

dSPACE

NEWS

FACTS · PROJECTS · EVENTS

Products

New Processor Technology for Computing-Intensive Models

Customers

Elasis: ECU Testing With Greatest Flexibility

AutomationDesk at Behr-Hella Thermocontrol



**Bugatti:
Powerful Cars Need Powerful Tests**

Editorial

- 3** By Dr. Herbert Hanselmann
President

Customers

- 4** CRF: Smooth Gear Changes
with Dual Clutch
- 6** TNO: Testing Intelligent
Road Vehicles
- 8** AKH Wien and MicroMed:
New Hope for Heart Patients
- 10** Elasis: Adaptivity Counts
- 12** Bugatti: Powerful Cars Need
Powerful Tests
- 14** Behr-Hella Thermocontrol:
AutomationDesk –
Positive Feedback

Products

- 16** DS2211: New Board Functions
- 17** DS1006: New Board Power
- 18** CalDesk 1.1 Offers New Features
- 19** Diagnostic Tool Set Up and Running
- 19** dSPACE Release 4.1

Business

- 20** Partners On Site
- 21** Japanese User Conference
- 21** New Catalog and DemoCD 2004
- 22** Paderborn Has it All
- 23** Info and Dates

dSPACE NEWS

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10 *ELASIS went online with a simulator network to test electronic control units for a variety of future car models. The concept's flexibility is outstanding.*



12 *The powertrain ECUs for the new Bugatti were tested in hardware-in-the-loop simulation. dSPACE Simulator provides a reliable test environment for testing individual and networked ECUs.*



In early 2003, the automobile industry made sudden unexpected investment cuts. Some companies took 30% off their development budgets across the board – including electronics. Others simply stopped approving investments altogether. Developers were expected to carry on the remaining projects with their existing tools. We were amazed to learn that old AutoBoxes with the DS1003 (remember them?) were going back into action. Well, they do still work.

Then towards the end of the year, a lot of companies evidently decided to ease their budget restrictions, and we were flooded with orders. Perhaps they had realized that there is simply no alternative to investing in modern tools.

So 2003 was another growth year for dSPACE (even if things were a bit quieter than in boom times) – despite the fact that some of our new products did not have an impact until 2004, and our competitors are by no means standing still. What customers appreciate is the reliability of dSPACE's systems, our broad range of

applications, high performance, and the much praised support that we give. At the end of the day, it's things like this that decide the success of a project.

The demand for hardware-in-the-loop test systems increased beyond expectations last year. This reflects the familiar fact that vehicles with extensive electronics and software cause most problems in development and field testing. Obviously, processes in the early phases of development need improving, but that will take time. In the meantime, better testing is the quickest solution. dSPACE products cover the entire range of testing needs, from simple component tests right through to system network testing with 40 electronic control units and all the frills. Our experience with hundreds of simulator projects guarantees our customers fast, productive testing.

dSPACE is working in a field that is constantly evolving and expanding. We are therefore continuing to recruit new people, especially developers and engineers. Our payroll is fast approaching the 500 mark, including employees at our three subsidiaries. There's still so much to do.

*Dr. Herbert Hanselmann
President*



14 *Stefan Wanoschek from Behr-Hella Thermocontrol GmbH spoke to dSPACE NEWS about his experiences with the AutomationDesk test automation software.*



17 *dSPACE is adding a powerful processor board with a 64-bit server processor to its range of modular hardware. This makes processing-intensive models up to 9 times faster.*

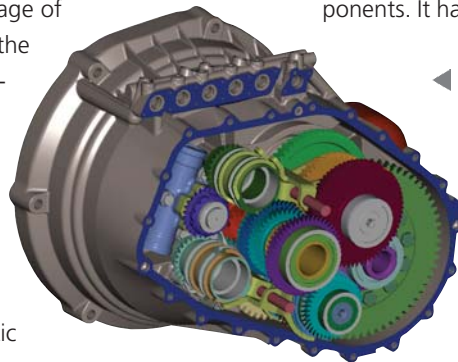
Smooth Gear Changes with Dual Clutch

- **Centro Ricerche Fiat (CRF) uses dSPACE Prototyper**
- **Development of a dual clutch transmission (DCT) control**
- **MicroAutoBox for in-vehicle tests**

During the past fifteen years, the Fiat Research Centre (CRF) has acquired considerable experience in the design, analysis, testing and validation of automatic manual transmission control applications, for cars with different kinds of motorization: gasoline, diesel, natural gas, and electric. With dSPACE Prototyper and ControlDesk we at CRF were able to set up different dual clutch transmission (DCT) applications in a notable time, concentrating on the control strategies and the system design. DCT represents the evolution of automated manual transmission (AMT), as it overcomes the loss of comfort due to the torque transient.

Dual Clutch Transmission

Dual Clutch Transmission (DCT) is a six-speed gearbox with two standard dry clutches (electro-hydraulically actuated) and a sequential electro-hydraulic engaging actuator. The two dry clutches transmit the engine torque through the two input shafts at the wheels, while the engaging actuator manages the disengaging/engaging operations during the gear-shift transient. The advantage of the mechanical architecture of the gearbox is that it allows the gearbox to manage the power shift operations between the two ratios without a longitudinal acceleration change. The drivers can use the gearbox in the manual mode via a joystick lever, or they can choose an automatic function type from the economy, standard or sport mode. DCT significantly increases the driving comfort during gear-shift operations due to the smooth torque transient.



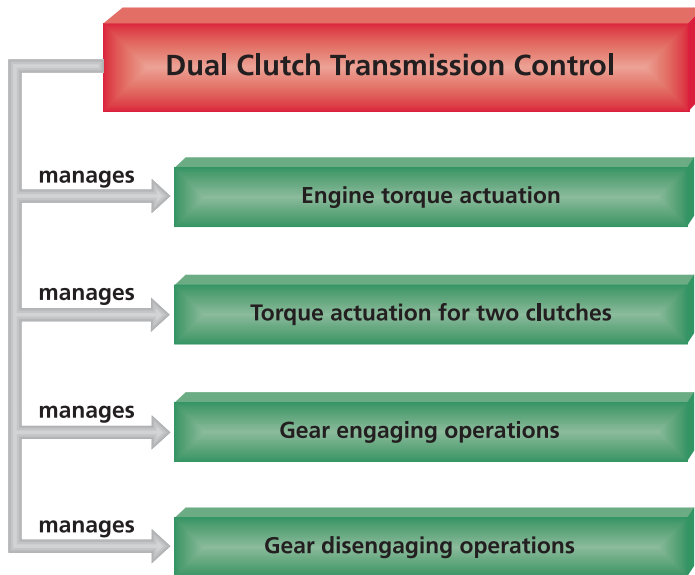
◀ *The mechanical architecture of the Dual Clutch Transmission (DCT) gearbox manages powershift operations between two ratios without a longitudinal acceleration change.*

Control Requirements

Designed completely under MATLAB®/Simulink®/Stateflow®, DCT ensures a higher level of comfort by managing the torque shifting with the two dry clutches. The core concept of the transmission control is a model-based control able to handle the

complexity of four main actuations: the engine torque, the clutches' torque and the disengaging/engaging operations. The power shift operations calculate the references for the two clutches and the reference torque for the engine control unit, in order to have null longitudinal acceleration losses during the gear change. The main control task also needs to recognize faults of sensors, and hydraulic and mechanical components. It has to preserve the synchronizer's

integrity during the gear-shift transient, and adopt opportune recovery strategies to guarantee the system safety and functionality. The control also includes automatic mode strategies with the possibility to have low consumption gear change strategies, sport control strategies, and a personalized mode which can be automatically tuned to any personal guiding style. The basic automatic mode control strategies choose the gear ratio, using low consumption or performance power-based rules in order to optimize



▲ Four complex main actuations are handled by the control system of the Dual Clutch Transmission (DCT). Driving comfort during gear shifts is increased significantly, and gear changes during turning maneuvers are safer.

the engine's working set points and the vehicle's desired behavior. The development tool chain based on MATLAB/Simulink and dSPACE tools allowed the experiment team's engineers to easily design and test the application, change parameters and acquire main data signals.

