are needed in different projects to be interchanged easily.

Hartmut Weckenmann
DaimlerChrysler AG
Germany

"With TargetLink, we are able to convert complex, executable, functional specifications available as Simulink/Stateflow models to C code for production ECUs, with no conversion losses and in a process-safe way. Thus, over the last two years, we were able to bring new, high-quality functions up to production status, giving us the competitive edge. The maturity of the implementation environment, the quality of the code that is generated, and direct support from dSPACE enabled us to set up a development environment that can be seamlessly integrated into our software development process with reasonable effort."

Dr. Jürgen Bortolazzi, Christian Dziobek
DaimlerChrysler AG

Getting There Faster: TargetLink at Conti Temic

- TargetLink for complex control functions

- Documentation always up-to-date

- Increased clarity through model-based development

The electronics of diesel injection systems interact with electromagnetically controlled injection nozzles. This imposes tough demands on the electronics, which have to improve injection and combustion processes and considerably reduce fuel consumption and exhaust emissions. Conti Temic is developing an electronic control unit (ECU) for diesel engines that will meet these demands for use in DaimlerChrysler's commercial vehicles. The project is being implemented using model-based function specification and automatic production code generation with dSPACE's TargetLink. This makes it easier to produce well-organized specifications for complex engine control functions and implement them in ECU code.

Engine Control Requirements

One of the key tasks of engine control is the fast availability of the torque required by the driver's gas pedal input. Further requirements are to cut fuel consumption while at the same time achieving a high level of utilization and efficiency, and to comply with compulsory exhaust limits such as the EURO/EPA exhaust standards. In addition, the engine needs to be protected against overload in all operating states, for example, when the vehicle is starting, cruising or running at full speed.

Onboard diagnostics monitor all the components involved in the exhaust system and help to detect hardware faults such as defective sensors. The faults are read out via a standardized interface, so that garages can perform the relevant repairs.

Software Architecture at Conti Temic

The software architecture is based on the standard embedded systems layer model. The lowest layer is the microcontroller core, which contains all software components that are specific to the processor and other hardware. It includes an OSEK operating system, BIOS and hardware-related communication routines for the CAN bus and K-line. The microcontroller core also contains functions that control data exchange between it and the Real-Time Interface above it. This

▶ *State-of-the-art ECU technology from Conti Temic for DaimlerChrysler.*
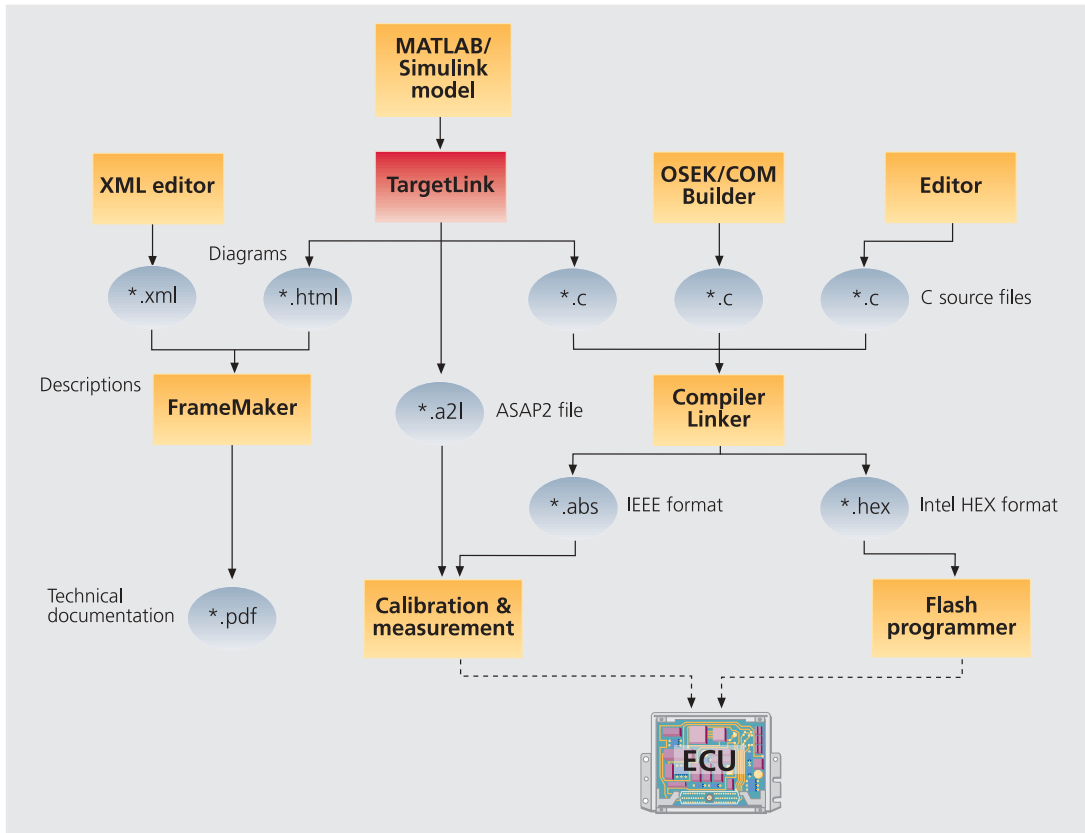
▲ *Software development process at Conti Temic.*

