BOSCH Research Info

Issue 1/2005

Digital Models Up to Series Production

Researchers and developers at Bosch are using digital models to optimize product functions even in the design stage, which means many of the usual time-consuming intermediate steps and prototype stages can be eliminated. Using the models cuts development times and ensures high-quality products.

Innovation is a Bosch specialty: Every product generation brings with it new or improved functions – in everything from anti-lock braking systems to hammer drills. The developers' task is to adapt the implementation of their ideas to rapidly changing and dynamic markets. The tools they use to do this include digital models created with computers. In addition to being used to design products, computers are also – as far as possible – used to test the products' structural characteristics and materials and to subject them to virtual conditions simulating the conditions of everyday use encountered later by the customer. Here the engineers use computer modeling to simulate thermal stress, for example, noise generated by the products and their stability.

The art of large-scale production: Bosch researchers are using digital design and virtual testing to ready the next ABS generation for volume production.

The virtual tests help the experts to understand all aspects of a product. If problems or opportunities for improvement emerge, the developers can react immediately. The time required for the design phase, which normally includes a number of prototype stages, is reduced thanks to digital development of products – with many advantages. The virtual method systemizes and accelerates the product creation process, eliminates the need to make costly prototypes and makes it possible to optimally tune many product properties in advance. „Steel and iron" prototypes aren't built until a later stage of development, when the finishing touches are applied and final approval is given. In view of the large number of customers (multiplied by the desired product variants), using a highly digitized development environment pays off very quickly, because changes and customer requests can be rapidly implemented. The aim of current research projects is to use simulations to provide even more comprehensive data on product reliability and wear-and-tear and to integrate these methods into development processes.

The Bosch developers are assigned to many different locations, and all of them want to utilize advanced simulation tools. That's why Bosch Research is also developing cooperation concepts for teams with members scattered at different locations. Employees from many different areas in the company – from researchers to developers to sales and service engineers – can use software platforms to control product creation all the way to the series production stage.

Editorial

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Corporate Research and Development

New Products, New Methods

In this age of globally distributed development and production networks, of ever shorter development cycles and increasing cost pressures, well-established conventional product development methods are reaching their limits. New methods are needed to develop new products across global networks.

Bosch is making the necessary changes in its working methods. Computer applications support new approaches in the areas of product development and process organization. And Bosch Research is setting the trends in this area. Once it has obtained the initial research results, it further develops them to meet specific Bosch requirements before transferring them to the operative business units.

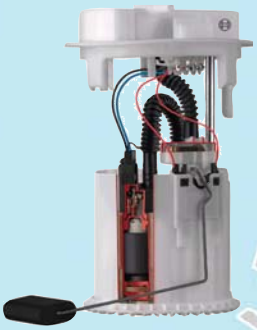
When the use of CAD tools became widespread in the 1980s and '90s, computer design and modeling were the main areas of application. Today these CAD methods have been largely established at Bosch. And the challenge is now to use existing models and methods economically and effectively in the product development process.

Model-based development methods range from the computation of simple design elements to the simulation of entire vehicles. These methods support the worldwide cooperation of simultaneous engineering teams in virtual engineering environments. Best-in-Class methods are indispensable for future success in terms of the values that Bosch represents: innovation and quality.

Cooperation without Borders

Bosch produces and develops automotive components in several European countries. Development and production engineers in geographically dispersed teams use 3D models to collaborate.

The fuel pump in the gas tank's in-tank assembly looks inconspicuous. But it's a good example of how Bosch, an international company, develops and manufactures products in distributed teams. The network has two principal nodes: All initiatives originate at the Schwieberdingen development location (1), which is home to the higher-level project coordination. The development flows eventually converge at the Budweis location (3), where the individual components are assembled into the complete in-tank unit.



