

# Bertrandt*magazine*

No. 7 • November 2006

**Audi Q7 – Joint Project Development**

**Mercedes-Benz S-Class – Body-in-White Development Support**

**Airbus A380 – Display Models**

**Renault/Nissan – Development Support Diesel Engine**

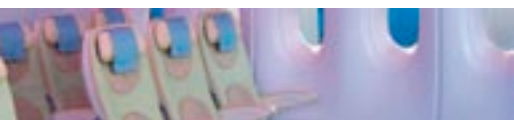
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## Editorial

Speed is thrilling. We car enthusiasts enjoy the sensation of powerful acceleration in a comfortable vehicle as one of the more pleasant aspects of our personal mobility. But against the background of discussions about energy-saving and ecological motoring, it is becoming increasingly important not to focus exclusively on high engine output in the development of new engine generations but also to look at other aspects: The automotive industry is facing new challenges. New approaches range from concrete, module-specific innovations in engines, sub-assemblies and drive trains to weight-saving developments and the intelligent use of materials. What is more, alternative drive systems are contributing to a positive market development: Studies predict growth of up to five percent a year in the engine/drive system sector in Europe over the next decade.

These are promising market perspectives for development service providers – also for Bertrandt. In recent years, we have expanded our range of services in the engine/drive system sector and networked them in the Powertrain Competence Centre. Our customers can now benefit from expert support in every aspect of functional development, from components and modules right up to testing – and all this is available throughout Europe.

In the centrefold of the latest edition of our customer magazine we focus on information about our Powertrain Competence Centre. Put us to the test! Our dedicated automotive specialists truly work with petrol in their veins – competently and efficiently. This edition of *Bertrandtmagazine* also presents a number of interesting projects: The Audi Q7, Mercedes Benz S-Class or special emergency vehicles are just some of the projects that we have recently been involved in. And in addition, one project really sent us "above the clouds". Let us inspire you. Taking a journey into the world of Bertrandt is certainly worth it!

Dietmar Bichler

AUDI AG landed a great shot with the "Performance SUV", the Q7. It elegantly combines sportiness with versatility and highly developed technology with the comfort of a luxury saloon. The project even surpassed the own expectations of the development partner, Bertrand Ingolstadt.

► From a facelift to a complete development

While Bertrandt was still involved in the final phase of the A4 facelift, Audi was on the lookout for a development partner for its new project, the Audi Q7. The plan was to develop the new premium vehicle together with an engineering service provider in Ingolstadt. Bertrandt was keen to be on board. For Bertrandt's Ingolstadt site, the Q7 would represent a further challenge in the development depth of a vehicle.

► First project partnership between competitors

In order to continue the development of the Audi A4 on a high level, a tender for the Q7 was made together with the local competitor IVM Automotive. With each being a long-term partner of AUDI AG, Bertrandt and IVM Automotive ideally complemented each other. A special challenge was the awarding of a development project including simulation, testing and vehicle safety to a single engineering service provider for the first time – in this case to the project partners Bertrandt/IVM Automotive. This unusual constellation of two competitors working together was a particular feature of the project.

► Structured project organisation

The prerequisites for functioning project management are a structured exchange of information as well as decision-making on working procedures on management level. This was created jointly with clear specifications and commitments at the beginning of the project and throughout its entire duration.

The first task was to define the project organisation of Bertrandt and IVM Automotive in order to present the two companies as a unit. The rules for cooperation both internally as well as with the customer were set out in a project handbook. This also described further project objectives, the organisational conditions, the interdisciplinary

# Audi Q7 High-Performance Re-Defined



## Audi Q7

The four-zone air conditioning system ensures maximum comfort in the vehicle interior.



Vibration testing in the climate chamber – stresses applied over years experienced in days.



functions as well as the set forms and auxiliary support used.

This clear definition of responsibilities, contact persons and decision levels as well as the description of interdisciplinary functions helped all those involved to quickly feel at home in the project. The binding specifications set out in documents and plans ensured that a uniform picture was presented both internally and to the customer. The handbook was continuously updated and adapted to the state of progress of the project.

An important function of the kick-off session was to coordinate the expectations and the specifications and to fix regular consultation meetings. Furthermore, the organisational structure in the project on the customer's side was harmonised with the providers' own structure in order to

ensure that clear communication was achieved as required.

### ► Technical highlights Concept vehicle

A special feature of the project was the development of a high-quality concept vehicle at an early stage in the development. In addition to virtual verification, this allowed AUDI AG to experience all of the driving characteristics, functions, ergonomics and component geometries in a real form during test-drives.

### ► Pedestrian safety

The systematic expansion of the process chain at Bertrandt allowed the functional development of the pedestrian safety features – and therefore the entire front-end of the vehicle – to be completely developed using own resources. Close

cooperation between the Computation, Design and Testing divisions allowed work to be carried out quickly and efficiently under optimum conditions.

### Rear-hatch

A unique feature of the Q7 is the aluminium rear-hatch that wraps around the D-pillar, thus providing a particularly large opening to the luggage compartment. This design made especially high demands on the developers in terms of precise fitting, weight and stiffness, as it also integrates the entire rear light unit for the first time.

### Interior

On completion of the prototype release, Bertrandt supported the development of the interior components up to series production, together with nominated system suppliers. This work was carried out in close cooperation with the partners, with Bertrandt Ingolstadt providing the platform for Simultaneous Engineering in the project house. Cooperation with the engineers responsible at AUDI AG and with the system suppliers resulted in an interior that is superior to any other in its class. A development engineer, responsible for Interior Development at AUDI AG, describes it in the following way: "The equipment versions exhibit Audi's customary quality and attention to detail. In spite of having the robust character of an SUV, the Q7 does not have centi-



The entire rear light unit is integrated into the rear-hatch.

## Audi Q7

metre gaps but millimetre gaps and a meticulous finish."

### Air conditioning

With regard to the vehicle's air conditioning system, Audi's project specifications were implemented in close cooperation with the system developers and Volkswagen AG as the platform developer. Bertrandt also provided support for the sub-assembly cooling system and ensured that the platform could be used unchanged in the Q7.

### Digital mock-up

In order to carry out the DMU process, the vehicle was divided into individual zones and modules, each of which was attended to by a module supervisor. Their main responsibility was the analysis of the latest geometry data. Using the DMU navigator, the modules were examined with regard to collisions and the necessary clearances and the results were regularly presented in DMU meetings. The introduction of Virtual Product Management (VPM) allowed the development process to be further optimised. A structured DMU was performed for the first time. Thus, the partners came closer to the aim of replacing physical

prototypes by digital ones. The new quality of the prototypes was also clearly recognisable. Many of the problems that had previously been recognised only when the vehicle was assembled had now been solved in the DMU, or they did not occur at all.

### ► Project completion

The project review for the Q7 with the management of AUDI AG took place at the beginning of 2006. For the body-in-white, interior, air conditioning and cooling, vehicle safety, simulation DMU, testing and project management project areas, the partners presented an analysis of the execution of the project. The result was extremely positive for the companies involved. The decisive feature of this undertaking was that two development service providers acting in unison could successfully complete a project of this size. That encourages us to try other unconventional solutions in the interests of our customers.

We would like to thank all those responsible at AUDI AG as well as our project partners for the excellent cooperation in this project. ■

*Michael Neisen, Bernd Romahn, Ingolstadt*

## Scope of the Audi Q7 Project in Brief (Bertrandt)

### Body-in-White

- Bonnet, Wings
- Rear-Hatch, Windows, Wipers, Washers
- Front-End

### Analyses

- Complete Vehicle Tolerance Management

### Digital Car

- DMU: Front-End, Cockpit, Seats, Underfloor, Rear-End, Rear-Hatch

### Interior

- To P-Release: Cockpit, Door and Side Panelling
- To SOP: Center Console, Greenhouse, Luggage Compartment, Carpets, Seatbelts
- Air Conditioning/Complete Vehicle Cooling

### Component Testing

- Bonnet, Rear-Hatch and Tank Lid
- Pedestrian Safety
- ECE-R21, FMVSS 201

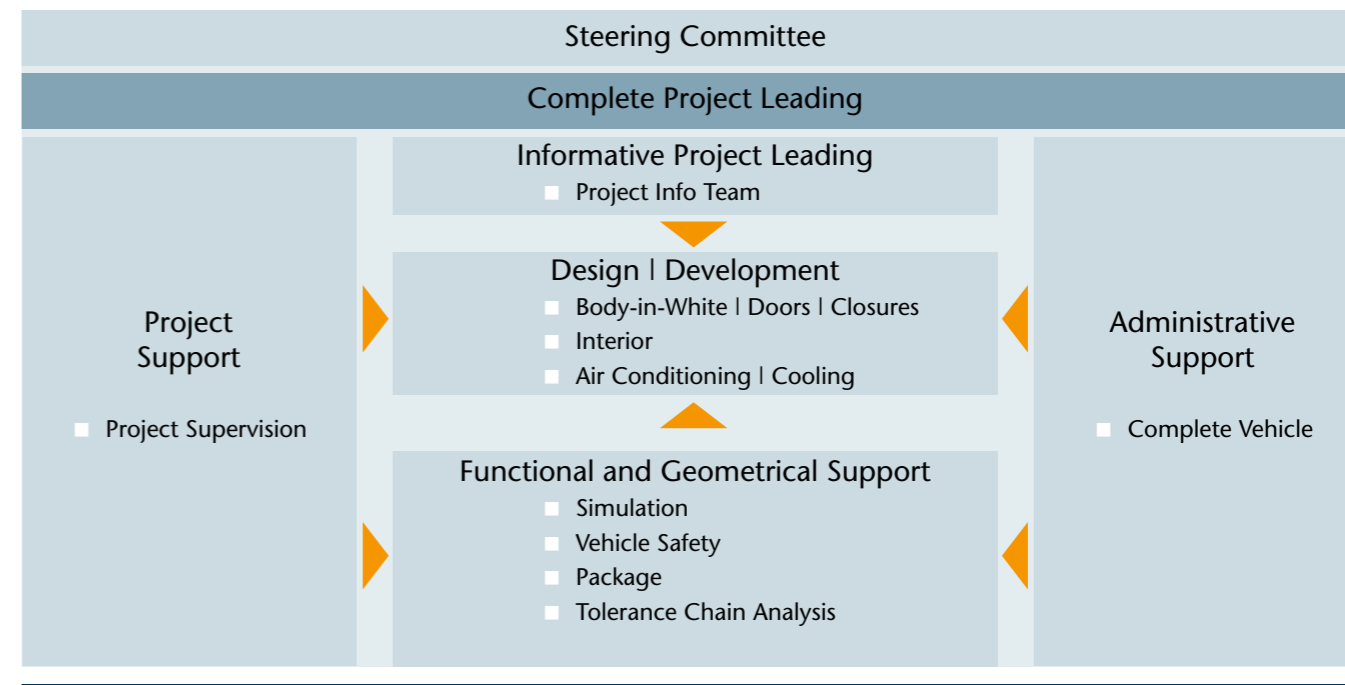
### Computation/Simulation

- Functional Design of Bonnet and Rear-Hatch
- Pedestrian Safety
- Cockpit

### Project Management

- Interior, Air Conditioning/Cooling
- Bonnet/Wings, Rear-Hatch, Front-End, Add-On Parts
- Joint Project Supervision and Control

## Project Structure Audi Q7 | Bertrandt/IVM Automotive



## Mercedes-Benz S-Class



## Innovative Body-in-White Expertise

Groundbreaking innovations, safety at the highest standard and unique levels of comfort – these are the superior qualities expected of the flagship model from Mercedes-Benz. And the new S-Class fully lives up to these expectations, also when it comes to its innovative body, which won the EuroCarBody AWARD 2005. Over a period of five years, Bertrandt in Ehningen accompanied the development of this car body.