Control Implementation

The DCT control strategies and the support control functions, realized with MATLAB/Simulink/Stateflow, were verified with the software-in-the-loop (SIL) approach before going on the bench and on the road. We successfully customized the dSPACE tools to our needs in order to adjust the system with the on-board vehicle testing and perform fine tuning. dSPACE MicroAutoBox and the related tool kit libraries fulfilled our requirements. The tool environment helped reduce development time and minimize safety-critical testing during the validation procedures of the DCT application. The dSPACE Real-Time Interface Library let us effortlessly link the control strategies



implemented in MATLAB/Simulink with the real sensors and actuators field, and we automatically generated the code with Real-Time Workshop. It was easy to install and use the dSPACE MicroAutoBox inside every standard production vehicle because of its high number of input and output channels, various hardware configurations, and compact size. We well appreciated ControlDesk's capabilities to change parameters, visualize and acquire data, because these features supported the DCT calibration. Thus ControlDesk is well integrated inside our calibration process, which uses a MATLAB procedure in order to help the engineers fine-tune and optimize the DCT application.

Results

The DCT control ensures gear-shift operations without significant longitudinal acceleration losses, especially during increasing gear-shift operations. The smooth load torque transient during a gear-shift maneuver not only improves comfort but also lets the driver manage safe gear changes during turning maneuvers. Using dSPACE Prototyper and ControlDesk significantly reduced the development time.

*Dr. Renato Gianoglio,
Massimo Fossanetti,
Dr. Giancarlo Osella
Vehicle Control Systems
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Italy*

◀ *The Dual Clutch Transmission (DCT) control has been successfully implemented on a Lancia Thesis prototype car. For in-vehicle tests, the Fiat Research Centre (CRF) used dSPACE MicroAutoBox.*

Testing Intelligent Road Vehicles

- TNO Automotive building large test facility VEHIL
- Control systems for automatic guided vehicles
- Controller prototyping with dSPACE AutoBox

To facilitate the development and testing of intelligent transport systems, TNO Automotive has developed an intelligent vehicle test facility called VEHIL (**vehicle hardware-in-the-loop**). VEHIL consists of a test vehicle, wheeled robots (moving bases) representing other road users and an experiment controller. Because of good experience gained in previous projects, TNO decided to use dSPACE Prototyper in this project too. The computational hardware for controller prototyping of the moving bases was realized using AutoBox.

Modern society's ever-increasing desire for greater mobility is placing an enormous demand on the expansion of existing transport systems for both people and goods. However, this expansion is being severely curbed by the limited space available and the constraints imposed by environmental legislation. One of the solutions is to enhance the efficiency, capacity and safety of today's road network by developing intelligent transport systems. With our intelligent vehicle test facility VEHIL, these new systems can be tested thoroughly in a laboratory environment, i.e., more safely, cheaply and manageably than on public roads.

VEHIL Concept: Full-Scale Testing Under Laboratory Conditions

To evaluate the functionality of an intelligent vehicle, its sensors and actuators have to be subjected to realistic driving conditions, such as high vehicle speeds

and realistic tracking distances. This usually involves expensive and risky road tests. TNO has developed an alternative in which a vehicle can be tested under laboratory conditions, while realistic road conditions are being simulated. In VEHIL, the complete intelligent vehicle is placed on a chassis dynamometer. The vehicle is able to ride and brake as if on the road. The dynamometer simulates road behavior based on a simulation model of the test vehicle. Realistic vertical movements caused by braking and accelerating are ensured through the use of an advanced vehicle fixation system. The maximum speed is 250 km/h. Realistic emergency braking can be simulated up to 150 km/h for most vehicles. The chassis dynamometer can accommodate very small vehicles as well as small trucks and busses up to a mass of 12,000 kg.

The Moving Bases

Other road users in VEHIL are represented by automatic guided vehicles, the so-called moving bases (MBs). To execute the complex maneuvers that arise from the relative movements of the test vehicle with respect to neighboring vehicles, the MB must be able to maneuver unhindered in all directions. This resulted in a unique package of requirements which was the reason to develop and build this MB in-house and trust in the capabilities of dSPACE's AutoBox, which we knew from former projects.

A lightweight (plastic) representation of a car body can be attached to the MB chassis, completing the resemblance to a normal



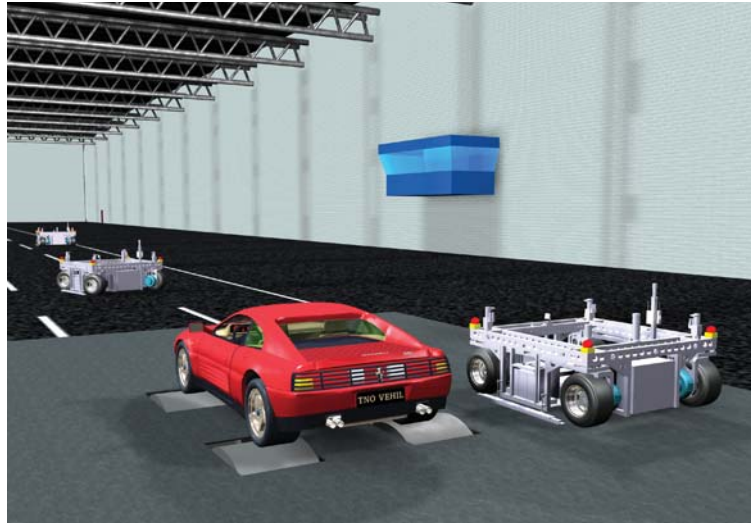
► Dehlija Willemsen and her colleagues with the moving base.

vehicle in traffic. The MB has a four-wheel drive and steering concept, hence it is possible to control the vehicle's three directions of movement (longitudinal, lateral and yaw) independently of one another. In addition, the MB can accelerate and brake with a maximum of 1 g in all directions. This is important for simulating an emergency stop of the test vehicle.

Moving Base Controller

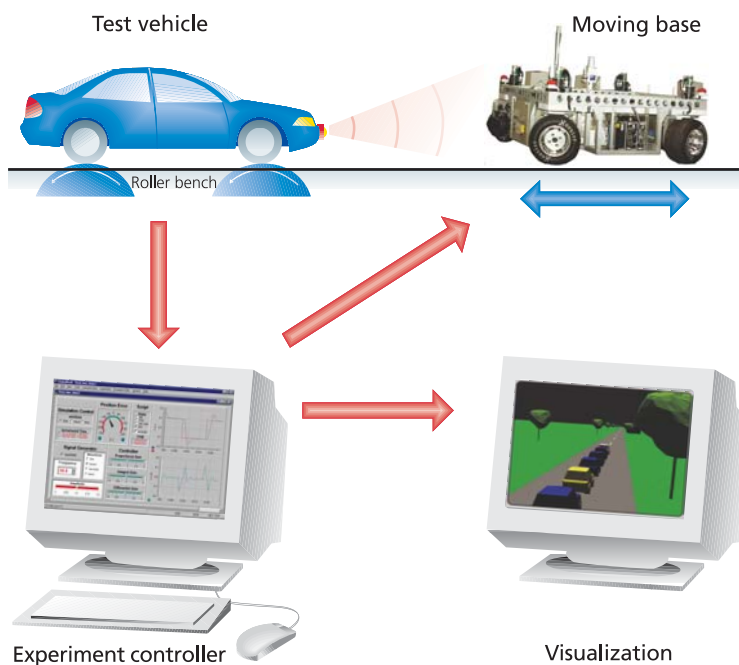
The control system of the MB consists of two main hierarchical levels. The higher level is the path-following controller.