In-tank assembly with fuel pump

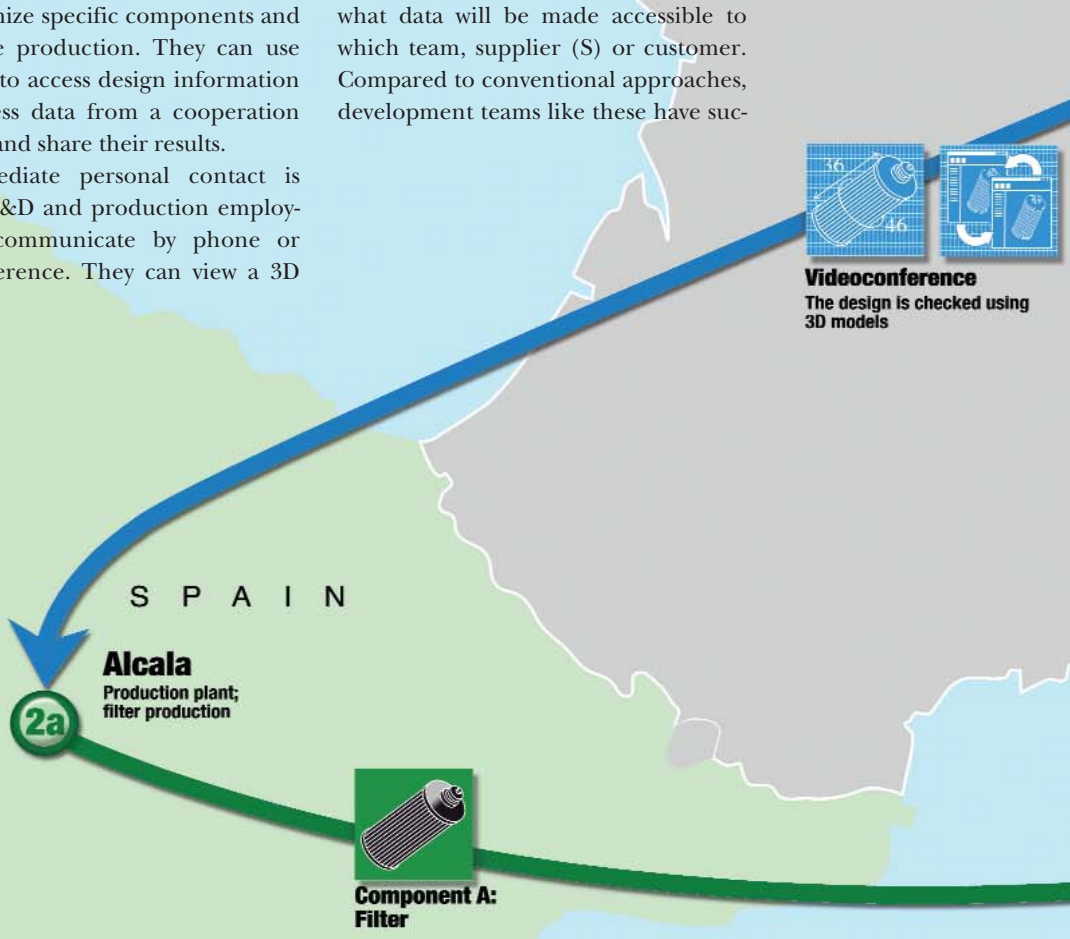
Development teams at the components factories in Alcala (2a) and Bühl (2b) optimize specific components and coordinate production. They can use data lines to access design information and process data from a cooperation platform, and share their results.