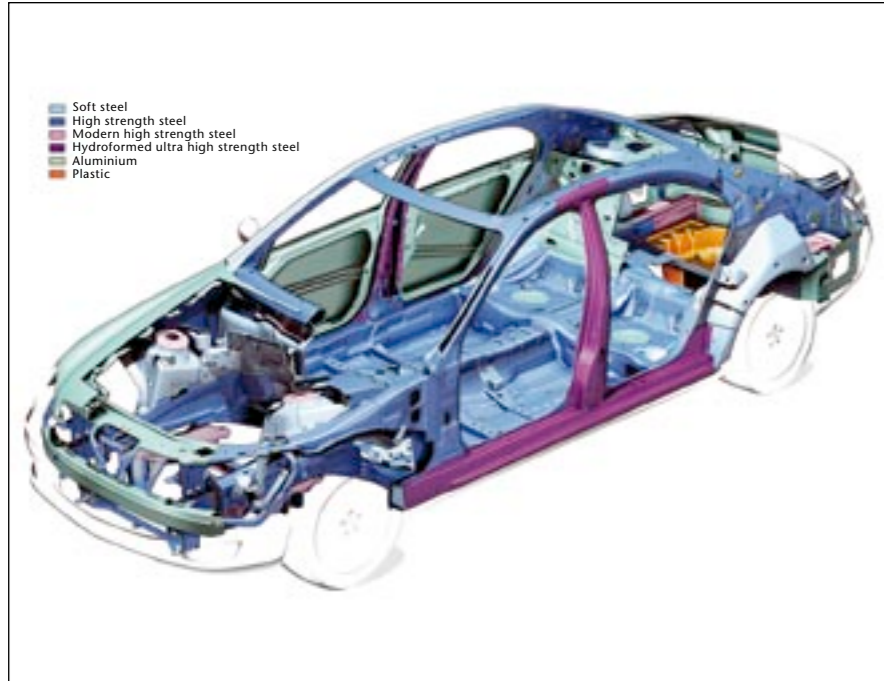


1:5 scale display model. Bertrandt produced this model of the car's body using SLS technology.

### ► Project organisation

Four Bertrandt project teams were involved in developing the body of the new S-Class, divided up into the areas of the front-end, main floor, rear as well as the bonnet and wings. Regular coordination meetings between the individual teams and the specialist departments of DaimlerChrysler and other suppliers guaranteed smooth and reliable communication in the project. Bertrandt also provided active support for the change and release management processes. The entire development was carried out exclusively in 3D, in other words without the use of drawings. The extremely high demands that this placed on the quality of the data were comfortably met. Specialists from Technical Documentation supported the archiving process in "Smaragd", DaimlerChrysler's documentation system. For this purpose, Smaragd direct clients were established at Bertrandt using a dedicated line.

## Mercedes-Benz S-Class



### ► Innovative technology

Due to the many innovations in the new body, the design engineers were repeatedly faced with special challenges. For example, the material mix in the body-in-white called for specific and demanding solutions for joining the different parts.

One particular innovation was the use of vault-structured sheets with asymmetrical vaulting in the floor area. This provides optimum vibration behaviour and therefore better acoustics. Bertrandt's Computation/Simulation Competence Centre was also involved in the development of these structures.

Furthermore, it was also necessary to consider the different versions of the S-Class body. The floor area had to be designed to accommodate not only the saloon with a longer wheelbase but also the four-wheel drive version and the S-Class Coupé. With their expertise gained over many years of experience, Bertrandt's engineers were able to provide optimum support for the specialist departments at DaimlerChrysler.

Lightweight engineering with different materials. The body of the new S-Class.



Michael Bausenhardt, Project Leader of one of the Bertrandt project teams, demonstrates the divided bulkhead using a 1:1 model from the model-making workshop at the Technikum in Ehningen.

### ► Meeting the weight challenge

The newly developed body is designed to meet even higher specifications than its predecessor, including such aspects as crash management and torsional stiffness. The vehicle dimensions have also increased. In spite of this, it was possible to keep the weight of the body-in-white constant. Over several weeks, a working group made up of all the relevant DaimlerChrysler specialist departments as well as simulation and testing teams and the various suppliers examined every single component to determine potentials for weight reduction. Here too, the experience of Bertrandt's engineers was in great demand. The result is a body made up of a variety of materials, from plastic and aluminium to ultra high strength steel, manufactured using innovative forming processes such as hydroforming.

### ► Conclusion

The successful cooperation between the specialist departments of DaimlerChrysler and the Bertrandt project teams has resulted in a vehicle, which is visible on the streets today with a self-confident, powerful and at the same time elegant character. Bertrandt is very pleased at being able to contribute to the development of this luxury car. ■

*Michael Bausenhardt, Hartmut Mezger, Ehningen*

## Scope of the Mercedes-Benz S-Class Project in Brief

### Body-in-White

- Front-End
- Main-Floor
- Rear-End

### Doors/Closures

- Bonnet
- Acoustic Insulation

### Exterior

- Windscreen Glazing
- Rear-Window Glazing

### Powertrain

- Damping
- $C_d$  Covers and Noise Encapsulation below the Engine
- Shielding Plates
- Rear-Engine Mounts

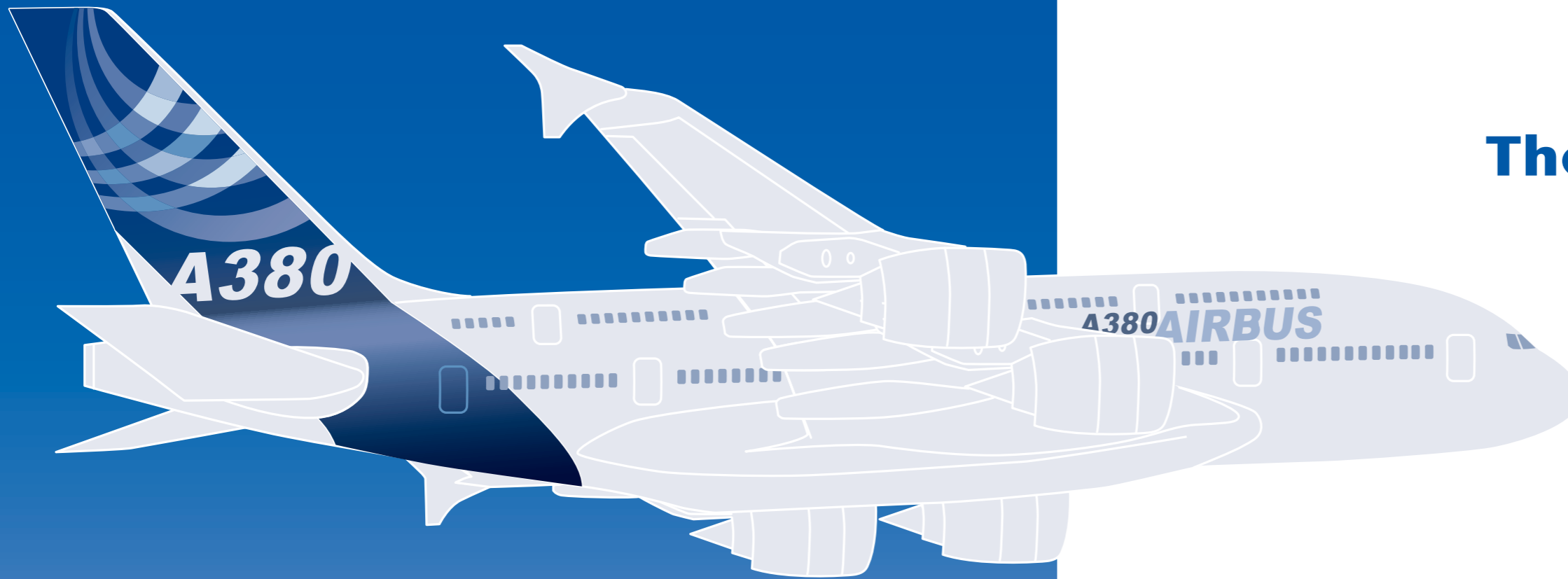
### Documentation

- Drawing Inspection
- Technical Documentation

### Rapid Technologies

- 1:5 Body Models using SLS





# The Sky is the Limit

## Designing and Realising True-to-the-Original Airbus A380 Display Models

Two one-of-a-kind Airbus A380 interior display models were designed and manufactured by the engineering service provider Bertrandt on behalf of Lühmann Ingenieur AG in Buxtehude: A "Cabin System Test Center" (CSC) for cabin system tests, lighting scenarios, demonstration, presentation purposes and workshops as well as a transportable interior model (EXPO mock-up) for exhibitions. The project planning started in the Swabian city, Ehningen. In September 2004, three Bertrandt teams started the challenging project work here under the management of Christian Riedel from Airbus Buxtehude and Bertrandt Lead Engineer, Dirk Liebegall.



The Cabin System Test Center being assembled. The first interior panel trims are installed.

### ► Project requirements

Beforehand, the Airbus engineering partner Bertrandt had to produce a replica of the cabin interior as true-to-the-original as possible, for Airbus' new flagship, the A380. A special challenge in this project was the integration of the built-in interior components within the cylindrical and conical areas by means of a flexible supporting frame structure in the shortened frame structure approximated to the original fuselage.

### ► The Cabin System Test Center

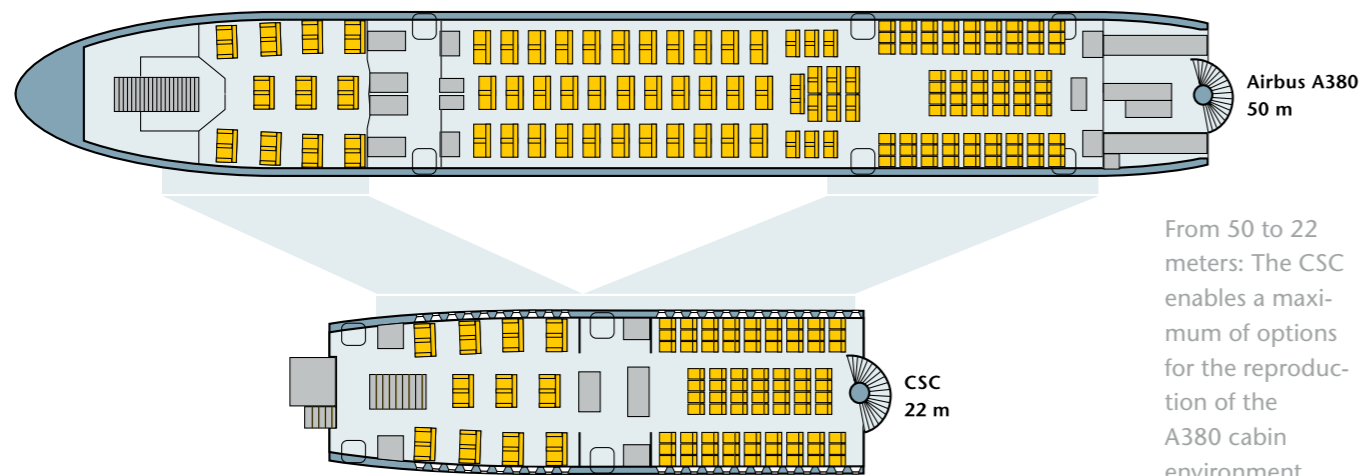
The Cabin System Test Center was built by the Lühmann Ingenieur AG (Airbus Buxtehude) in Buxtehude, Germany. It had to be the spitting image of the Airbus A380 cabin, which has an original length of approximately 50 meters. The aim was to represent as much possible options in as much possible reproductions of the cabin environment in the reduced overall system. "All of this on a stately 22 meters", highlights the Lead Engineer, Dirk Liebegall.