ensures that programming of the software above this interface is largely hardware-independent. The real-time interface is used for project-specific adaptation of the application to the microcontroller core below. It also contains all the routines that have tough real-time requirements and that cannot be implemented as OSEK tasks. Part of the real-time interface was implemented with TargetLink. The top layer, which we call the application layer, contains all the control algorithms for running the engine. These components were entirely designed, simulated and implemented with TargetLink. Overall, 80% of the ECU code was generated by TargetLink.

Software Development Process at Conti Temic

At Conti Temic, we use MATLAB®/Simulink®, the standard simulation tools from The MathWorks, to develop control algorithms. The software is modular, allowing the individual function requirements to be dealt with in separate models. Simulink libraries are also used, so several developers can work on one project in parallel.

Alongside other standard tools, dSPACE's TargetLink plays a major role in our development process. It not only performs production code generation, it also allows efficient verification, by simulation, of the model-based functions that have been developed. First we check functional behavior using floating-point simulation (model-in-the-loop simulation). When we are happy with these results, we compare them with the results of the fixed-point simulation (software-in-the-loop simulation). This is also performed on the developer PC. Any parameterization errors, such as a wrong data type, insufficient quantization, etc., are quickly detected and easily corrected, which saves considerable time otherwise spent debugging on the target hardware in a later phase. The C files generated by TargetLink are perfect in quality, the C code is well commented and optimized for the processor type used in the ECU. Our experience with using TargetLink in the project has also shown that
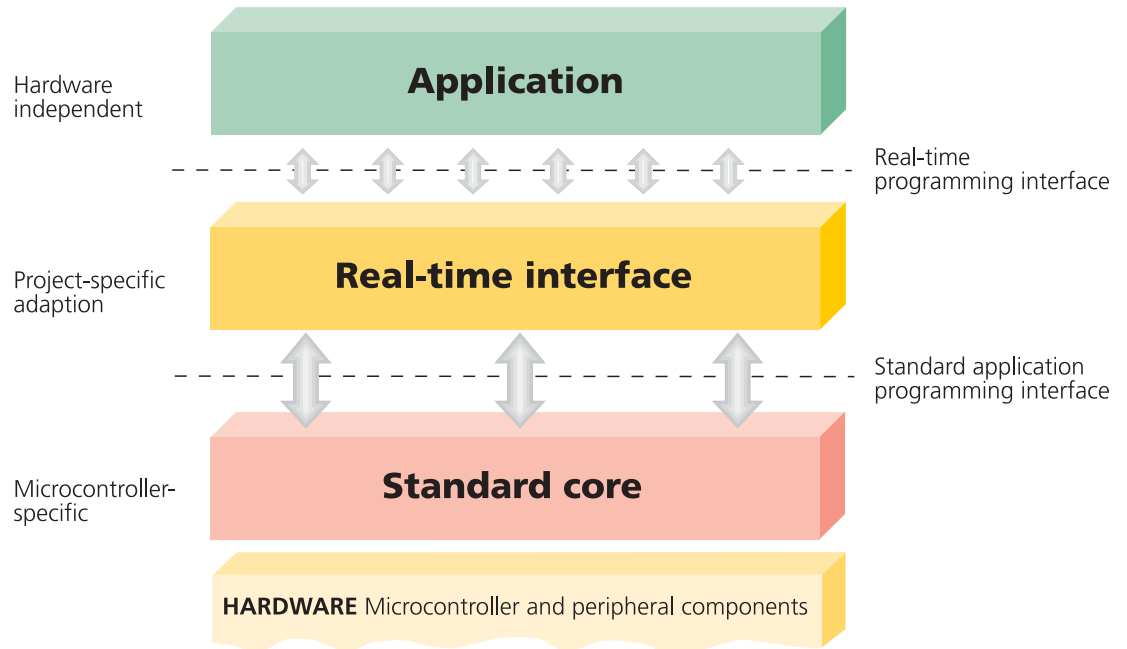
▲ *Model of the software architecture for embedded systems at Conti Temic.*