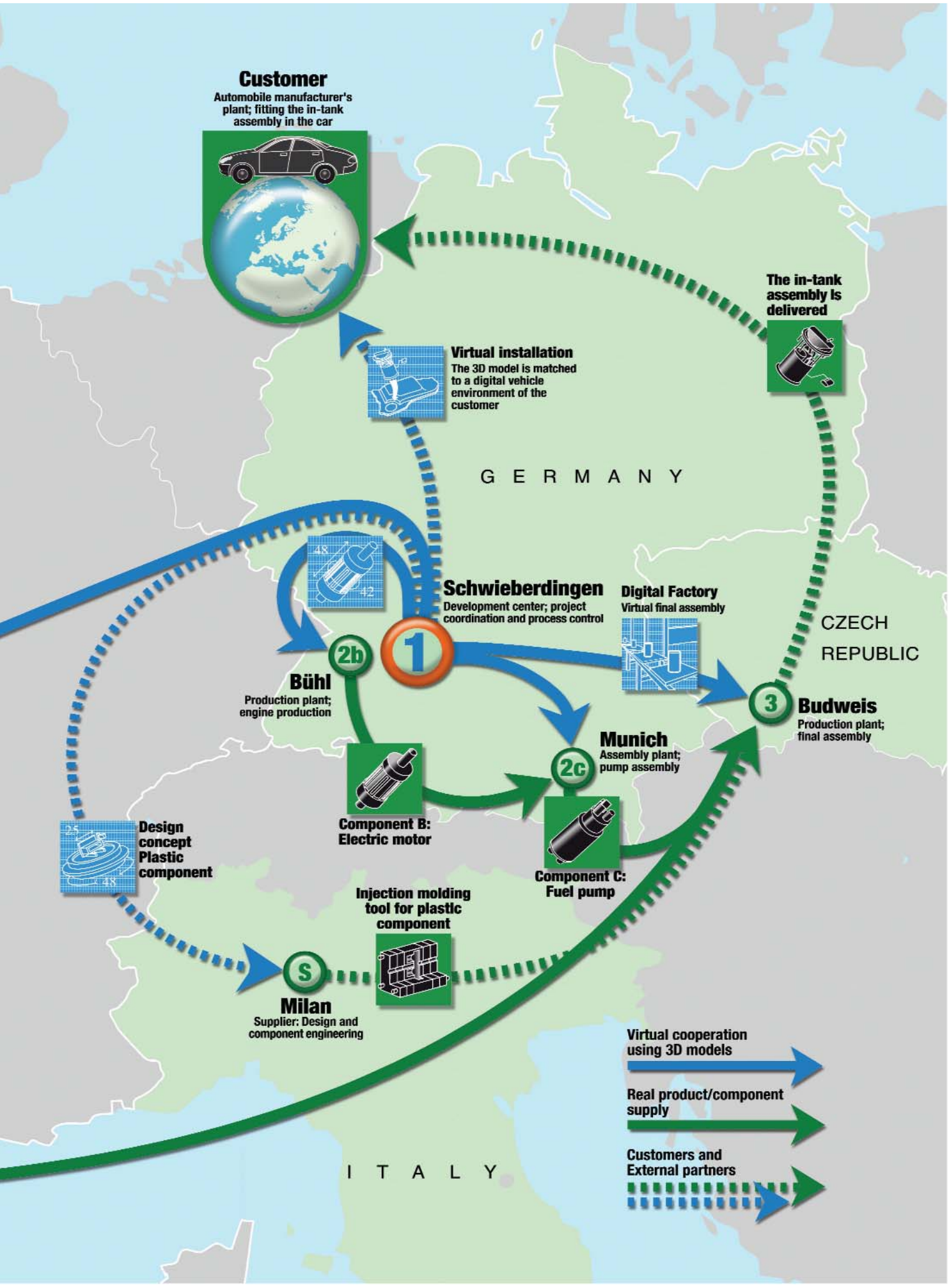
If immediate personal contact is needed, R&D and production employees can communicate by phone or videoconference. They can view a 3D model of the current design on a display screen. And if they wish, they can rotate this 3D image, make measurements, discuss possible changes and document them.

The 3D model is a highly simplified version of a CAD design. It's intended for people who are not skilled in CAD applications. A sales engineer, for instance, can display the image on a 3D viewer to easily discuss design details with a customer. The simplified 3D model has given development, manufacturing, sales and service engineers a common language.

On their cooperation platform, development coordinators can select exactly what data will be made accessible to which team, supplier (S) or customer. Compared to conventional approaches, development teams like these have succeeded in reducing the time required for coordination and changes by one third on average.

Other advances have been made in the research project that supports such virtual teams. While Bosch product development and manufacturing teams have successfully been using the cooperation platform, external partners are now being integrated into pilot projects. The long-term goal is consistent utilization of 3D models throughout the entire value chain, including Service. That's why Bosch researchers are leading a joint working group of the VDA (German Automotive Industry Association) and the ProSTEP Society to establish a standard for industry-wide use of 3D models in the automobile industry.




Customer
Automobile manufacturer's plant; fitting the in-tank assembly in the car
The in-tank assembly is delivered
Virtual installation
The 3D model is matched to a digital vehicle environment of the customer
GERMANY
Schwieberdingen
Development center; project coordination and process control
Digital Factory
Virtual final assembly
CZECH REPUBLIC
2b
1
Bühl
Production plant; engine production
3
Budweis
Production plant; final assembly
Munich
Assembly plant; pump assembly
2c
Component B: Electric motor
Component C: Fuel pump
Design concept Plastic component
Injection molding tool for plastic component
S
Milan
Supplier: Design and component engineering
Virtual cooperation using 3D models
Real product/component supply
Customers and External partners
ITALY

Down to the Details

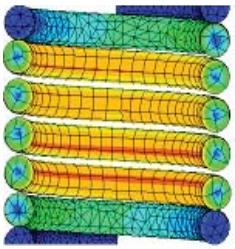
At Bosch, testing and optimizing components on a computer is increasingly becoming routine. Bosch researchers pay attention to all technical details, such as the stress levels that materials are exposed to, and how reliably products perform their functions.