Lühmann provided the steelwork-girder construction (frames). The Bertrandt engineers developed the design data for the CSC from the design data of the Airbus' surfaces. At the same time a concept for the restraint system was provided, in order to be able to install the many individual parts in different variants. Thus most different lighting scenarios are to be tested in the cabin interior replica for example, like the simulation of daylight, the dawn phases and total darkness. The airline passengers can be relieved as such and jetlag can be counteracted.

The development of the sealing system also turned out to be challenging. No ray of light of the fully functional lighting may penetrate between the interior panel trims. Not an easy task, if one regards the many different construction variants.



## Airbus A380



From 50 to 22 meters: The CSC enables a maximum of options for the reproduction of the A380 cabin environment.

A further project scope covered the construction and the subsequent milling of the tools. The short channels within the Bertrand Technikum between Engineering and Modelmaking proved to be an advantage. In only 16 weeks the tools were developed and finished as well as the visible surfaces of the CSC: These were subsequently illustrated as laminate construction units, painted and installed.

The result is impressive. Both the main deck and upper deck look majestic. The decks were completely equipped with interior construction units in different variants. As for example, two luggage rack variants within the cylindrical range: a fixated "Fixed Bin" for the tourist class and a flexible "Movable Bin" for the first

class. This clearly provides for more generous spatial conditions. The new A380 also sets new standards here.

### ► Expo interior model:

**Main exhibition attraction**  
Parallel to the CSC, Bertrandt built a genuine "eye catcher" for aviation exhibitions, the seven meter "EXPO mock-up". "The EXPO mock-up was the number one attraction at the Paris Airshow 2005", Dirk Liebegall said pleased at the end of June 2005 about this splendid accomplishment. "The fascination lies in the full operability – and naturally the possibility to transport it around the world", Lead Engineer, Liebegall adds. No wonder does this model attract visitors like a magnet does iron splinters.

The relaxed atmosphere and the pleasant temperature inside are inviting: One is able to forget the hectic exhibition environment for one second and to immerse into the world of the new A380.

Also the Bertrandt engineer, Samuel Kohler stresses with pride: "Knowing that it is possible to produce something in this quality and size is very satisfying." In 2005 the model was already flown across the globe, in order to fire further important visitors at aviation exhibitions with enthusiasm and above all airlines for the new king of air. These journeys are made possible by the Airbus Beluga, which reliably transports the detachable model in four parts across the clouds.

### ► The project partnership's top result

During the project work a positive cooperation developed between Bertrandt, Lümann Ingenieur and Airbus Buxtehude. "By means of first-class project management, the collaboration resulted into the customer's full satisfaction", Dirk Liebegall reflected and also Christian Riedel confirms the joint accomplishment, which quality was fascinating. Such glass fibre interior model components are the first ever to be made. These are usually manufactured from foam material and polystyrene. ■

Monique Saier, Ehningen

The interior components are fastened by means of a flexible supporting frame structure to the frame structure of the CSC.



## Interior Display Models



Crowd puller on the Paris Airshow 2005: The EXPO mock-up.



The EXPO mock-up makes the most different lighting scenarios possible.

### Scope of the Airbus A380 Interior Display Models in Brief

#### Aircraft Development

- Surface Development
- Sealing and Attachment System Development

#### Toolmaking

- Tool Design and Manufacturing

#### Modelmaking

- Laminate Components

### Product data management with ENOVIA LCA

The advantages of the Product Lifecycle Management System ENOVIA LCA could be intensively proven with this aviation interior project. So far engineers have used ENOVIA within the automotive range with the emphasis on data management and part list management. Due to the high amounts of data within aviation projects, ENOVIA could be used with a multiplicity of its functionalities for the first time: The handling of several different "work packages" as configurations, a large number of multiplied (up to 800 times) and relatively positioned construction units and modules offered challenges during the development. For example 7 000 positions alone were on the parts list. Bernhard Zechmann, Project Leader ENOVIA LCA, concludes from the excellent result: "With the A380 project it was to be clearly recognised, what we can achieve with ENOVIA, primarily within the data management range. With a PLM System, projects in all orders of magnitude and complexities can be professionally processed. We also mastered the due date for the project preparation and aerospace methodology development successfully".



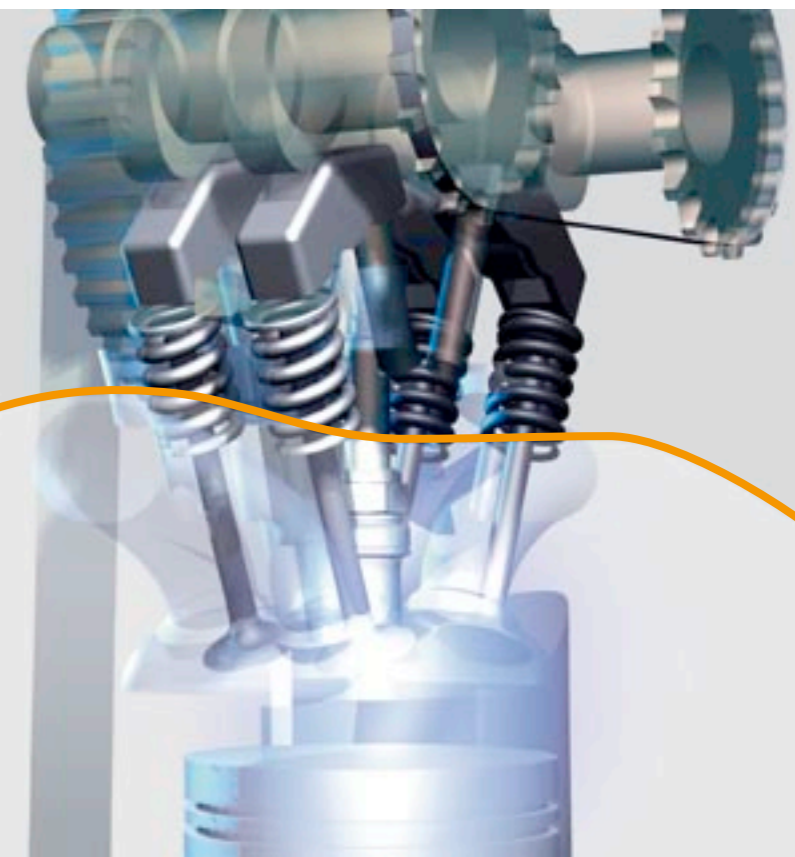


# Powertrain

Experts are forecasting that alternative powertrain/engine concepts and solutions for reducing fuel consumption and pollution will continue to grow in importance. Engine concepts that offer increased efficiency will play a significant role in this respect. However, developers are focussing not only on engines, but also on the overall powertrain concept, which will contribute to providing environmentally friendly, comfortable and dynamic mobility solutions based on an efficient use of resources in future.

The engine is the heart of any vehicle and is therefore increasingly being seen as the core competence of manufacturers. New powertrain concepts will also give OEMs and their suppliers the opportunity to strengthen their brand profiles. The complexity of the latest innovations also offers the possibility of a growth in business for development service providers. External partners of the automotive and subcontracting industries can provide support in traditional fields, such as concept, component and module development, on the basis of their long and extensive experience. In addition, engineering partners can offer integration services aimed specifically at the interfaces between the engine, peripherals, powertrain and chassis, but also focusing on testing and on the increasingly complex vehicle electronic and software networks.

COMPETENCE FROM THE CONCEPT STAGE THROUGH TO TESTING



# Powertrain

## Concept Development

The aim is to develop effective concepts on the basis of initial ideas. The technical limitations of the engines, modules or components under development will be investigated and variant comparisons, benchmarking and concept designs will be implemented – for individual components or a complete package.

Package Development  
Benchmarks  
Feasibility Studies  
Variant Development  
Complete Systems  
Individual Components  
Front-End

## Component Development

Every individual component plays a significant role in the overall functioning of an engine. From the crankcase through to the radiator hoses – everything is important. In-depth know-how forms the basis for the development of components in the individual engines and peripherals.

Base Engine/Peripherals  
Auxiliary Cooling  
Air-Conditioning Cycle  
Transmission/Drive Train  
Developing:

- Castings and Forgings
- Pressed, Turned and Milled Parts
- Pipe and Hose Systems
- Plastic Parts

## Module Development

During the module development process, the overall functioning of an assembly consisting of several components is determined. Important factors include an understanding of the technical requirements, the identification of solutions and taking overall responsibility for the interaction between customers, suppliers and development partners.

Base Engine/Peripherals  
Auxiliary Cooling  
Air-Conditioning Cycle  
Transmission/Drive Train  
Concepts  
Design  
Computation/Simulation  
Testing

## Engine Integration

Understanding the functions of the engine and its interfaces. These are the prerequisites for integrating a base engine into a vehicle. The Powertrain Competence Centre pools both expert knowledge and technical equipment – also for increasingly important areas such as DMU, PMU and prototyping.

Package/Concept  
Integration/Assembly Studies  
DMU/PMU  
Developing:

- Media Carrying Systems
- Engine Components
- Engine Peripherals

## Computation/Simulation

Technical simulation forms the basis for decisions that are taken about concepts or projects in the early stages of development. Real-time, reliable information, for example about the service life and flow patterns of components, contributes to short development phases.

Stiffness/Harness  
Flows  
Vibration  
Pedestrian Safety  
Crash

## Engine Development Support

The route taken by an engine from the initial design to the start of its volume production in the vehicle is a long one. The development service provider Bertrandt is a reliable partner in every aspect of the process. Whether testing, application, engine and vehicle prototyping and flash and logistics support.

Endurance/Functional Testing  
Application  
Engine/Vehicle Assembly  
Logistics/Flash Support  
Testing Support  
Component Testing

**Bm:** Matthias Rühl, your groupwide competence centre combines extensive expertise with highly technical equipment. Which benefits can you offer your customers?

### Three questions for Matthias Rühl, Managing Director, Powertrain Competence Centre



**Matthias Rühl:** Over the last few years, many of our customers have redefined their core internal activities. The resulting outsourcing strategies in some cases differ significantly from one another. This is where our decentralised structure pays off – at each subsidiary we can focus fully on our respective main customer. In some cases, the customer's requirements are so complex that they cannot always be met using the resources available at just one of our subsidiaries. This is where our departmental focus comes into play. Our decentralised specialisation, the requirements-based grouping of expertise and resources and our networked working methods bring a large amount of added value for our customers.