the functional behavior of a model as verified by PC simulation is always consistent with the behavior on the target hardware.
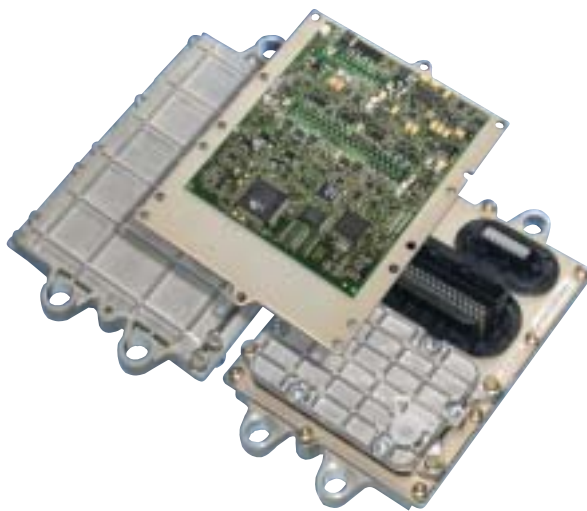
Another task that TargetLink performs for us is automatic creation of an ECU description file in the standardized ASAP2 file format. We also use TargetLink's options for automatic documentation of the developed models, which dSPACE specifically adapted to our needs.

This ensures that we always have the necessary customer documentation for every model version.

▲ *Developed with innovative tools – the Conti Temic ECU.*

The extreme complexity of the requirements imposed on engine control meant we had to constantly further develop and optimize TargetLink. We did this in close cooperation with dSPACE. The extensive support and competence provided by the TargetLink Support Team was a decisive factor in our success.

Outlook

In January 2003, the engine ECU was tested in a real vehicle, under extreme conditions within the Arctic Circle. Our client's very positive reactions reflect our own experience. Using TargetLink allowed us to achieve an unprecedented test depth, which automatically means that our client has far fewer error messages. We feel that the improved quality and clarity provided by model-based software development are key factors in the endeavor to cut development times despite the growing complexity of projects. These aspects are relevant to almost all automotive electronics projects, so at Conti Automotive Systems, we have defined TargetLink as a mainstream development tool.

Jochen Diehm and Dr.-Ing. Stefan Günther
Conti Temic microelectronic GmbH
Powertrain & Chassis product line
Diesel Engine Development
Germany

MicroAutoBox Ready for FlexRay and LIN

To meet the increasing needs of function prototyping, three new variants of dSPACE's MicroAutoBox are on their way, two with a LIN interface, and one with both FlexRay and LIN interfaces (*www.dspace.de/goto?releases*). This will be the first compact, vehicle-capable platform for function prototyping in FlexRay and LIN environments. The integration of intelligent sensors and actuators during the prototyping process, and the development of safety-critical real-time systems, can now be performed in the actual vehicle, using the new MicroAutoBox variants.