It uses measured signals indicating the actual position and orientation and compares these to the reference trajectory sent by the VEHL experiment controller. Based on this comparison, eight actuator signals are calculated using the concept of a virtual actuator that acts on the center of gravity of the MB, which is the lower-level controller. Using the virtual actuator, a decoupled motion control system is achieved for the overactuated MB (eight actuators for three degrees of freedom). Hence the higher-level path controller simply consists of three independent control loops:



▲ The vehicle test facility (VEHL) with the test car and other "road users", the moving bases.

the longitudinal, the lateral and the yaw control loop. The controller runs on dSPACE's AutoBox with the DS1005 PPC board as the processor board and five different I/O boards. Eight actuators and numerous sensors (incremental encoders, accelerometers, gyroscopes, position measuring systems, etc.) are used for control. dSPACE's experiment software ControlDesk controls, monitors and visualizes the test variables. The MB can also be controlled manually via remote control using the same lower-level controller and hardware.



Two MBs have been built and are undergoing final testing with the prototype controller, using ControlDesk in combination with MATLAB®/Simulink®. The VEHL test facility was officially opened November 2003 with large national and international interest. VEHL is now welcoming its first customers.

*Dehlia Willemsen
TNO Automotive
Netherlands*

◀ The VEHL principle of operation.

New Hope for Heart Patients

- Mini-turbine for cardiac assistance
- Automatic speed control with dSPACE Prototyper
- A possible alternative to a heart transplant

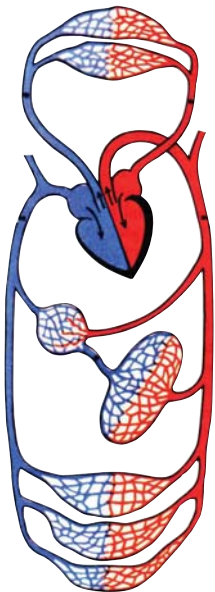
Donor hearts are scarce, and many cardiac patients never survive the long wait for a heart transplant. Even if a donor heart does become available on time, this does not automatically mean that the patient is saved. The patient's general health has often deteriorated so far that the new heart is unable to function properly. The solution could be artificial pumps that assist the patient's own heart. In a joint project with MicroMed Technology, Inc., the general hospital (AKH) in Vienna has developed a controller that continuously adjusts the output of a DeBakey VAD® blood pump to the patient's needs. dSPACE Prototyper was successfully used for laboratory testing and the first clinical study.

The idea for the miniature pump implant goes back to the end of the 1980s. Surgeon Michael DeBakey had operated on a cardiac patient who also happened to be a turbine machinery engineer at NASA, and together they came up with the idea of reducing the size of a Space Shuttle injection pump and adapting it to the human organism. This led to the founding of MicroMed Technology, Inc., in the mid-1990s, and it was this company that finally brought the pump, or, ventricle assist device (VAD), up to clinical application level. The pump has now been in clinical use for more than four years.

assist the left ventricle and generate blood pressure in the arteries.

Tiny Life-Saver

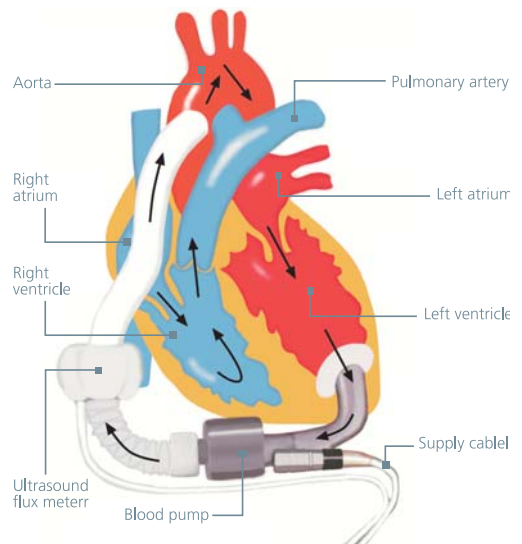
The blood pump implant is actually a mini-turbine the size of a golf ball. Its special mechanical rotor bearing ensures quiet and non-wearing operation even at rotary speeds of 12,500 rpm. Now it has yet another special feature: the speed controller that adjusts its output to the patient's varying blood pressure requirement, whether he or she is sleeping or jogging. This was developed with the aid of



▲ The left half of the heart (shown on the right in the illustration) supplies the body's entire blood circulation, while the right half serves only the smaller pulmonary circulation

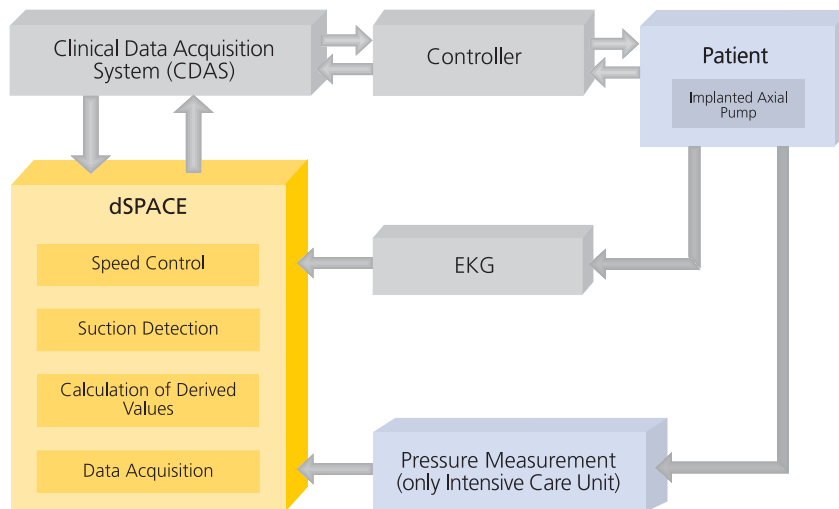
The Healthy Heart and the Sick Heart

In a healthy human heart, the right ventricle pumps blood that is low in oxygen to the lungs, where it is replenished with oxygen from inhaled air. The blood then flows back to the heart via the left atrium and into the left ventricle. This pumps the blood to the body to provide oxygen to all other organs. The depleted blood returns via the right atrium to the right ventricle, and the cycle starts from the beginning again. The right ventricle merely pumps the blood to the lungs, but the left ventricle has to provide the blood supply to the whole of the body. So it is the left ventricle that does the really heavy blood circulation work. It is this ventricle that needs the most help in the majority of patients with weak hearts. To assist an ailing heart, the pump inlet is joined to the lower left ventricle and its outlet is joined to the aorta by means of an artificial artery. This enables the pump to



▲ Cross-section through the heart with blood pump connected.

dSPACE Prototyper. Up to now, rotary blood pumps have always had a constant speed, which can only be adjusted by the physician for specific cases. Automatic speed control can therefore increase the patient's quality of life by adapting to his or her physiological requirements and avoiding overpumping in the case of reduced venous return.



▲ Schematic design of the speed control.

Automatic Speed Control

There were several candidates for a development system for the speed control, and the choice fell on dSPACE Prototyper with the DS1103 PPC Controller Board.