**Bm:** How does Bertrandt's Powertrain Competence Centre differ from its competitors?

**Matthias Rühl:** Bertrandt has subsidiaries all over Europe. This attribute clearly distinguishes us from our local competitors. The range of services offered by each subsidiary is heavily oriented towards the requirements of the respective

main customers. In the Powertrain Competence Centre we pool and market our services, which results in an extensive portfolio of services that is available throughout the group. Our employees also have an above-average level of expertise. We are taking the next important step towards maintaining our position as one of the best service providers on the market by introducing our "Engine and Engine Function" skills programme.

**Bm:** Your objective is to take over complete responsibility. What are the next milestones in this process?

**Matthias Rühl:** For us, complete responsibility means primarily the "functional development of components and modules". In the medium-term, we want to develop engine derivatives, such as turbocharged engine and cylinder capacity variants. Three factors play an important role in this process: highly qualified employees, developing specialist resources throughout the group and completing our range of services. This focus becomes clear if we look back over the last 24 months, when the number of employees in the Powertrain Competence Centre has increased by 40 percent to around 290. In order to expand our range of services, we are currently accelerating the development of the testing/application area and are on the lookout for possible project partnerships. ■

### ► Competence from the concept stage through to testing

The development service provider Bertrandt offers its customers an extensive range of services covering all aspects of drive systems, from concept development through to production and from design through to testing. Bertrandt's Powertrain Competence Centre makes use of expertise from the entire group of companies and its in-depth understanding of the base engine and the accompanying powertrain elements that has developed over many years. The department's engineers can simulate the use of components, run test bench and vehicle tests or integrate a complete drive train into a vehicle. Bertrandt has adapted to the increasing use of electronic and electromechanical components in the drive train by developing close links with specialists from its electronics department. The aim is to use the group's existing electronics skills as a major force for the creation of added value for the customer in the central engine module.

In the drive train field, Bertrandt is speeding up the development of its expertise. The service provider regards new legislation, different country and engine variants and changes in customer requirements as the main driving forces behind the development of a new global generation of engines for the automotive industry. At the same time, the number of base engines will be reduced, while the number of derivatives based on changes to basic engine components and peripherals will increase. Bertrandt's objective is set. The company wants to take over complete responsibility for the development of complex modules and entire engine derivatives over the next few years. ■

# Boosting Performance

Bertrandt France Helps to Develop Renault/Nissan's Latest Diesel Engine



Renault's current strategy includes developing innovative engine/transmission units that meet the Euro 4 standards. A particular highlight is the latest development in their engine range – the new 2.0 dCi diesel engine, in which developing Bertrandt France was involved in.

## 2,0 dCi Diesel Engine

► **Challenge:** Developing the most powerful diesel engine while complying with all environmental regulations

Renault was in charge of designing the new diesel engine. The new power unit competes with the best performing engines on the market. Ever since the start of this demanding project in September 2002, Bertrandt was involved in developing the entire base engine above the cylinder head gasket, as well as the intake and exhaust systems and durability testing. Special attention was also paid to the wide-ranging production and environmental requirements.

**Considering production requirements**

Parallel to the development of the 2.0 dCi, a new assembly line was put into operation at the Cléon plant near Rouen. The contact persons supporting the process were involved in the development of the various components from the concept phase onwards. This allowed all the specific requirements to be taken into account at an early stage. Even during the design process, Bertrandt considered all the requirements at the plant, such as processes, service and vehicle and engine assembly, while at the same time keeping in close contact with the suppliers. The focus at all times was on the main objective: to secure a manufacturing process that meets Renault's stringent quality standards.

**Environmental requirements**

The engine/transmission unit had to be adapted to the Euro 4 emissions standard. This was, of course, not to be at the expense of engine performance. The teams from Renault and Bertrandt optimised all components without revolutionising the entire engineering. As a result, power output, torque and fuel consumption were considerably improved. The 2.0 dCi therefore relies on proven technology – without multiple turbocharging or even increasingly high-pressure fuel injection.

**Design**

For the area of the upper base engine and the intake system, Renault has chosen top-quality products in order to get the very best out of its new power unit. For example, it includes third-generation fuel injection from Bosch. This system works with six-hole piezo-electric injectors that allow four to five injections per cycle. At 3 000 rpm, it provides two pre-injections, the main injection and one post-injection. The two first injections heat up the combustion chamber. This promotes rapid ignition of the main injection, thus reducing noise and at the same time optimising pollutant emissions. The post-injection allows an almost total post-combustion of the soot content. The remaining soot is collected by the particulate filter and removed by periodic regeneration.

In addition to the improvements in fuel injection, the compression ratio was reduced to 15.7:1, as is the case with all new ramp injection engines of the third generation. This serves to limit the combustion temperature and the NOx emissions.

Furthermore, Bertrandt successfully worked on adapting the air intake, which is also vitally important for the performance of the engine.

**Computation**

Computation played a major role during the entire course of the project. Bertrandt was responsible for the computation of all assemblies – fuel injection system, air intake, etc. – and designed the exhaust gas recirculation system (piping and valve) together with the Renault team. In the area of the exhaust system, computations were also performed on the vibrations of the manifold, turbocharger and catalytic converter.

At present, work is being carried out on the further development of the new version, in particular on components such as the crankcase, bearing cover and cylinder head. The focus is on taking into account the necessary modifications to the basic structure, particularly in relation to the new regulations on pedestrian safety, at an early stage.

**Testing**

The first tests on the engine test stand and subsequently in vehicles were used to verify the design and computations. This was followed by further observation and analysis of the weak points within the scope of several release cycles. Bertrandt was responsible for numerous components within the engine validation process (intake, EGR, exhaust system). This involved not only the everyday project support but also the complete analysis of the parts after the tests as well as the development of suggestions for improvements to remove the sources of defects. This was done in close cooperation with the design teams and the suppliers.



Air intake, fuel injection system and exhaust system.

**Supplier management**

The suppliers were integrated into the process of developing and building the engine. During the entire administration and technical documentation of the individual components, the teams from Bertrandt worked closely together with the suppliers. Regular meetings were organised with the purchasing departments reporting to Renault, in particular to determine coordination processes and final requirements as well as to clarify financial aspects. Coordination with the suppliers continued right up to the transfer of the project to series production.

## 2,0 dCi Diesel Engine

**Project management:** Assignment of responsibility, process control, teamwork, communication

Within the scope of the cooperation with Renault, the 2.0 dCi is an example of a project in which Bertrandt was given comprehensive responsibility. In contrast to providing purely technical support, Bertrandt is in this case responsible for the complete project and its delivery – to the same extent as the Renault teams. The organisation is specified monthly by a steering committee. In this project, Bertrandt coordinated its processes with those of Renault in order to achieve optimum transparency and comparability throughout the entire project.

**Project planning**

Precise planning was required to ensure that the project ran smoothly and to define the activities of all those involved.

All responsibilities with regard to design, technical requirements, parts availability and testing, both on the test stand and in the vehicle, were coordinated. The aim was to ensure that all project evaluations up to the final production release were successfully passed.

### ► The 2.0 dCi and its future

The 2.0 dCi is being manufactured in Cléon. It will soon make up half of the production at the plant and will be installed in several models from Renault and Nissan.

The highly motivated Bertrandt teams are currently facing up to new challenges and are working with great commitment on new applications for this engine. At present, 30 Bertrandt employees are working on the ongoing project either at Bertrandt in Bièvres and/or directly at Renault in Rueil Malmaison.

### ► Conclusion: Performance booster

Over the past four years of joint development work, Bertrandt successfully mastered new technical challenges, taking on the role of a “performance booster”. We would like to thank Renault for giving us the responsibility for the project and for the trust it has placed in us. ■

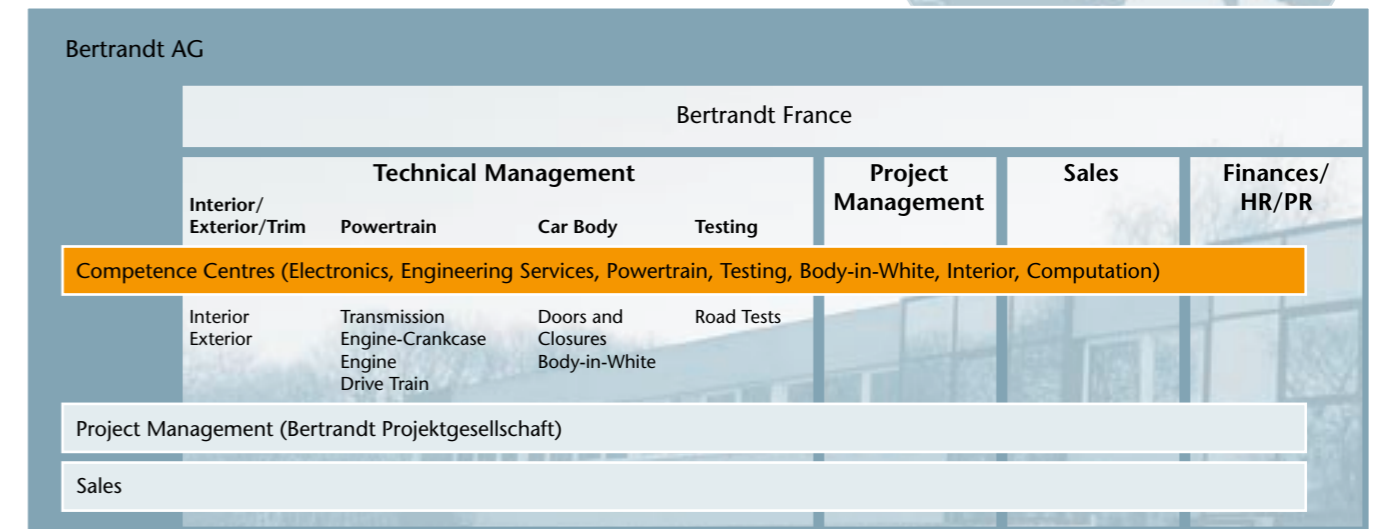
*Olivier Taque, François Rodrigues-Afonso, Frédéric Strady, Agnès Vogt, Paris*

Motor Show Geneva 2006.



## In the Spotlight: Bertrandt France

The Bertrandt subsidiaries in Bièvres near Paris and in Sochaux in the east of France are located in close proximity to the French customers Renault, PSA Peugeot Citroën and their suppliers. More than 300 engineers and designers are involved here in the development of future vehicles from the French car manufacturers, contributing their technical know-how and their expertise in various working methods to the different projects. Interface management in the Bertrandt Engineering Network guarantees interdisciplinary competence centre organisation. The coordination of international projects is supported by the Bertrandt Projektgesellschaft at the Technikum Ehningen near Stuttgart.



Structure of Bertrandt France.

### Scope of the 2.0 dCi Project in Brief

#### Upper Base Engine and Intake

- Project Management and Planning
- Design
- Computation
- Testing
- DMU
- Supplier Management

Project Leaders: Olivier Taque (left) and François Rodrigues-Afonso (right).



### Interview with the project leaders

**Bm:** Renault chose Bertrandt as a partner to develop part of its new diesel engine. What, in your opinion, were the reasons for this decision?

**Project Leaders:** We already worked on an engine project for Renault-Nissan in 2000, in which we were responsible for part of the engineering of the base engine. On the basis of this experience, Renault saw a reliable partner in Bertrandt, who is also much in demand and highly regarded by German car manufacturers.