Function Prototyping for FlexRay and LIN

You can tell by the slightly increased size of the first new MicroAutoBox variant that there are a lot of new things inside. With its two I/O boards and processor board, it makes for easy integration of all major automotive bus systems – CAN, LIN and FlexRay – into in-vehicle function prototyping. The FlexRay interface is implemented via two slots for FlexRay controllers (FlexIM modules). The software currently supports two FlexRay channels (that is, one FlexIM module). Like our modular FlexRay solution, which consists of the DS1005 and DS4501 boards with a FlexIM module and

tools from DECOMSYS, prototyping is supported by the new RTI FlexRay Blockset. The CAN interfaces have been supplemented by an on-board LIN interface, which can also be used as a K-line interface if desired. Configuration of the LIN bus and LIN nodes is done easily via the RTI LIN Blockset.

The two other new MicroAutoBox variants, without FlexRay interfaces, are contained in the familiar housing, and have reworked I/O boards and either one or two LIN interfaces. These provide two and four CAN interfaces respectively.

▲ *The new MicroAutoBox 1401/1505/1506 with FlexRay, LIN and CAN interfaces.*

All the New MicroAutoBox Variants at a Glance

	MicroAutoBox 1401/1501	MicroAutoBox 1401/1504	MicroAutoBox 1401/1505/1506
Integrated boards	1 processor board + 1 I/O board	1 processor board + 1 I/O board	1 processor board + 2 I/O boards
Processor	PowerPC 603e, 300 MHz	PowerPC 603e, 300 MHz	PowerPC 603e, 300 MHz
CAN interfaces	1 CAN controller, total of 2 CAN interfaces	2 CAN controllers, total of 4 CAN interfaces	2 CAN controllers, total of 4 CAN interfaces
Serial interfaces	1 RS232 interface 1 serial LIN or K-Line interface	1 RS232 interface 1 serial LIN or K-Line interface	2 RS232 interfaces 2 serial LIN or K-Line interfaces
FlexRay interface	No	No	2 slots for FlexRay controllers; currently one controller (2 channels) is supported
Analog inputs	16 x 12-bit channels	24 x 12-bit channels	16 x 12-bit channels
Analog outputs	8 x 12-bit channels	No	8 x 12-bit channels
Digital I/O	Digital I/O based on a 68336 slave processor, 20 MHz, with time processor unit (TPU)		

▌ MicroAutoBox
▌ RTI FlexRay Blockset

The dSPACE Simulator Success Story

- ◢ **ECUs tested without vehicle prototypes**

- ◢ **Expensive mistakes avoided by systematic error finding**

- ◢ **Early verification**

- ◢ **Greater software quality**

Innovation is booming in the automotive industry. The trouble is, schedule times between design and launch are getting tighter, and the sheer volume of tasks involved is hard to handle. The growing number of recall campaigns is a clear indication of this. It is little wonder that testing and error finding have become key tasks in the development process. dSPACE Simulator has become the world's leading system for the systematic testing of electronics and software. A success story indeed.

Time is Money in Testing Electronics

90% of automotive innovations are currently connected with new electronics. Conventional methods cannot cope with the systematic testing that this requires. The embedded controller software is too complex for test drives to find every possible error situation. Hardware-in-the-loop (HIL) simulation is a viable alternative, allowing new electronic control units (ECUs) and software to be tested largely in a virtual environment, without real vehicles or prototypes. Such tests are very systematic and also completely safe, even when critical thresholds are exceeded, while allowing ECU errors to be reproduced whenever and however required.

The advantage is obvious: HIL simulations improve quality even at an early stage. A major Japanese automobile manufacturer states that HIL simulation finds 90% of ECU errors, and almost all the errors that it is possible to find before the calibration phase. Recall campaigns and concomitant damage to the company's image are minimized. The investments made in HIL systems and in developing tests have usually paid off after only a few months.

Technological and Market Lead

dSPACE Simulator has made dSPACE the world's market leader in HIL technology. Around 800 HIL simulators with dSPACE technology are in use around the world, amounting to a market penetration of 65%. Almost all automobile manufacturers and their suppliers are now using dSPACE Simulator as their central testing system.