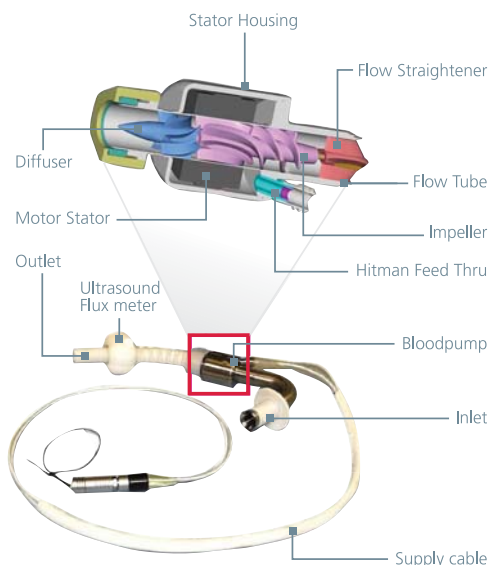
- The hardware is easy to configure straight from MATLAB®/Simulink®, without having to bother with hardware details.
- The dSPACE hardware is especially reliable, because the independent CPU of the controller board runs even without a monitoring PC. It also has a high throughput as well as a large number of analog inputs and outputs.

The flow of blood through the pump, the pump current and the rotary speed are all recorded. For the clinical study, the heart's electrical activity was also captured using an electrocardiogram. To optimize the effectiveness and efficiency of the control, not only all the settings and reference values are registered, but various process reports are also continuously recorded and displayed. A total of 23 signals are recorded at a sampling rate of 100 Hz. The measurements are then used to compute the desired speed for the pump and send an analog signal to the MicroMed VAD pump controller, which adjusts the miniature pump's brushless DC motor accordingly.

The Alternative to a Heart Transplant

We expect we can considerably improve a patient's quality of life using the blood pump with automatic speed adjustment. Moreover, it should relieve the workload of the doctors and nursing staff that have to adjust the pump, and improve the blood supply in extreme situations. Optimization of implantable miniature pumps for everyday use could soon make them a genuine alternative to heart transplants.

*Michael Vollkron and Prof. Heinrich Schima
AKH Hospital, Vienna,
Austria
Robert Benkowski and Gino Morello
MicroMed Technology, Inc., Houston, TX,
USA*



▲ The design of the blood pump in detail.

ELASIS: Adaptivity Counts

- **Testing new ECUs with hardware-in-the-loop simulation**
- **Complete motor vehicle simulation with networked dSPACE Simulators**
- **Maximum flexibility for future Fiat projects**

ELASIS is a Fiat-owned engineering company, which works mainly for Fiat Auto and on the Fiat-GM Powertrain joint venture (FGP), carrying out research and development on vehicles and powertrains. ELASIS plays a key role in many innovations. Recently, ELASIS went online with a dSPACE Simulator network to test networked electronic control units (ECUs) of new car models. This test environment stands out in terms of flexibility, and is designed for a huge variety of car models. Successful projects already ran with the new Fiat Stilo.

Thorough testing reduces the risk of ECU malfunction. However, many faults are difficult to discover unless tests are performed at integration and system level. At ELASIS, we use a virtual car to run these tests. It is based on dSPACE Simulators and is an excellent tool for improving software quality. The virtual car is designed to find errors and bugs in the software of powertrain, body, and vehicle dynamics ECUs through automatic ECU testing based on user-defined test procedures.

The Limits of Conventional Tests

Conventional tests on “static” test benches can test the ECUs together with the network management, gateway functionality and CAN physical level. But there are many restrictions. The tests can only be performed manually and are not reproducible. Moreover, there is no automatic test report generation. Worst of all, test coverage is incomplete and CAN communication cannot be checked thoroughly. So we were understandably looking for a new hardware-in-the-loop (HIL) simulation system to fulfill our requirements:

- Read-in of all pertinent ECU power drivers and signal outputs
- Stimulation of all ECU inputs
- Electrical fault insertion capability
- Logging of all CAN messages
- Network management functionality
- Interface to diagnostic serial line, in our case ISO9141
- Flexible and powerful automation software

- Flexible, scalable and reusable hardware
- Behavior like a real car and real-time-capable models (for engine, transmission, vehicle dynamics and parts of body/comfort)

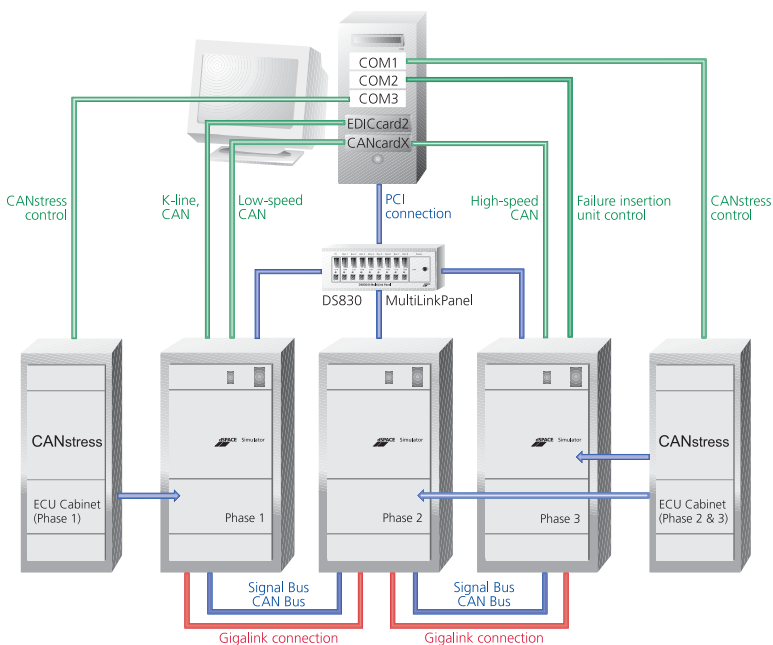
We evaluated several HIL systems available on the market and opted for dSPACE Simulator over other HIL vendors' products, not only because of its technical lead. What was also decisive were successful earlier projects with dSPACE Simulators and good experience with many other dSPACE tools both at ELASIS and in other parts of the FGP group.



▲ ELASIS' virtual car: The networked simulators are controlled from one central PC.

Designed for Many Projects

The philosophy of the virtual car is to cover a wide range of different test types – from unit test, through integration tests, to system tests. Our aim was maximum flexibility and adaptability to as many vehicle models as possible. This is a real challenge. Because the test phase is extremely short nowadays, an HIL system needs to be configurable in a minimum of



▲ The system setup: Flexibility is crucial for switching to new vehicle versions.

real-time model development and for running the experiment software. The real-time models were completely specified in MATLAB®/ Simulink®. A team consisting of experts from dSPACE, TESIS and ELASIS worked closely together and included models for vehicle dynamics and engine (TESIS), manual automatic transmission (ELASIS) and body (dSPACE). An ACC model was added to the vehicle dynamics model for active cruise control (ACC) simulation, and the MotionDesk software was integrated for 3-D online animation.

time, and must then be available 24 hours a day, 7 days a week. Due to the complexity of the electronic systems, many variables have to be controlled and signals have to be acquired with precise timing. This is possible only with test software that automatically drives the simulated vehicle in the states to be tested. Our ELASIS test automation, based on dSPACE software, solves these problems, so that tests require less time and more details can be tested, resulting in broader test coverage and greater test depth. The heart of the virtual car is three 19" cabinets (dSPACE Simulator Full-Size). The cabinets are all similar in construction and contain a real-time processor, I/O boards for discrete signals, signal conditioning, and failure insertion units, plus loads for generating electrical faults. Moreover, components like an A/W bus simulator (gateway to the Fiat A- and W-bus), a dSPACE CAN gateway and CANstress systems from Vector Informatik (for generation of CAN errors) were included.