**Bm:** The organisation of this project was characterised by a wide-ranging transfer of responsibility. Is this tendency proving itself?

**Project Leaders:** This form of partnership allows projects to be comprehensively controlled. It provides us with a certain autonomy with regard to our design tasks for the product and its release. We can react directly to all requirements in the course of project planning. At the beginning of the project, Renault was still unaccustomed to working together with independent engineering service providers, but in the meantime this has become an established procedure.

**Bm:** How do you rate your experience with the project today?

**Project Leaders:** The technical requirements were very demanding and our employees have gained valuable experience in the project. It was above all a human challenge to integrate all the project teams involved and to motivate them for the common goal: to work together in the interests of progress. This experience has shown us how important it is to coordinate the activities of the individual areas such as design, computation and quality control, in order to do justice to all responsibilities.



Since September 2005, Bertrandt has been supplying the BMW plants in Regensburg and Munich with special bodies for emergency vehicles for the police, emergency doctors and fire brigade. This involves fitting standard vehicles with specific equipment for emergency services. The first vehicles were handed over to the police in early October 2005.

## Development Services for Emergency Vehicles

In the spring of 2003, BMW commissioned the Bertrandt site in Munich to develop emergency vehicles on the basis of the 3 Series saloon and estate models. This was the first time that BMW had assigned all the electrical, electronics and design tasks to an external partner. The start of vehicle production was planned for September 2005.

### ► Integrating special equipment

The work involved in integrating the special equipment ranged from developing a variety of electrical and electronic components and wiring loom modules, adapting the vehicle's electrical system and designing the necessary brackets and retainers inside and outside the vehicle through to developing prototype components and incorporating them into prototype vehicles.

The objectives of the project were to allow the equipment to be "fitted on the standard production line" and to be "removed easily and cost-effectively". In addition, special requirements had to be

taken into account in the development process. For example, the special equipment in unmarked police cars must not be visible from the outside and therefore had to be integrated into the interior fittings.

From the very beginning of the project, the Bertrandt development team worked closely with the relevant departments at BMW to develop the concepts. A project office was set up for the Bertrandt team in order to ensure that the project ran efficiently and that the design (CAD) and electrical development units were closely networked to allow for direct cooperation between the two teams.

In order to integrate the electrical components, such as the radio, roof signalling unit, loudspeakers, front and rear signalling units and an additional back-up power supply, the standard wiring loom had to be extended. The bodywork and audio wiring loom modules were developed using the "Grivad" tool. Preparations were made for the release of the modules for volume production in close cooperation with the suppliers of

the individual emergency vehicle components and the supplier of the wiring loom.

### ► From prototype development through to small-scale production

After the detailed concept design process was completed, the prototype components for mounting the special equipment were produced. Using these parts, it was possible to test the ease of assembly on prototype vehicles on the production line. A wide range of manufacturing processes were used to produce the functional prototypes, ranging from sheet metal working and the creation of polyurethane castings through to coating the plastic components. The special fittings from the various suppliers were modified sufficiently to allow the components to be assembled without problems on the production line. After optimisation loops had been incorporated in the prototyping process, the final concepts and the "final" volume production status were determined. The next step was to verify the production

status using volume production processes during the pre-production and production start-up stages.

### ► Developing a central control unit

The control centre used to operate the special equipment was developed in parallel with the process of integrating the special fittings. The control centre comes in two different versions with either six or twelve buttons. At the heart of the control centre is a processor card that collects information from the vehicle and coordinates it with the button positions to produce the appropriate output for the special signal unit or special equip-

ment. The control centre had to be tested for EMC (electromagnetic compatibility) before it could be used in the vehicles.

Since September 2005, Bertrandt has been working on the pre-assembly of the electrical components and on integrating them into the hardware modules that are delivered to the production line as parts sets. The Bertrandt team and BMW are pleased that the production start-up has gone smoothly and that the feedback from the various BMW departments on the collaboration with Bertrandt was universally positive. ■

*Dr. Gerhard Elfinger, Munich*



Front signalling units in a 3 Series BMW. The standard wiring loom was extended to accommodate the additional electrical components.

Bertrandt developed two versions (with six or twelve buttons) of the control centre used to operate the special equipment. Information is collected by a processor card and checked against the button positions in order to produce the appropriate output for the special signal unit or special equipment.

## Background Information

The trend for leasing amongst car manufacturers is also being extended to emergency vehicles. The manufacturers have developed concepts that allow the vehicles to be converted back to their standard form after a limited period of use. Once the vehicles have been returned to "civilian" status, they can be sold on the normal market. Engineering service providers such as the Bertrandt AG have adapted to meet these new requirements and now offer a complete range of development services for the special equipment in emergency vehicles.

## Scope of the BMW Emergency Vehicle Project in Brief

### Project Management

- Release Procedures and Parts List Management
- Special Equipment Documentation in the Form of CAD Data, Drawings and System Wiring Diagrams using Grivad

### Electronics

- Control Unit Development and Production for the Central Operation of the Unmarked and Marked Emergency Vehicles
- EMC Test Supervision of Special Equipment at BMW

### Electrics

- Special Electrical Equipment Integration (e.g. Radio, Signalling Units etc.)
- CAD Design and Package
- Specific Module Development for Bodywork and Audio Wiring Loom

### Tests

- Prototype Vehicle Preparation and Pre-Production Test Implementation
- Crash Test Preparation and Supervision for Special Equipment
- Functional Component Testing

### Engineering Services

- Start of Production Supervision at the Plants

### Rapid Technologies

- Prototype Development through to Small-Scale Production

### Logistics

- Logistic and Quality Concept Creation for Small-Scale Component Production

### Supplier Management

- Subcontractor Coordination



## Electronic Systems for Special Derivatives

The increase in demand for special-purpose and armoured vehicles has led to manufacturers extending their product ranges. Engineering service provider Bertrandt provides support for OEMs in this market segment by developing electric and electronic systems and offering design, production and logistics services. Bertrandt was involved in the development of electronic systems for several special derivatives of the current A6 and A8 on behalf of AUDI AG.



Bertrandt Ingolstadt designed and built the removable blue light for the A8 heavily armoured vehicle on behalf of Audi.

▶ **Developing networked functions**  
Shortly after the development process for the special derivatives of the A6 and A8 began, it emerged that a number of mutually influential standard functions were distributed across an almost equivalent number of standard electronic control units (ECU). As a result of this, networked function concepts for the different derivatives were first of all developed and then divided across a newly developed multi-function ECU and the relevant standard ECUs. The objective of this phase was to keep the adaptations to the standard ECUs

to a minimum. The Bertrandt engineers converted the requirements for each ECU that emerged as a result of this stage into functional descriptions.

▶ **Development support for a multi-function ECU**

In modern, networked vehicles with high levels of integration, conventional forms of intervention in vehicle functions, such as lights and indicators, represent very complex tasks. For this reason, Audi decided to develop a multi-function ECU with special functions that acts as the interface between the vehicle network and the peripherals. This integrated ECU allows the comfort CAN bus functions to be implemented or initiated via the existing standard ECUs.

Bertrandt was responsible for supplier management in this process. In addition, the Bertrandt engineers also validated the software and hardware modifications to the ECU and provided specifications for the ECU at application and diagnostics level. After this, the ECU was integrated into the vehicle network and all the func-

tions were tested in the vehicle. It was important for Bertrandt to stay in very close touch with the relevant development departments at Audi in order to ensure that the development process ran smoothly and that the components were produced on schedule.

▶ **Function tests of networked functions**

In order to ensure that the concepts that had been developed functioned correctly, manual function tests were carried out – both on the networking board that represents the entire vehicle, for example a taxi, and in prototype vehicles. Bertrandt also provided support for networking and diagnosis tests at the OEM's site. The engineers documented the change requests that resulted from the test results and followed up the implementation of the changes.

▶ **Developing the vehicle electrical system and wiring diagram**

The interfaces specific to the special vehicles, such as relays and switches in

the existing vehicle wiring loom, were integrated in VOBES (Volkswagen Bordnetz Entwicklungs-System – Volkswagen vehicle electrical development system). VOBES allows the routes of the individual wires to be designed on the basis of system plans and using links to geometry information from the bodywork design and to the integration studies carried out as part of the bodywork design process.

Bertrandt was responsible for developing the system wiring diagrams, which document the logical connection of the electrical systems. The project also involved specifying wire colours, cross-sections and outgoing wires from the electrical connections in the existing standard modules. After the production supplier had created the initial prototypes of the wiring loom, Bertrandt tested the wiring and connections, the lengths of the wires and the outgoing wires and redesigned them where necessary.

Then additional wiring looms were developed, so that the systems specific to the special vehicles could be adapted

AUDI AG offers a wide range of emergency service, special purpose and armoured vehicles. Bertrandt was responsible for developing electronic systems for the Audi A6 emergency service vehicles (police, emergency doctor, fire service, CID), taxis and driving school cars, plus a lightly armoured vehicle.

Special-Purpose Vehicles at Audi (Models in General)	Armoured Vehicles at Audi
<ul style="list-style-type: none"> <li>■ Police</li> <li>■ Crime Squad</li> <li>■ Fire Service</li> <li>■ Emergency Doctor</li> <li>■ Emergency Doctor (Civil)</li> <li>■ Taxi</li> <li>■ Driving School</li> <li>■ Driving Aid</li> <li>■ Rented Vehicles</li> </ul>	<ul style="list-style-type: none"> <li>■ Heavily Armoured Vehicle A8</li> <li>■ Lightly Armoured Vehicle A6</li> </ul>



Special-Purpose Vehicles with Network					
Electronics/Electrics					Special Equipment Wiring
Electronics			Power Circuit		
Networking	Software	Hardware	Series Modules	Self-Sustaining KDW Wiring Harnesses	
Checking of Network Interlocking Documentation, Releases Series Integration/Supervision	Development Programming Dry Run	Development Simulation Concepts and Hardware Production	Circuit Diagram Development Prototype Construction, Installation Attempt <i>Design/Production System Supplier (Series)*</i> Wiring, Documentation, Releases	Circuit Diagram Development Prototype Construction, Installation Attempt, Finalisation Design <i>Production*</i> Wiring, Documentation, Releases	Development Installation Attempt Testing Documentation, Releases  <i>*coordination and information work only</i>

Special vehicles require significantly more network development effort than normal vehicles. The additional functions often need to be completely re-integrated.