There are many reasons for this. The system's modular hardware concept allows precise adaptation to customers' requirements, whether these relate to processor power, I/O or signal conditioning. Our customers usually get a turn-key system, preconfigured and ready to go. dSPACE Simulator is also flexible and extendable, so it can be used in parallel and future projects.

Functions are increasingly distributed across several ECUs, and network testing is essential. dSPACE provides unique hardware and software solutions for such tests. Simulators can also be networked to perform extremely complex HIL simulations. Networked dSPACE Simulators can even simulate a vehicle's entire electrical system in a "virtual vehicle".

dSPACE is setting standards with tools such as ControlDesk, the central experiment software, and powerful test automation. The tools can be integrated into MATLAB®/Simulink®, the leading development platform for system modeling, with unbeatable ease and reliability. dSPACE Simulator allows integration of any models – legacy, user-defined, or third-party.
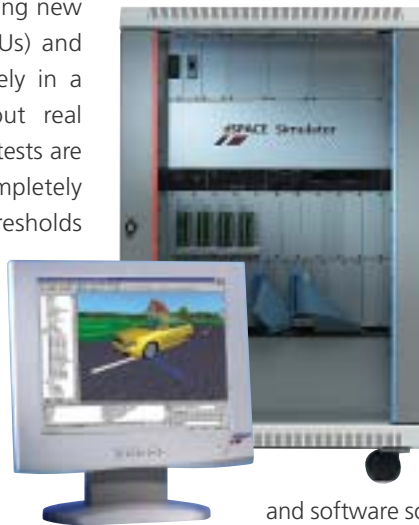
This openness with regard to modeling allows our customers to test successfully in many different areas, such as functions and individual ECUs (vehicle dynamics, spark ignition and diesel engines, powertrain, vehicle interior), and also to perform integration tests that simulate the entire vehicle. We are still brimming with new ideas and aim to increase our lead!

dSPACE Simulator – Future Features

dSPACE Simulator is to get brand-new functionalities. Just a few examples:

AutomationDesk – The systematic structure, reusability and reproducibility of test sequences with the AutomationDesk software will be unequalled (see dSPACE NEWS 3/2002).

CAN gateway – In large-scale ECU networks via CAN, the testing of bus communication plays a key role. Engineers need to know how ECUs and distributed functions behave if an expected CAN message fails to arrive or contains unexpected signals.

dSPACE Simulator functions as an error gateway between the ECUs. The software will generate error situations right down to message or individual signal level.

New user interface for failure simulation – Electrical failure simulation with dSPACE Simulator will be even easier. ControlDesk 2.4 will have new components for managing and using failure simulation graphically. Failure simulation hardware, failure patterns and ECU signal channels will be managed centrally, and electrical faults activated and deactivated centrally too.

Power switch modules – ECUs consume power even when the vehicle is stationary. Many modern ECUs have a sleep mode to avoid draining the vehicle's electrical system unnecessarily. dSPACE Simulator allows precise measurement of sleep mode current, selection of different input voltages and simulation of power supply management. For example, ECU sleep and wake-up modes can be simulated, as can vehicle startup.

Release Info at a Click

For information on upcoming dSPACE Releases, you can now visit a new Web address: *www.dspace.de/ goto?releases*. This gives you all the new products and features in chronological order, plus links to detailed background information. You can also opt to receive e-mails on important innovations. Just send an e-mail to *release.news@dspace.de*

and we will send you advance information on extensions, updates and so on.

The Web address is also the ideal starting-point for more detailed information on dSPACE Release 4.0 and the dSPACE Calibration System, two major innovations due for launch in mid-year. dSPACE Release 4.0 includes AutomationDesk, the software for convenient processing of large-scale test projects, with everything from graphical test development to test result management. ControlDesk, our experimental software, will have a graphical interface for handling fault simulation modules. For more details on this, see the article on hardware-in-the-loop developments in this issue of dSPACE NEWS. And finally, the dSPACE Calibration System is a new hardware and software concept for building tailor-made solutions for your calibration tasks. For more information on these and other new features, see the new Web address: *www.dspace.de/ goto?releases*

▨ dSPACE Calibration System
▨ AutomationDesk

The Winners of Our Survey

In February we asked our German customers for their assessment of dSPACE products and services. We were really pleased that so many responded and provided constructive criticism.