Control from One PC

The host PC contains a CANcardX for accessing the B and C CAN bus, and an EDICcard2 system with DTS software from Softing for accessing diagnostic services via K-line. All these tools are controlled by the test automation software; in the future this will be AutomationDesk. The host PC is also used for

Looking Ahead

We installed the system during the late development stage of the new Fiat Stilo. Our primary goal was to gain experience for upcoming projects, but as it happened, the virtual car already worked well in the Stilo project, with 27 ECUs on three different networks. Since all data is stored systematically, it is now easy to analyze malfunctions by reproducing the failure situation. Moreover, simulating ECUs that are not yet available allows us to execute tests much earlier. In the future, the virtual car will be used from the very beginning of new car projects. As soon as an ECU supplier develops the first version of a new ECU, the virtual car will be updated according to the same specifications. This way, the HIL system and the automatic tests will always be up-to-date, and new ECUs can be tested intensively over a long period of time.

*Antonello Caraceni,
Control System Department Manager
Ferdinando Ferrara,
Control System Validation Manager
ELASIS
Italy*

I/O channels required for testing the Fiat Stilo's ECU network

- 88 ADC channels
- 99 DAC channels
- 366 digital I/O channels
- 6 resistor simulation channels
- 10 PWM input channels
- 10 PWM output channels
- Special channels for ignition, injection, crankshaft and camshaft signals
- 4 different CAN controllers
- Total number of ECU pins: about 900

Bugatti: Powerful Cars Need Powerful Tests

- Powertrain simulator for Bugatti
- Simulation models from Volkswagen
- ECUs network-tested using dSPACE Simulator

At 1001 HP, the Bugatti EB 16.4 Veyron seems set to become the fastest and most expensive production vehicle ever built. And for active safety at speeds of over 400 km/h, a whole range of electronic control units (ECUs) are needed. Bugatti first performed intensive validation work on the ECUs in the laboratory, using dSPACE Simulator. This allowed functions to be tested efficiently, both in individual tests and in a network, with no danger at all to driver or vehicle.

The figures speak for themselves: from zero to 300 km/h in less than 14 seconds, a top speed of over 400 km/h and a buying price of 1,160,000 euros. With figures like these, it is easy to see why it is not possible to test the entire ECU behavior on the road. On top of this, there are only a very few prototype vehicles available, and the technical requirements are extremely high. The only reasonable alternative is to test the ECUs thoroughly in the laboratory first.

We Used Our Own Models

At Bugatti, we used a dSPACE Simulator Full-Size to test the ECUs for the powertrain: 2 engine ECUs, one ECU for the 7-gear dual clutch transmission, and one each for the all-wheel and ESP components. So that the ECUs could be integrated into a virtual world,

mathematical models of the components to be controlled were needed. Our parent company, Volkswagen, developed models for the W16 engine and the 7-gear dual clutch transmission. We were able to put the models on the Simulator and use them for real-time simulation with a minimum of adaptation work.



▲ The tests are run from the realistic instrument panel of the ControlDesk user interface.

The models for the all-wheel transmission and the ESP component were outsourced. dSPACE developed the I/O connection for integrating the models into the simulator environment. The telephone support given by dSPACE project engineers was very productive for our Simulator staff, who had not formerly had any experience with dSPACE.

Testing Diagnostic Functions

The main focus of investigations was on hardware-in-the-loop tests for diagnostic functions. We tested the ECUs by systematically applying faults to them. With its powerful processor hardware and flexible I/O hardware, dSPACE Simulator had no problem coping with the tough demands made on signal generation and the simulation of faulty sensors. dSPACE's experiment software, ControlDesk, was used for graphical instrumentation and interactive operation



▲ The Bugatti's powertrain ECUs were tested in virtual test drives in hardware-in-the-loop simulation.

of the Simulator. MotionDesk performed 3-D visualization. A test automation system developed by Volkswagen was used for the management and automation of the tests. Some tests that had already been created were efficiently imported onto the dSPACE Simulator.

Network Testing

The functions for controlling the powertrain are distributed across several ECUs, so network testing of these is vital. dSPACE Simulator provided the following support for this:

- Parallel and constant monitoring of all CAN channels: drive CAN, ESP sensor cluster CAN, and private CAN between engine master and engine slave with ControlDesk
- Arbitrary switching of individual ECUs, and their simulation in the network, on and off using CAN restbus simulation (for isolated testing of individual ECUs without interactions)
- CAN signal manipulation for all messages and signals from all participating ECUs, for example, the corruption of CAN messages and their contents, failure of senders, failure of individual messages

Project Ran Smoothly

The project was highly dynamic, as the vehicle had to be developed according to an extremely tight schedule. This necessitated a variety of modifications to the specifications, which the dSPACE project engineers at Paderborn had to incorporate and implement quickly during the project planning phase. dSPACE delivered the system to us in February 2003, and we started using it immediately after installation.



▲ MotionDesk, software for visualizing real-time simulations, displays the simulation results in a 3-D on-screen world.

Current Project Status and Outlook

We have been productively using the system for ECU testing for some months now. During this period, we have set up the Simulator several times, whenever the software and hardware versions of the ECUs to be tested changed. In parallel to this, further tests automated by Volkswagen's own test automation system are being put into operation on the Simulator. HIL-based laboratory testing with dSPACE Simulator has proven a great success.

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Bugatti Engineering GmbH
Germany

Dr. Dirk Lichtenthäler
Volkswagen AG
Germany

AutomationDesk: Positive Feedback

Behr-Hella Thermocontrol GmbH develops and produces electronic control units and manual controls for vehicle air conditioning. To ensure that the development of control strategies runs smoothly, the company chose to integrate dSPACE tools into its development process. The latest addition to Behr-Hella's tool chain is AutomationDesk, the dSPACE software for handling ECU tests that was launched in August last year. Stefan Wanoschek from Behr-Hella Thermocontrol GmbH spoke to dSPACE NEWS about his experiences with AutomationDesk.



▲ Stefan Wanoschek, Test Engineer at Behr-Hella Thermocontrol GmbH: "The tool is chic, and gives us lots of potential."

What do you use AutomationDesk for?

To construct software tests with as full a coverage as possible. We have requirements specifications and test our control functions against them. AutomationDesk is mainly used for regression tests, often overnight or on weekends, to check the functionality of specific software versions according to our release plans.

What's your view of the working procedures that AutomationDesk involves?

The solution is generally very good and well thought out. For example, the visibility rules for the data objects mean that general data can be stored higher up in the project tree, with more specific data further down.

AutomationDesk's features range from graphical description to Python module

integration. How do you utilize these?

Obviously, graphical programming is also programming. Test creators still need knowledge in programming control and data flows. But with AutomationDesk, you can simply use graphical blocks for actions such as embedding Python functions. This makes it easy to keep track of test sequence structures, even enormously complex ones.

How do your developers learn to use AutomationDesk?

You have to distinguish between developers who have experience with modeling and simulation techniques in testing, and developers who do not. The ones with no experience are often a bit nervous at first about working with simulators without real loads – because you also have to understand and be familiar with the peripherals. But once they've overcome this inhibition, learning runs smoothly. No compilation is needed, and each block can be executed individually from the editor, so you can get to know the tool, the model, and the test bench interactively.

What are AutomationDesk's greatest strengths?

You can just switch it on and go. You can produce your first executable test sequences very fast, using AutomationDesk's graphical description features. Even so you still have to ensure that sequences are well-structured so that individual subsequences can be reused. Another of AutomationDesk's strengths is the Custom Library, with all its potential for reusing

tests – even across different projects. Further features we would like to have in the future are the ability to import and export parts of projects and libraries, distributed teamwork, and integration of a versioning tool to manage test sequences.

Does AutomationDesk interact smoothly with your other tools?

That mainly depends on how well a developer knows the other tools. Where developers are familiar with the tools – such as the Diagnostic Tool Set DTS 6 from Softing – and the peripherals, everything runs very smoothly.