Each innovative advance makes today's cars safer, more economical and cleaner. But for the research scientist and the engineer, there's much more to it: These products are becoming increasingly more complex. Anti-lock brakes, for instance, have added a network of sensors, hydraulics and electronics to the automobile. The Electronic Stability Program (ESP®) is based on ABS technology and integrates even more functions.

Another challenge facing researchers is the dynamic nature of innovation. Whereas ABS took 20 years to achieve 40 percent market penetration, ESP® reached the same level in just half the time. The complexity of product design and the speed of innovation influence all product development at Bosch. And the only way to meet this dual challenge is by applying virtual engineering methods. Bosch researchers are using computers to model and test product designs and their functions.

Rough road. Products can't be developed in isolation: Components such as ESP® or generators must function perfectly once they have actually been installed in a car. In the past, engineers used to perform road tests to check the vibrations and temperatures to which products were exposed. But it isn't possible to drive down a cobbled street when the vehicle only exists on the drawing board. So researchers are now simulating bumpy rides on the computer. With the use of mathematical methods, a generator can be thoroughly vibration-tested in less than a week. Researchers enhance standard simulation software by using sophisticated algorithms to test product functions, and physical experiments are used as reality checks for the computer models. When the computer methods and models have been checked out in Research, they're released to the engineering departments of the business units.

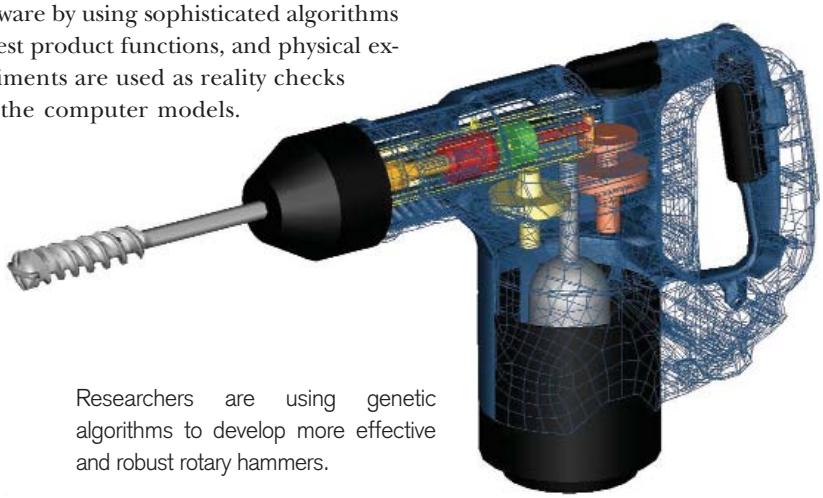
Down to the tiniest spring. Compression springs rank among the smallest parts of a common-rail diesel direct injection system. After each fuel metering cycle, these little springs push the injector needles back to their starting position. Bosch researchers want to find out exactly how these springs vibrate within their guide channels.



3D simulation of a compression spring.

Do they touch the channel wall? Are their movements being damped? Such interactions could affect the quality of the injection — and thus combustion and fuel consumption. Researchers use 3D computer simulation to observe the springs' movements. Even the tiniest spring must last for the lifetime of the whole vehicle.

The tree algorithm. Bosch engineers also imitate nature to optimize their products. The growth of trees is particularly active in places that are exposed to a lot of stress and strain. Engineers apply analogous methods to optimize the geometry of components. To improve the striking mechanism of a rotary hammer, for instance, Bosch researchers applied principles derived from biological evolution. As a result, the removal rate of the tool was increased by 25 percent.



Researchers are using genetic algorithms to develop more effective and robust rotary hammers.

In Brief

■ *New dimension of cooperation*

In January, Bosch Research established the VDA/ProSTEP working group Collaborative Product Visualization. Its aim is to make it possible for participants without CAD to use a 3D display of components to communicate between companies. The method will allow CAD engineers to simplify their data exchanges. Pilot applications due for completion by 2006 should lead to a new VDA standard. Many large automakers and suppliers are participating in this initiative. For information, contact Ralf.Mendgen@de.bosch.com

Dates

■ *June 16/17, 2005*

At the VDI Conference on "Testing & Simulation – Measurement and Trials Technology" in Würzburg, Rüdiger Benz gave a presentation on "Dynamic simulation of vehicles on uneaven roads to determine vibrational load on car body-fixed components."

■ *June 20 – 22, 2005*

At the 11th International Conference on Concurrent Engineering at the Bundeswehr University in Munich, Armin Hoffacker gave a presentation on "Collaborative Engineering at Bosch."

Masthead

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