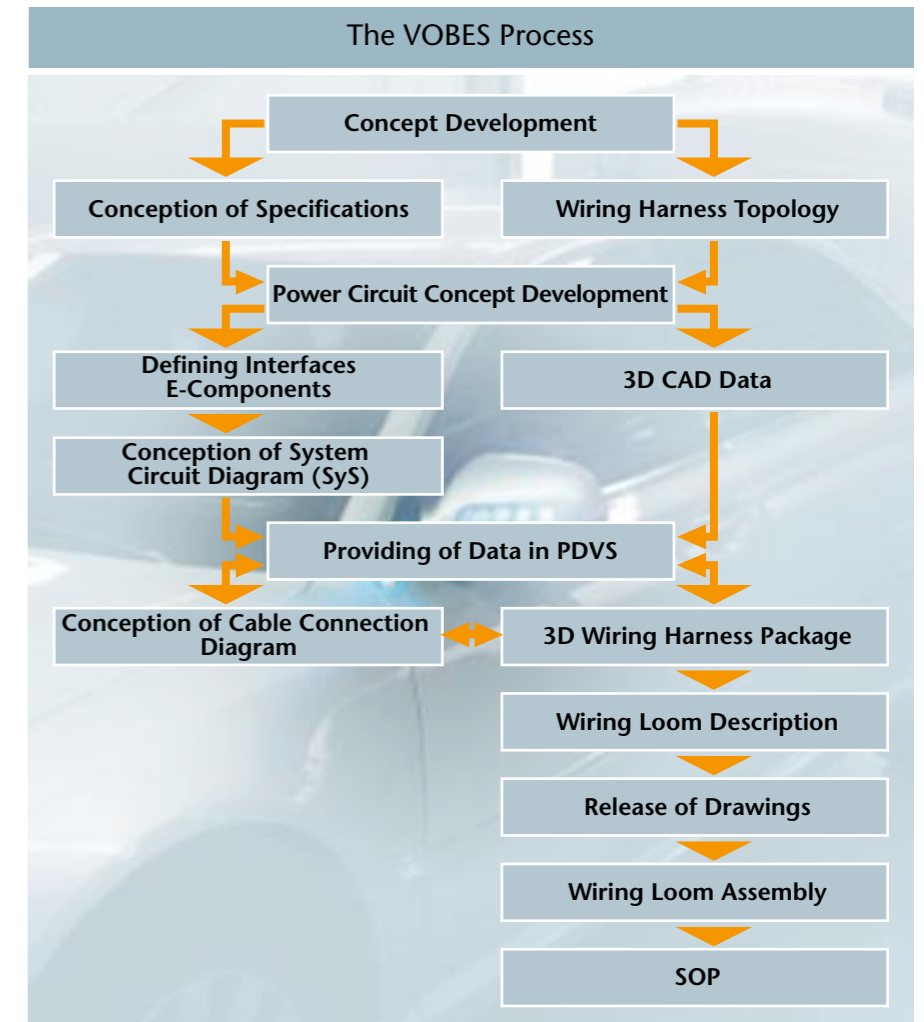
to the existing connections. Systems from different suppliers were carefully selected to cover a wide range of the special vehicle functions. Once the manufacturer had chosen a supplier, the supplier then produced prototype-wiring looms, which were tested by Bertrandt to ensure that they were correct and provided the required functionality. After this, the wiring looms were released by the OEM. The wiring was produced and assembled on the basis of product

detail assembly instructions or photo documentation. The modular wiring looms specific to each derivative were partially integrated into the standard wiring loom as a part of the production process and directly assembled on the production line. The resulting production time was relatively short, particularly when taking into account the wide variety of devices and functions specific to each special vehicle.

## Summary

As a result of the growing functional complexity of individual electronic components and entire systems and the related networking problems for special and armoured vehicles, a pragmatic and flexible approach to development is needed. As development service provider with the philosophy of „integrating systems and components into the vehicle cost-efficiently and efficiently on the basis of collaboration and constant dialogue with the client“, Bertrandt provides support for vehicle manufacturers in the development of complex derivatives. ■

*Klaus Härtl, Christian Schweiger, Ingolstadt*



Developing wiring diagrams using the Volkswagen vehicle electrical development system VOBES.

## A8 Heavily Armoured Vehicle Developing Wiring Looms for Armoured Vehicles

As a result of the special conditions involved in the development of armoured vehicles, including small production volumes and the space restrictions caused by the installation of the armour, the development and integration process for the wiring loom of the Audi A8 heavily armoured vehicle moved away from the standard 3D development methodology used in volume production. Initially Bertrandt Ingolstadt produced wiring diagrams and functional con-

cepts, which were implemented in the form of a wiring loom module specific to the heavily armoured vehicle. Another important part of the project was the technical validation of additional equipment, such as the intercom, emergency exit and fire extinguishing system, together with conceptual development tasks. The wiring loom module developed in collaboration with Audi was integrated into the standard production-wiring loom and consists of up to 1 000

additional wires. As a large number of the cable ducts used in the standard model have to be rerouted because of the vehicle's armour, the engineers adapted the standard wiring loom to the armoured vehicle. Bertrandt now supplies the complete wiring loom for the Audi A8 heavily armoured vehicle and coordinates the procurement and customisation of the components. The series supply also includes the production of a removable and lockable blue light.



## Scope of the Audi A6 Emergency Service and Special-Purpose Vehicles and the Audi A8 Heavily Armoured Vehicle Project in Brief Electrics/Electronics

- Integration Management: Networking
- Functional Development of Multi-Function ECU
- Hardware Development: Window Motor ECU, Door Test Box
- Component and System Testing
- Vehicle Electrical System Development: Wiring Loom and Wiring Diagram
- Prototype Assembly
- Design**
  - Packaging
  - Blue Light, Various Brackets
- Series Supply**
  - Audi A8 Wiring Loom, Parts Specific to Heavily Armoured Vehicle



# Convenient Entertainment

## Integration of an MP3 Player Using Bluetooth

A new concept now makes it possible for drivers to use their car radio to operate an MP3 player while driving. The secret is a Bluetooth/CAN gateway that has been developed by Bertrandt in Cologne.

### ► More safety, more convenience

The integration of an MP3 player using Bluetooth technology offers several advantages. The main ones include improved safety on the road and more user-friendliness, as the player can now be operated entirely via the car radio. The user no longer needs to reach for the MP3 player, which often lies unsecured somewhere in the car. The system is also extremely practical, as music no longer needs to be stored on numerous CDs but can be kept on a single memory card.

### ► Integration via an existing interface

In order to connect an external device to the existing environment of the vehicle, Bertrandt used an already existing interface – that of the CD changer. This interface is particularly suitable, as it has all the signals required for controlling an external audio device. Furthermore, it is already factory fitted in modern radios from different manufacturers and does not need to be installed as an extra.

### ► Development of a Bluetooth/CAN gateway

Wireless integration was achieved by using a specially developed Bluetooth/CAN gateway. This receives and processes the signals sent by the car radio via the CAN bus and transmits them via Bluetooth to an MP3 player (in test operation: a PDA from Hewlett Packard). Until now, it was necessary to use a stereo audio cable to transmit the audio data, as Bluetooth 1.2 was not able to transmit uncompressed audio data in a sufficiently high quality due to the low data transmission rate of 64 kBit/s. Now, the new Bluetooth standard 2.0+EDR with a transmission rate of 3 MBit/s makes wireless transmission possible. Decoding of the data takes place in the MP3 player. This means that different

codecs (coder/decoder) can be used and replaced easily.

The newly developed Bluetooth/CAN gateway can receive, process and transmit certain commands and data via Bluetooth and the CAN bus. It represents the main component of the system, as it forms the interface between the vehicle and the MP3 player. In fact, the entire system acts like a CD changer connected to the bus. In doing so, the gateway has to meet important manufacturer-specific specifications in order to be recognised as a CD changer by the radio.

### ► New application allows remote control

The MP3 player used in the test was a PDA running on the Windows Mobile 5.0 operating system from Microsoft. The Windows Media Player included in the software package allows music to be played in a digital format. However, neither the Windows Media Player nor the operating system have an interface that allows remote control of the device. For this reason, an application for the PDA running on the .NET Compact Framework 2.0 was developed. This ensures simple portability to other Windows Mobile systems. In addition, the

Windows Media Player was integrated into the application, as this is able to decode the most common audio formats such as mp3, wav, wma, etc., which means that no other audio decoder needs to be installed on the PDA. The application therefore has all the functions of a “familiar” multimedia player, while at the same time offering the functionality of a CD changer.

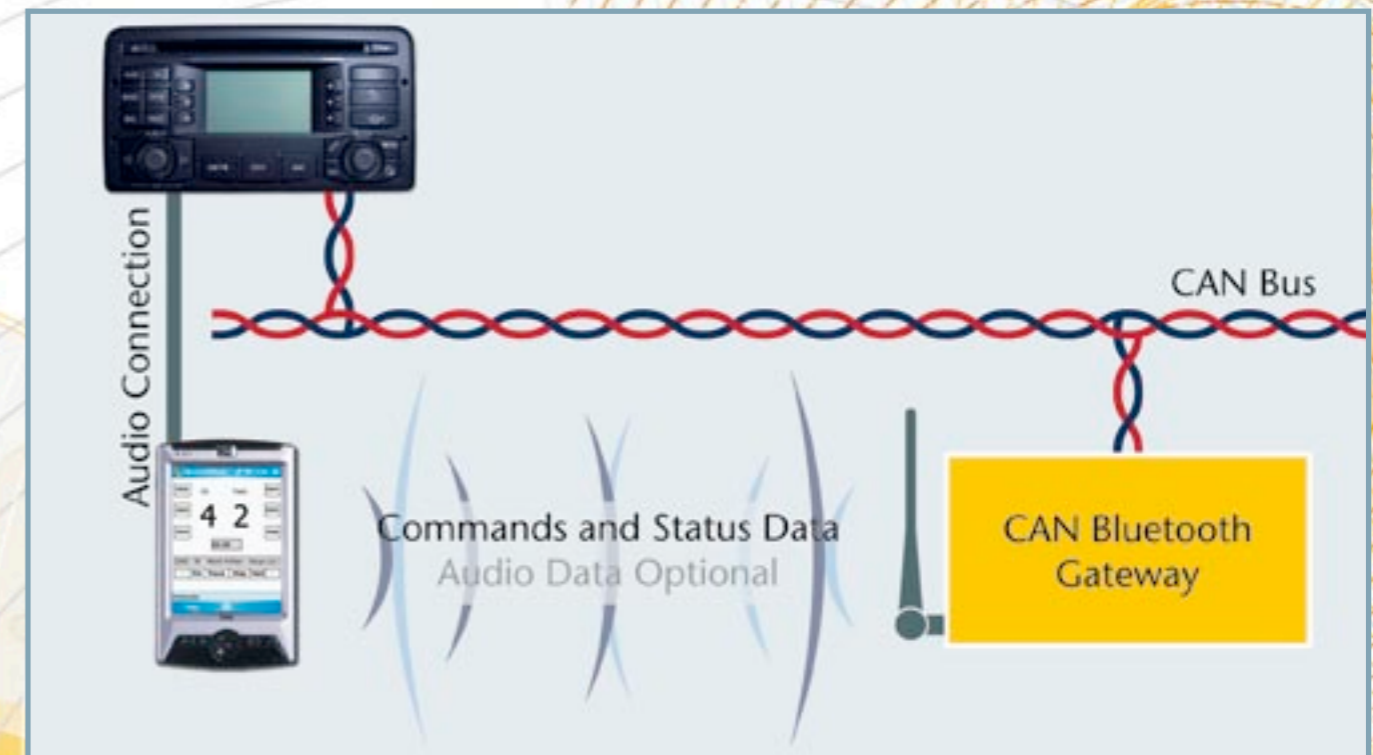
The system can be controlled either externally, i.e. by the control commands transmitted from the radio or the gateway via Bluetooth, or using the Windows user interface, which allows easy and intuitive control. Status details such as playing time, track number, etc. are shown on the PDA display and transmitted to the gateway via Bluetooth, so that they can also be shown on the radio display.