Do you plan to use AutomationDesk in other areas?

Yes. We’re interested in using it in preproduction and production development. We are already using dSPACE’s TargetLink for automatic code generation

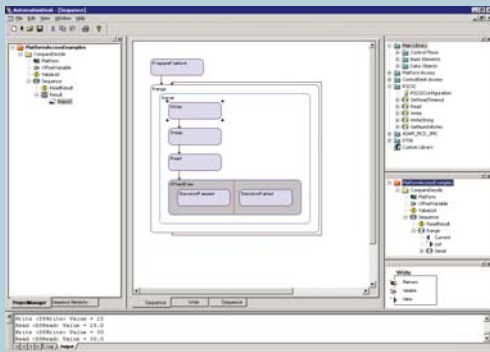
in these areas. These are also potential application areas for AutomationDesk. For example, we might use MTest, the AutomationDesk extension, for systematic test development.

And finally: What’s your overall impression of AutomationDesk?

We wouldn’t have gotten where we are today if we hadn’t had AutomationDesk. The tool is simple to use, and is still evolving. It’s exactly what we need. Cooperation with dSPACE during the beta phase was also excellent. We could make suggestions which were then correctly implemented in the tool. Moreover, AutomationDesk is open and extendable. For example, it’s easy for us to integrate our own Python modules. The tool is chic. It opens up plenty of potential. And provides ways of arriving at solutions.

Mr. Wanoschek, thank you for talking to us.

About AutomationDesk



AutomationDesk is used to handle ECU software tests. Its main features are graphical test description, test management, and a function library that is a “storehouse of know-how”.

Intuitive, Graphical Test Description

Graphics-based working procedures make test description intuitive. The tool provides access to Simulink® and real-time simulations, so testing can be done both during hardware-in-the-loop simulation (HIL) and in early phases of function

design. This offers great potential for reusing existing test sequences.

Project Manager for Good Organization

Structuring test projects is simple with AutomationDesk’s Project Manager. It is also easy to handle several test projects, together with data and results. Moreover, the Project Manager automatically generates test reports on an XML basis.

Libraries Store Know-How

The integrated library contains a wide range of functions (for example, for all kinds of calculations) and can easily be adapted to individual requirements. Access to external software tools via DLL or COM interfaces is also provided – for example, to MATLAB®, Microsoft Office tools, and the Diagnostic Tool Set DTS 6 from Softing.

New Board Functions

- **New basic I/O board for dSPACE Simulator**
- **More I/O channels and increased angular resolution**
- **Signal conditioning up to 42 V**

The new DS2211 HIL I/O Board is now the basic I/O hardware for dSPACE Simulator. The DS2211 supports automotive signals up to 42 V (with peak voltages of 60 V) and two-voltage electrical systems, for example, 12/42 V or 24/42 V. It has more I/O channels than its predecessor, and its angular processing unit (APU) has a greater angular resolution, allowing future HCCI engines and similarly complex entities to be simulated.

Ideal for Hardware-in-the-Loop Simulation

All typical automotive I/O functions, for example, for the engine, powertrain and vehicle dynamics, are now on this one single board. Together with a dSPACE processor board (such as the DS1006), the DS2211 HIL I/O Board constitutes the hardware core of dSPACE Simulator. The DS2211 measures and simulates all the signals required for engines with up to 8 cylinders, while the processor board computes the real-time model, for example, an engine model. The simulator can be expanded from 8-cylinder to 16-cylinder simulation and higher by cascading two or more DS2211 HIL I/O Boards.



And with the DS2211's expanded signal conditioning feature, you will be well prepared for the future.

A key component on the DS2211 is its APU, which provides important automotive functions such as the generation of crankshaft and camshaft signals or the capture of ignition times and injection signals. The DS2211 has an integrated complex comparator, which converts the incoming voltages into injection times and angles directly. This is very important for features such as diesel direct injection. The integrated signal processor and the APU also allow ion flow measurements to be simulated.

The DS2211 is compatible with its predecessor, the DS2210 HIL I/O Board, but provides far more functions for HIL simulation and additional I/O channels. Previously, you needed additional I/O boards. Now everything is on just one board, giving you enhanced functionality at a reduced price.

Perfect Interaction

The DS2211 HIL I/O Board communicates directly with other dSPACE boards. For example, the I/O boards exchange angle signals for synchronous I/O processing at high speed. The DS2211 HIL I/O Board is installed in dSPACE Simulator Full-Size and in the new dSPACE Simulator Mid-Size.

New Functions

The new DS2211 HIL I/O Board is the technically more mature successor to the DS2210 HIL I/O Board, for years a very successful – and the highest powered – processor board. The angular resolution for engine simulations has been increased by a factor of 8, and is now 0.011°. The board can therefore test future ECU generations that need particularly high

resolution in a restricted engine speed range – for example, for direct injection and homogenous charge compression ignition (HCCI) engines. Moreover, automobile manufacturers are planning to use voltages of up to 42 V and two-voltage electrical systems. The DS2211 is ready for this.

- DS2211 HIL I/O Board
- dSPACE Simulator Mid-Size
- dSPACE Simulator Full-Size

Technical Data

Analog inputs	16 (14 bit, 0–60 V)
Analog outputs	20 (12 bit, 0–10 V)
Digital inputs	16 (0–60 V)
Digital outputs	16 (5–60 V)
PWM inputs	8
PWM outputs	9 (16 bit)
CAN bus interface	2 CAN channels
Serial interface	RS232/RS422
Load outputs	10 (16 bit, 15.8 Ω ... 1 MΩ)
APU resolution	0.011° (16 bit)
Digital signal processor	TI TMS320VC33

New Board Power

dSPACE is about to launch the world's first new, extremely fast processor board for rapid control prototyping (RCP) and hardware-in-the-loop (HIL) simulation: the DS1006 Processor Board. The DS1006 is based on a 64-bit server processor and is the ultimate in processor boards for very complex, large, and processing-intensive models – for example, for powertrain and virtual vehicle simulations.

- x86 technology for RCP and HIL
- Greater performance and memory
- Ideal for large, processing-intensive models

Benchmarks Reveal Impressive Performance

With the DS1006 Processor Board, you can process large, complex models faster than ever before, on one single board, with no partitioning. The DS1006 Processor Board is the fastest processor board ever for testing electronic control units (ECUs) and for RCP. It is



up to 9 times as fast as real-time hardware containing a 480-MHz PowerPC, depending on the model. The F14 model in MATLAB®/Simulink® from The MathWorks has execution times of under 1.5 microseconds on the DS1006. Complex engine and vehicle dynamics models using enDYNA® and veDYNA® from TESIS DYNAware routinely achieve execution times of under 150 and 200 microseconds respectively (with real-time I/O hardware connected).

The board has a 2.2 GHz AMD Opteron® Processor 248 with a 1 MB L2 cache based on AMD64 technology, a pioneering new architecture that provides 64-bit technology on an x86-compatible CPU. The board has 256 MB main memory for executing real-time models and exchanging data with the host PC, plus an optional 128 MB application flash memory on a CompactFlash board for automatic, host-independent booting of real-time applications.

A Choice of Two Boards

You will soon have two processor families to choose from: the DS1006 with the AMD Opteron processor and the DS1005 with the IBM PowerPC®.

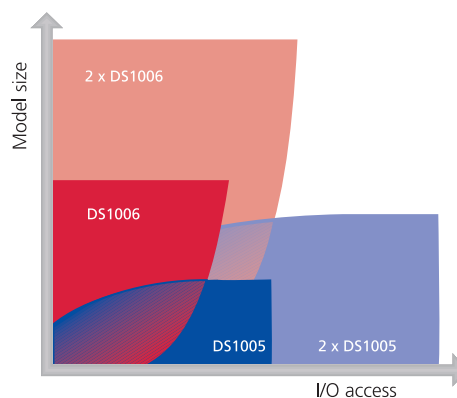
The PowerPC architecture of the DS1005 PPC Board makes it ideally suited to rapid control prototyping and HIL simulation of models that need very high sampling rates and a lot of I/O capacity.