▲ *Watched over by our lawyer Timm de Beer, his assistant, Anne Hoffmann, pulled the names out of a hat.*

So a big thank you to everyone who took part!
The survey covered the following areas: products, sales, order processing, support, engineering and marketing.
The result is very positive: More than 90% of all who responded scored dSPACE's overall performance as good or very good.
We plan to continue this dialog with our customers so that we can respond more precisely to their wishes in future.

We also have the winners of the three Nikon Coolpix2000 digital cameras:
John Hasenclever, ZF Lenksysteme
Carsten Hoffmann, fka
Christoph Wilken, Wabco

Congratulations to the three of you!

Wanted: dSPACE Applications

dSPACE User Conferences in the USA and Germany

We are already planning our User Conferences in the USA and Germany (June 15-16, Stuttgart) in summer 2004. The User Conference is a forum where dSPACE users and product experts meet in a relaxed atmosphere and exchange ideas and experiences using dSPACE systems in controller development. The papers will be presented in sessions based on the various development stages: rapid control prototyping, automatic production code generation, hardware-in-the-loop simulation and calibration.

Call for Papers

Have you been working with dSPACE systems for some time now? Have you an application you would like to present to a wider expert audience? If so, we would welcome a paper on your project at one of the above events. We are particularly interested in topics describing the new technologies and the use

of different dSPACE systems within one project.
To begin with, please send us a 400-500 word abstract on your application, the dSPACE tools used, and an indication of the results achieved:

- to Michelle DuHadway *mduhadway@dspaceinc.com* for the User Conference in the USA.
- to Bettina Henking *bhenking@dspace.de* for the User Conference in Germany.

The closing date for the abstract is September 30, 2003.

The latest information on the conferences will be on our Web site soon.

For information on the last conferences in the USA and Germany, go to:
http://www.dspace.de/ww/de/pub/company/events/ankon.htm and
http://www.dspace.de/ww/en/inc/company/events/ucpaper.htm

Thank you for your interest. We are looking forward to talking to you!

▲ *People are enormously interested in other companies' development work, as seen at the last conference in Germany in October 2002.*

Papers

A. Rolfsmeier, Dr. J. Richert, R. Leinfellner
"A New Calibration System for ECU
Development"
(SAE 2003)

Dr. K. Lamberg, Dr. J. Richert, R. Rasche
"A New Environment for Integrated
Development and Management of ECU Tests"
(SAE 2003)

T. Thomsen
"Integration of International Standards
for Production Code Generation"
(SAE 2003)

S. Köhl, Dr. D. Lemp, Dr. R. Otterbach, M. Plöger
"ECU Network Testing by
Hardware-in-the-Loop Simulation"
(VDI 2003)

Please check the corresponding field on your
response card.

Job Opportunities

Are you an engineer who is just graduating? Or are
you looking for new professional challenges? Then
come and join our team in Paderborn, Munich
or Stuttgart, Germany; Paris, France; Cambridge,
United Kingdom or Novi, MI, USA!
Due to our continuous growth, dSPACE is looking
for engineers in

- Software development
- Hardware development
- Applications
- Technical sales
- Product management

Training

Please check the corresponding field on your
response card.

- dSPACE Systems
- ControlDesk
- AutomationDesk
- HIL Simulation
- TargetLink
- dSPACE Calibration System

Events

EUROPE
SAE Toptec
June 16-19, Turin, Italy
Incontra Conference Center

MeasComp
September 23-25, Wiesbaden, Germany
Rhein-Main-Hallen, Hall 1
Booth #33/34

VDI – Elektronik im Kraftfahrzeug
September 25-26, Baden-Baden, Germany
Kongresshaus Baden-Baden

Aachener Kolloquium
October 6-8, Aachen, Germany
Eurogress Aachen

USA
Embedded Systems Conference (ESC)
September 16-17, Boston, MA
The Hynes Convention Center
Booth #1129

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Your opinion is important. Please send your
criticism, praise, or comments to
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