### ► Simple operation for safer driving

The complete system consisting of the gateway and the PDA was kept as simple as possible. The user does not need to worry about operating the equipment but can concentrate entirely on the traffic and enjoy the music. For example, the devices are connected automatically, just like the connection between a Bluetooth wireless telephone and a headset. The MP3 player needs to be registered only once by the gateway. In normal operation, it then connects automatically and is ready for use immediately. The music tracks are organised in play lists with a structure corresponding to that of a real CD changer with six slots.

The integration of an MP3 player into the vehicle has resulted in a comfortable and convenient solution that allows trouble-free enjoyment of MP3 music collections while driving. The driver is neither impeded nor distracted. ■

*Daniel Schmitz, Michael Kleinow, Cologne*



# Making Clever Decisions

## Bertrandt Projektgesellschaft



For more than 30 years, Bertrandt has offered its customers a range of services from design to series production. But what actually happens before the development of a product? This is the domain of the specialists at Bertrandt Projektgesellschaft (BPG), who also offer consulting services within the scope of module and derivative projects. This provides significant customer benefits compared to classical consulting, as it combines technical implementation competence with market expertise.

### ► The project: New vehicles for different markets

The initial situation was clearly defined – a customer wanted to develop a new vehicle platform. The challenge facing the Bertrandt team was equally clear: to take responsibility for the platform concept, the business case including market analyses, the styling, packaging and dimensional concept and the basic design in the production planning for a complete vehicle family. The question was: Which vehicle types with which

equipment are to be offered in the different sales markets? This is where the Bertrandt Projektgesellschaft team was able to help.

### ► Collecting and analysing information

As a first step, the Bertrandt team together with the customer defined six core markets for the planned sale of the vehicles, including Asia, Africa, South America and Europe. For these six core markets, data on the market, the customers and the competitors was col-

lected from publicly accessible sources and conversations with experts.

- The market survey was used to calculate the possible sales potentials of the various vehicle types in order to obtain information about a possible market share in the respective core market. Furthermore, an overview would show how the different vehicle segments would be distributed on the market.
- The aim of the customer analysis was to determine the specific customer requirements with regard to certain vehicle types in the respective market. In addition, it included a detailed study of the population development over the next two to three vehicle generations.
- The competition analysis was carried out to determine the brand position of the customer on the respective market. Parallel to this, benchmarking was performed for more than ten vehicle models. The aim was to identify the technically leading vehicles and, on the basis of this, to align the individual vehicle types with regard to their function and market position.

### ► Developing strategies

Having collected and analysed the data, the Bertrandt team derived a separate strategy for each core market and vehicle type as a second step. Among other things, they took account of synergies that would be created by using carry-over parts. In a standardised process, the data were transferred to a set of requirement specifications for the different vehicle types.

### ► Finding technical solutions

The requirement specifications form the basis of the platform to be developed, resulting in technical requirements and the design of the platform and the package. The third step involved the implementation of the market and customer requirements for the different body versions. This was achieved by using processes from “Quality Function Deployment” and the “TIPS” method (Theory of Inventive Problem Solving). Combining the individual matrices resulted in a set of functional requirements to be met by the different body versions. The concepts for the different body versions were then realised with the Design Services Competence Centre.

### ► Presenting results

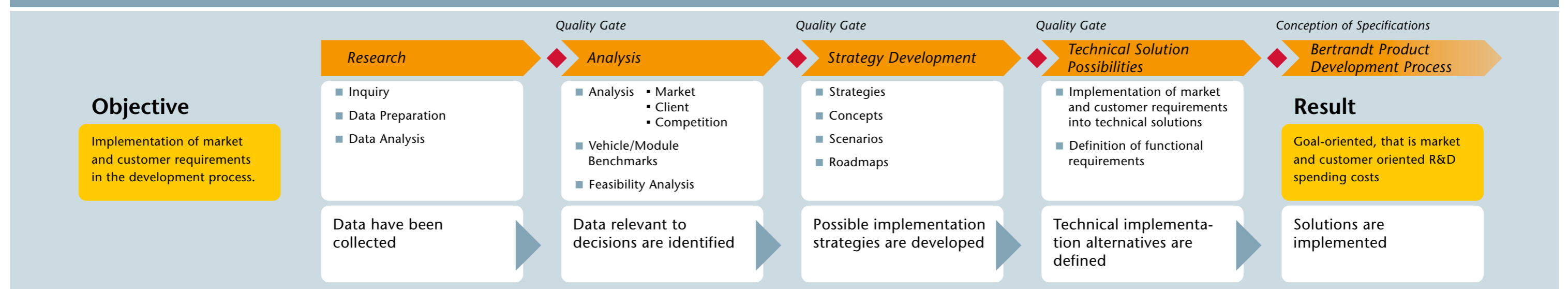
The aim of the project was achieved after five months. The Bertrandt team presented a platform concept and four body versions for six different markets. Sales volumes, market shares and launch prices for the vehicles were determined, specific customer groups were defined and the brand position in the respective core market was fixed. In addition, the BPG presented a strategy for the further development of the brand over the next two to three vehicle generations – from styling to brand positioning.

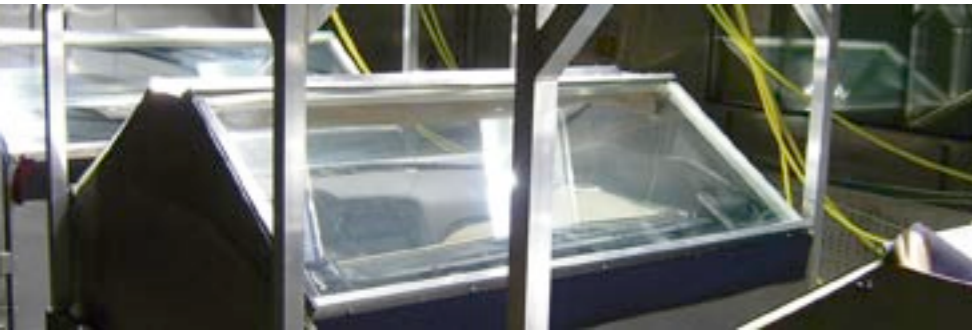
### ► Making clever decisions with Bertrandt

The consulting services offered by BPG go beyond mere consulting. Manufacturers, system suppliers and subcontractors are not left alone in their development process when they implement the market and customer requirements. Instead, they are supported by the BPG with innovative solutions. As a result, development tasks can be precisely targeted, from single modules right up to complete vehicle generations. ■

Alexander Mekler, Ehningen

## Value Chain: Bertrandt Consulting Services





### Laboratory for Climate Testing and Sunlight Simulation Accredited

Since April 2006, the Bertrand subsidiary in Wolfsburg has had ISO/IEC 17025 accreditation in the field of climate testing and sunlight simulation. This provides a substantial improvement in quality with regard to forthcoming requirements by manufacturers and suppliers. A further benefit: the engineers can generate results that are comparable worldwide.

Modern materials in the automotive sector are exposed to the most varied environmental influences. In particular, these include the effects of temperature, humidity and solar radiation. In order to predict how components react under real conditions, Bertrand's engineers perform simulations of the specific environmental conditions in the testing laboratory. As a result, potential weak points can be detected even during the development phase, allowing optimisation measures to be taken. ■

*Uwe Lewandowski, Wolfsburg*



The testing laboratory at the Wolfsburg subsidiary: with its state-of-the-art testing methods, Bertrand as a neutral development partner ensures that excellent products are developed.



### Making New Technologies Clear

Electronic functions become transparent in Bertrand's new "EE-Mobil". In an exemplary manner, the engineers of the Electronics Competence Centre have integrated their own developments and new technologies into a laboratory vehicle environment.

With the aid of a separate control centre and a converter simulation environment, the vehicle illustrates the special requirements that have to be met by the electronic systems in emergency service and special purpose vehicles, such as the actuation of flashing headlights. A specially developed Bluetooth/CAN gateway allows the wireless integration of a PDA-MP3 player with remote control via the car radio. Furthermore, the battery management system is used to show relevant characteristic values on a navigation display, and other measured values and display interfaces can be adapted. Last but not least, the Bertrand engineers present the completely model-based development of a steering column switch module on an additional right-hand drive vehicle. ■

For further information on the EE-Mobil, please contact Christian Ruland, Managing Director, Electronics Competence Centre, Tel.: +49 8458 3407-0.



### Bertrandt Presents its Services on the Basis of the New Audi Q7

On 5 July 2006, the 8<sup>th</sup> "Bayern Innovativ" Congress took place at the Audi Forum Ingolstadt. Once again, Bertrandt Ingolstadt had a stand at the fair, and presented a very interesting exhibit – the front-end of the new Audi Q7.

► **Latest news in functional development for pedestrian safety**  
From its attractive position right at the entrance of the exhibition area, development service provider Bertrandt presented its activities relating to all aspects of functional development for pedestrian safety based on the front-end of the new Audi Q7: Design services in the areas of the bonnet, bumpers and front-end, functional design in the simulation of bonnet load cases, pedestrian impact, low-speed and high-speed crashes and design validation in testing. In order to present these services to the visitors as vividly as possible, the exhibit revealed the measures taken to improve pedestrian safety – including a bonnet dented by test impacts and the corresponding impactors. The presentation was rounded off by a video showing excerpts from the pedestrian protection development process with high-speed films and computational animations.

Interested visitors at the Bertrandt stand:  
VDA President Prof. Bernd Gottschalk, Hans Spitzner, Bavarian State Secretary for Economic Affairs, Werner Widuckel, Board Member for Human Resources at Audi, Prof. Josef Nassauer, Director of Bayern Innovativ and Robert Werner, Bertrandt Ingolstadt.

► **Outstanding response from customers, celebrities and the press**  
The attractiveness of the exhibit did not fail to achieve its effect. Just twenty minutes after the fair was opened, Werner Widuckel, Board Member for Human Resources at Audi, called in at the stand on his tour of the fair, together with Hans Spitzner, Bavarian State Secretary for Economic Affairs, and VDA President Prof. Bernd Gottschalk. The celebrities were surrounded by the press – with Bertrandt also in the centre of attention. The Bavarian television company "Bayerische Rundfunk" was also impressed by the fact that a relatively heavy SUV like the Audi Q7 offers better pedestrian safety than previous generations of vehicles and did not hesitate to record a report for their evening magazine programme.

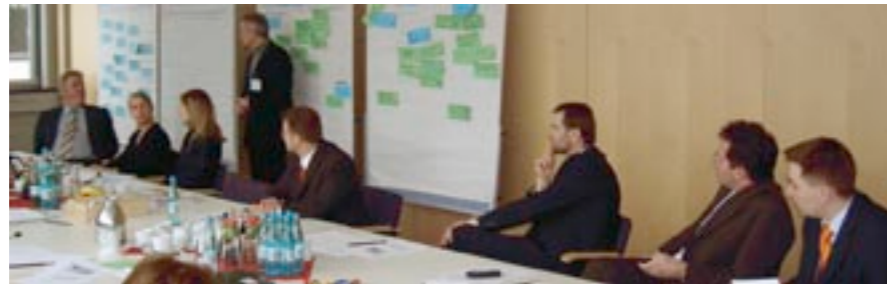
Just like the media representatives, visitors to the fair were also keen to learn more about Bertrandt's activities on the subject of pedestrian safety. Numerous contacts were made with suppliers and developers in the field of pedestrian safety. For example, manufacturers of sensors and actuators for active protection systems as well as service purchasing representatives from Audi came to the stand looking for information on the latest services offered by Bertrandt. In view of the very positive results of the fair as well as the customer contacts and media presence achieved, BAIKA can once again be seen as a complete success for the fair team and for Bertrandt Ingolstadt. ■

*Robert Werner, Ingolstadt*



## Development and Design of Work-Oriented Performance Models

Bertrandt as a Partner of the Fraunhofer Institute for Industrial Engineering IAO



Studies have shown that, in addition to factors such as expert skills and high working quality, the success of a company is increasingly dependent on clearly recognisable orientation models that are accepted by employees and management. Therefore, two years ago, Bertrandt developed a new performance model called "Gaining momentum through networked expertise", which, among other things, presented the basic concepts of such cooperation. Together with the Fraunhofer Institute for Industrial Engineering IAO and several partners, Bertrandt plans to further develop its model. The aim is to improve identification within the company and to increase the motivation of employees and management by developing a common corporate culture.