The DS1006 is used to execute very processing-intensive simulation models, which until now have always required a processor board network.

Part of the dSPACE Modular Hardware Range

The DS1006 Processor Board fits seamlessly into dSPACE's range of modular hardware. It has an integrated PHS++ bus, so you can continue to use your existing dSPACE boards. If you need even more performance to meet your requirements, you can build a multiprocessor system by connecting several DS1006 boards via DS911 Gigalink Modules.

- DS1006 Processor Board
- dSPACE Simulator Mid-Size
- dSPACE Simulator Full-Size



▲ Use scenarios for the two dSPACE processor boards.

CalDesk 1.1 Offers New Features

- **CCP Support, Interfaces for NEXUS and NBD/AUD**
- **CalDesk for Function Prototyping**
- **CalDesk in English, French, German, and Japanese**

CalDesk, our software for calibrating electronic control units (ECUs), will soon offer new features: it will support more calibration interfaces, and provide access to platforms for function prototyping, for example, to MicroAutoBox. In addition, CalDesk will be available in French and Japanese.

Support of Further Interfaces

CalDesk 1.1 will allow calibration via CCP (CAN Calibration Protocol), an established protocol standard for measurement data capture and parameter tuning. In addition, CalDesk 1.1 will also support calibration via NEXUS or NBD/AUD with new hardware – the DCI-GSI1, which supports a variety of on-chip debug ports for calibration and bypassing.

Due to the growing diversity of ECUs, calibration solutions based on standardized protocols are becoming increasingly important. In contrast to parallel calibration via a memory emulator on the ECU, serial calibration via CCP or XCP (Extended Calibration Protocol) uses additional service software that lets the calibration engineer access the ECU via defined protocols to modify parameters and capture measurement data.

and I/O modules, but also function prototyping platforms such as MicroAutoBox and the DS1005 PPC Processor Board. This means that function design, bypassing and calibration/measurement can all run in parallel, controlled from the same software. Being able to access ECU variables at even this early stage of the development process makes work extremely flexible, and can considerably reduce the time needed for calibration at later stages of the process. CalDesk was designed especially for in-vehicle tasks: for example, it can be controlled completely via the keyboard, and also outputs audible signals.

CalDesk Available in More Languages

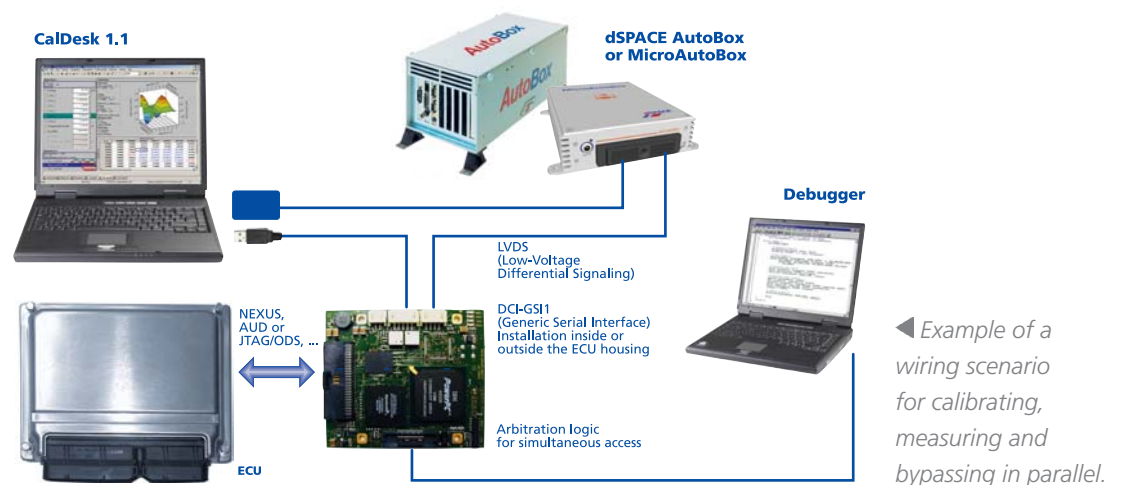
CalDesk 1.1 will be available in four different language versions, in Japanese and French as well as the current English and German versions.

Function Prototyping via CalDesk

CalDesk 1.1 supports not only calibration interfaces

For more details on the innovations in CalDesk 1.1, see www.caldesk.com.

▣ dSPACE Calibration System



Diagnostic Tool Set Up and Running

Diagnostic tests need efficient tools. dSPACE and Softing AG in Munich have been cooperating closely for some years now to meet this need. The result: successful integration of the Diagnostic Tool Set (DTS) from Softing into dSPACE Simulator, our test environment for electronic control units (ECUs). Diagnosis is a crucial component in modern ECUs. Diagnostic functions are used to detect vehicle faults such as short circuits. The functions require meticulous testing if they are to perform this task reliably.

Years of Experience

The Diagnostic Tool Set (DTS) product family from Softing is the preferred diagnostic solution for ECU testing with dSPACE Simulator. DTS is the only diagnostics product that provides complete support

of ASAM-MCD interfaces. Our joint venture with Softing means that our customers benefit from a proven solution for ECU testing, plus diagnostic access from the ControlDesk experiment software. Our AutomationDesk software plays a key role in automated ECU testing. AutomationDesk manages all automation tasks at a central location and also integrates the DTS tools into the test environment.

Automated tests with DTS access are important, as only test automation makes it possible to check the diagnostics for all the relevant errors. Two customers report on their experiences with DTS integration into dSPACE Simulator in this issue of dSPACE NEWS: Behr-Hella Thermocontrol on page 14 and ELASIS on page 10.



dSPACE Release 4.1

The upcoming dSPACE Release 4.1 will provide a range of extensions for your development environment. Some of the main innovations are listed in the table

below. For further details, and information on the release date, see www.dspace.de/goto?releases.

Product	New Features
ControlDesk 2.5	<ul style="list-style-type: none"> ■ Failure simulation for DS2211-based dSPACE Simulator Mid-Size ■ Remote control of ControlDesk (via Ethernet and TCP/IP) ■ Support of the DS1006 Processor Board
AutomationDesk 1.1	<ul style="list-style-type: none"> ■ Variable Browser for selecting model variables ■ Condition Editor with dialogs for creating conditions for If-Else and While blocks ■ Improved error handling ■ Supports the DS1006 Processor Board
RTI CAN MultiMessage Blockset 1.0	<ul style="list-style-type: none"> ■ Large CAN message packets (> 200 messages) can be handled from a single Simulink block. ■ Online switching between different main blocks ■ Simplified model updating via an automatically generated S-function for each DBC file ■ Reduction of code generation time, build time and overall processing time.

If you would like to receive release information by e-mail, send an e-mail to release.news@dspace.de.

Partners on Site

Successful start for dSPACE SARM and dSPACE Ltd.

Competent advice and services

Seminars and workshops

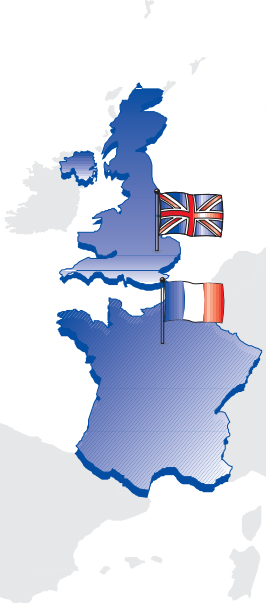
In November 2001, our subsidiaries in France and the UK went into action. Since that time, the engineers at dSPACE SARM and dSPACE Ltd. have been working in close proximity to our customers, providing competent advice and practical support that cover all aspects of the dSPACE product range and services.

Being geographically close to our customers makes working with them more efficient. Customers particularly appreciate the ability to communicate quickly on projects for turn-key solutions that enable them to concentrate on their core tasks. For example, one customer may require custom implementation of highly complex ignition and fuel injection functions for dSPACE Prototyper. While another may choose to install or extend dSPACE hardware-in-the-loop simulators and network them to create a virtual vehicle. Whatever the requirement, our engineers are ready to respond at short notice, discussing solutions, and providing their services on site as required. A large number of French and UK customers have benefited from this over the last two years, and have come to rely on dSPACE technology more than ever.

To enable customers to get off to a flying start with their projects, or give them a hands-on impression of the power and performance of dSPACE tools, dSPACE SARM and dSPACE Ltd. frequently run seminars and workshops, many at the customers' own request. They are held either on our own premises or at those of our customers. The effectiveness of the workshops and the competence of the instructors are highly regarded. The high number of participants and the positive feedback they provide us are clear evidence of this.

Adam Heenan, Senior Control Systems Engineer at TRW Conekt, attended a workshop and commented: "Thank you for the TargetLink workshop, it was very useful. It will definitely make my work easier." For information on the seminars and workshops currently available, you can visit our local Web sites or inquire about specific courses.

Our European subsidiaries are soon to have an impact on our product range. CalDesk, the new dSPACE calibration tool, will be available in French with Version 1.1. Customers outside France and the UK also benefit from the work done by the two subsidiaries: for example, dSPACE SARM developed a TargetLink I/O blockset for the Infineon C167.



▲ Engineers of TRW Conekt attending a TargetLink workshop presented by Romeo Ghiriti of dSPACE Ltd.



◀ Dr. Alain Gourdon and Yannick Hildenbrand of dSPACE SARM testing customer-specific ignition and fuel injection functions for dSPACE Prototyper.

www.dspace.fr
www.dspace.ltd.uk

Japanese User Conference

The fourth Japanese User Conference will take place at a spectacular location: The Pacifico Yokohama Conference Center (the world's largest convention center complex), which opens its doors for us on April 21, 2004.

The papers on applications with dSPACE systems will give you an inside view of the current research



and development work at leading automotive companies in Japan. Users from different fields such as Rapid Control Prototyping, Automatic Production Code Generation, Hardware-in-the-Loop Simulation and Calibration will be there. Take this opportunity to get the latest information straight from other users and exchange knowledge with fellow engineers and managers.

In addition to this, dSPACE's most recent products and developments will be presented: dSPACE Calibration System, TargetLink, Automation-Desk, and hardware innovations such as the DS2211 HIL I/O Board and DS1006 Processor Board. Come and join the conference. We're looking forward to seeing you there.

Japanese User Conference on April 21, 2004

◀ The Pacifico Yokohama Conference Center, an excellent place with a view of the Pacific.



▲ The latest developments of dSPACE systems will be shown with demo systems.

New Catalog and Demo CD

Solutions for Control 2004, our new product catalog with a new dSPACE Demo CD, is now available since January 2004. This year's catalog presents our pioneering new products, the dSPACE Calibration System and the CalDesk software, for the first time. And there are plenty of other innovations – for example, for test automation or prototyping safety-critical applications.

The numerous audiovisual demos on the new dSPACE Demo CD will give you a good impression of how easy our software is to use. Just check the box on your response card to receive the dSPACE Catalog and Demo CD.



Paderborn Has It All

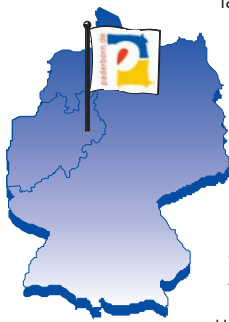
- Joint campaign uniting city and business
- A business location combining tradition with high tech
- The friendly little city



Paderborn, our home base right in the middle of Germany, is an attractive proposition as a business location and as a place to live. The city is currently running an image campaign to get this message across. Numerous business sponsors are participating in the campaign. dSPACE is one of them: We would like to see well-qualified people decide to come and enjoy life here.

An Upwardly Mobile City

Paderborn is a friendly city. Over the past three decades, its population has increased by over 40,000. It has now reached nearly 140,000 inhabitants – and is still growing. This above-average population growth is closely connected with economic growth during the same period. Paderborn is home to the largest computer museum in the world, so it is not hard to guess where much of this growth has come from. Numerous companies in the computer industry are located here, including major ones such as Fujitsu Siemens and Wincor Nixdorf. Such rapid growth has had a tremendous impact on the infrastructure and cultural life of the city. There is an international airport, excellent sports facilities, a dynamic university, and a unique range of other educational institutions.



14 Paderborn companies, including Wincor Nixdorf, Fujitsu Siemens, Benteler, and dSPACE, decided to support the “Paderborn Has It All” campaign. They began with joint activities to increase awareness among the city’s residents and visitors. Buses and trucks carry the new logo. Billboards proclaim the attractiveness of the life, work, education, leisure and culture in Paderborn.

Great Quality of Life

Paderborn lies among beautiful scenery in the east of the Federal State of Northrhine-Westphalia. Its name comes from the Pader, Germany’s shortest river, that rises from over 100 fresh water springs in pleasant green parks at the city’s center. Anyone who wants to spend their leisure time actively has a hard choice to make: There are more than 50 sports disciplines here, including unique ones such as water-skiing, American football and baseball. The University’s American football team has been German University Champion three times, the baseball team has also been German Champion three times, and the squash team even won the European Cup in 2003.

The Image Campaign

For some people, Paderborn’s image is slightly behind the times, which sometimes makes it difficult for local companies to attract qualified employees. This is why



▲ A city with many faces (from left to right): modern international airport; party time for the whole family in the historical old town; idyllic parks with the source of the Pader; Heinz Nixdorf MuseumsForum – the world’s largest computer museum.

Papers



M. Beine, M. Jungmann
„Automatic Code Generation for Safety-Critical Systems“

S. Köhl, Dr. D. Lemp, M. Plöger
„ECU Network Testing by Hardware-in-the-Loop Simulation“

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; Cambridgeshire, 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
- /// Technical writing

Request Infos



Please check the corresponding field on your response card and return it

- /// By mail
- /// By fax to +49 52 51 6 65 29
or
- /// Request information via our Web site
www.dspace.de/goto?dspace-news-info
- /// For more details, visit www.dspace.de
- /// Send us an e-mail at
dspace-news@dspace.de

Your opinion is important. Please send your criticism, praise, or comments to dspace-news@dspace.de – thank you!

Events



EUROPE

Embedded World

February 17-19 Nuremberg, Germany
Messe Nuremberg, Hall 12
Booth #438

RTS Embedded Systems

March 30 - April 1, Paris, France
Parc des Expositions
Porte-de-Versailles, Hall 3
Booth #P28

Total Vehicle Technology Conference (TVT)

April 26-27, Brighton, United Kingdom
University of Sussex

Testing Expo

May 24-25, Stuttgart, Germany
Messe Stuttgart, Hall 8
Booth #8035

USA

SAE 2004 World Congress

March 8-11, 2004, Detroit, MI
Cobo Center
Booth #2601

dSPACE User Conference

June 22-24, Detroit Metro Area, MI

JAPAN

dSPACE User Conference

April 21, Yokohama, Japan
Pacific Yokohama Conference Center

Training



Please check the corresponding field on your response card.

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

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