### ► Bringing performance models to life

Unfortunately, it is often the fate of many corporate performance models to gather dust on the shelf and gradually be forgotten. To prevent this from happening and to bring its model to life, Bertrandt is taking part in the "PerLe" project (Development and Design of Work-Oriented Performance Models). The project, which is supported by the German Federal Ministry of Education and Research, is aimed at transforming work-level models into so-called "performance models". The objective is to prevent a discrepancy from occurring between statements in glossy company brochures and the actual everyday activities of the employees. The project includes an academic and scientific partner, the Fraunhofer Institute for Industrial Engineering IAO, and six user companies.

### ► Promoting networked action

In this project, Bertrandt aims to anchor its network organisation more firmly within the company, following its creation with the implementation of cross-cutting, inter-disciplinary compe-

tence centres. The competence centres combine resources and advance the strategic further development of important growth and competence fields at Bertrandt. The managing directors of the competence centres act as "network managers" across all Bertrandt subsidiaries. Major challenges occur particularly at the interfaces between the classical development departments and the new competence centre structure.

### ► New performance model

Within the framework of the "PerLe" project, a performance model is now being developed for this new organisational structure in order to make cooperation more efficient. The critical success factors for effective action in networks were first of all developed in interviews and workshops with management and employees and together with the Fraunhofer IAO. On the basis of these factors, a performance model with concrete suggestions for managerial action in a network-oriented structure is now being derived. The effectiveness of this performance model will be assessed in a subsequent evaluation phase. ■

*Katja Schöll, Ehningen*

On time at the commencement of the new business year 2006/07 new corporate and service brochures will appear



According to the medium-term orientation, in order to develop the service offer alongside the automotive value added chain, development partner Bertrandt has updated a large part of its publications. With the new brochures customers, the financial community as well as future applicants should receive a comprehensive insight into the company with its services and its people.

- The corporate brochure gives insight into the company with all its services on 36 pages under the motto "Services for a Mobile World".
- Eight new competence centre brochures present the concrete service offer of the competence centres in DIN-long-format paper size: Body-in-White, Electronics, Engineering Services, Functional Configuration/Simulation, Interior, Model Making and Rapid Technologies, Powertrain, Testing and Validation.
- A new personnel brochure complements the corporate publications and depicts occupational outlooks and development possibilities at Bertrandt for potential employees.
- Capital market participants are extensively informed by means of annual reports and quarterly reports. ■

*Claudia Remsing, Ehningen*

All new brochures can be ordered on the Internet:  
[www.bertrandt.com/broschueren](http://www.bertrandt.com/broschueren)

### Bertrandt is a Partner of the VDI-Initiative "Sachen machen!"

On 2 February 2006, the first nationwide initiative in order to support and strengthen Germany as technology location, started with "Sachen machen!"



(Doing Things). Together with partner companies from highly mechanised branches, the VDI-Initiative has the goal to turn Germany into the worldwide leading technology location by 2015. The Bertrandt AG has been involved from the beginning, in supporting the initiative's campaign.

The campaign initiated by the "VDI Verein Deutscher Ingenieure" (the association for German engineers) and supported by the management consultancy firm, Grolman Result wants to transport three core messages:

- Inspire young generations for technical occupations
- Increase innovation strength and promote the development of competitive products and technologies
- Strengthen the image of Germany as technology location

As the Bertrandt AG develops innovative solutions for the international automotive and aviation industry as an engineering service provider, it also identifies with these goals. Thus, Chairman of the Board, Dietmar Bichler, sees a sustainable economic location, which unites sound know-how in the most different branches in Germany. "It is up to the companies to use sales opportunities and to satisfy customers with high-class products and services", Bichler emphasises. "Bertrandt wants to further develop its competitiveness with trendsetting solutions and create and maintain workplaces through successful operations. Our employees contribute towards reaching these goals – in which they think ahead and support the customer in his ability to get around bottlenecks." Bertrandt is happy to support the activities in the context of "Sachen machen!". Do become enthusiastic too! ■

### Optimised Development through New Material Concepts



On 11 May 2006, the ThyssenKrupp Steel and Bertrandt engineers met in Ehningen for the annual Information Forum. All Bertrandt subsidiaries from the Body-in-White Competence Centre were represented. The purpose of this event is to find ways to link material and technology applications optimally together with their development for the upcoming vehicle models. Thus components and modules can be optimised by means of considering different steel properties and tailored products in early phases of the development process with respect to their application and functions to be fulfilled – as for example stiffness, crash behaviour and weight. Mutual customers from the automotive industry will in future profit from this knowledge, for example, in the lightweight car body construction. ■

31.10.2006	University Contact Event: meet@fh-wiesbaden, Rüsselsheim	30.-31.01.2007	University Contact Event: bonding Braunschweig
08.11.2006	University Contact Event: HOKO, FH Munich	13.02.2007	Report on the First Quarter of the Financial Year 2006/07
14.-15.11.2006	Revolution in Vehicle Interiors, Ludwigsburg	14.02.2007	Annual General Meeting, Sindelfingen
15.11.2006	University Contact Event: KISS ME 2006, Hanover University	Februar 2007	Company Contact Event, Hamburg
16.11.2006	University Contact Event: ZWIK, Zwickau (FH)	13.03.2007	University Contact Event: Recruiting Day, FH Joanneum, Graz
17.11.2006	VDI nachrichten Recruiting Day, Ludwigsburg	21.-22.03.2007	VDI Plastics in Automotive, Mannheim
21.11.2006	University Contact Event: bonding Hamburg	27.-29.03.2007	Safety Expo, Aschaffenburg
23.11.2006	University Contact Event: ContactING, FH Nürnberg	19.-20.06.2007	Automobilforum, Stuttgart
04.-05.12.2006	University Contact Event: bonding Aachen	Juni 2007	Advances in Automotive Electronics, Ludwigsburg
06.12.2006	University Contact Event: VHK-Forum, Munich	Juni 2007	Saxon Suppliers Fair, Leipzig
07.12.2006	Annual Press Conference, Stuttgart	05.-06.07.2007	EDM Forum, Stuttgart
07.12.2006	Analysts Conference, Frankfurt am Main	Juli 2007	Zulieferer Innovativ (BAIKA Congress with Exhibition), Ingolstadt
		11.-23.09.2007	International Motor Show, Frankfurt

## [ Bertrandt in Brief ]

### +++ Aviation

On 22 November 2005 the EUROAER GmbH and the Bertrandt Ingenieurbüro GmbH Hamburg concluded a cooperation agreement. The goal of this cooperation is to increase the service range and combine and develop activities to the customers' advantage. +++

### +++ ECO-PROFIT

Bertrandt Munich was awarded "ECO-PROFIT Business Munich 2005" for conscious handling of resources. The objective was to preserve the environment and to save costs. +++

### +++ New Supervisory Board

On 15 February 2006 the 10<sup>th</sup> Annual General Meeting of the Bertrandt AG took place in Sindelfingen. Heinz Kenkmann did not run for a position on the Supervisory Board. His successor is Horst Binnig, Executive Committee Chairman of the KS Aluminium-Technologie AG in Neckarsulm. +++

### +++ Bertrandt Detroit Celebrates 5-Year Anniversary

On 2 May 2006 the Bertrandt US, Inc celebrated its 5-year anniversary with its subsidiary in Detroit. In Detroit the engineering partner Bertrandt offers services centred around complete vehicle development. Customers are GM, Ford,

DaimlerChrysler as well as the entire supply industry. +++

### +++ Capital Market Day

Approximately 40 participants attended the first Capital Market Day of the Bertrandt AG on 17 May 2006 in Ehningen. Board Chairman, Dietmar Bichler provided insights into the figures in the second quarter as at 31 March 2006 and pointed out the growth potentials of the Bertrandt AG. In addition, two prominent representatives from the automotive and supply industry, Prof. Dr. Hans-Joachim Schöpf, from automotive consulting and Dr. Henrik Adam of the ThyssenKrupp Steel AG, enriched the event. +++

### +++ Recertification

In the period of June/July 2006 the DEKRA carried out an external audit in Bièvres (France), Ehningen, Cologne and Munich. It involved the quality management rules ISO 9001 and VDA 6.2, the environmental management rules ISO 14001 and – firstly for the subsidiaries in Garching and Munich – the information security rules ISO 27001 and VDA Prototype Safety. The auditors evaluated the continuous improvement process, the traceability of defined processes as well as the universal „Management by Objectives“ especially positively. +++

### +++ Bertrandt Exhibition Stand Awarded Prize

An iF communication design award was won by the Stuttgart agency Totems Communication & Architecture in 2006 for the Bertrandt exhibition stand concept on the International Motor Show in 2005. +++

### +++ Cooperation with the University of Applied Sciences

Bertrandt and the University of Applied Sciences Braunschweig/Wolfenbüttel cooperate in the dual study course for a "Bachelor of Engineering" degree. During the eight-semester study course in the field of mechanical engineering,

the students complete their academic studies at the University of Applied Sciences in Wolfenbüttel. The students spend the practical semesters and holidays at Bertrandt in the operational divisions. +++

### +++ Report on the 3<sup>rd</sup> Quarter

After the first three quarters of the 2005/2006 financial year the Bertrandt Group gained sales profits of 173,798 thousand Euros, an EBIT of 9,841 thousand Euros and a net profit of 5,131 thousand Euros. In the past 12 months 337 new jobs were created. +++

## Portrait of Michael Neisen

Michael Neisen (42) is Managing Director of the Ingolstadt and Heilbronn subsidiaries and is Bertrandt's primary contact partner for the client Audi. Since July 2005, he has also been responsible for the company's technical orientation in his capacity as Head of the Technology Board.

Michael Neisen can already look back on 16 intensive and successful years at Bertrandt. During this period, he has had a storybook career, seeing the company flourish from being an engineering service provider to become an innovative partner for the development of modules, complete vehicles and aircrafts. Neisen played a vital role in this success story.

insight into the practical world of engineering.

His career at Bertrandt began in May 1990, when he joined the team in Heilbronn. After only six months, Neisen was promoted to the position of Group Leader for Design. Two years later he became the Head of Design at the Heilbronn subsidiary.

In January 1995, Neisen moved to Ingolstadt as the Head of the Interior Department. Two years later, Michael Neisen was given a new task at Bertrandt Ingolstadt – as Managing Director of the rapidly growing subsidiary. This position also gave him overall responsibility for the client Audi in Ingolstadt, and he implemented new areas of services such as testing, electronics and tool making.

The successful cooperation with Audi soon bore fruit. In 2000, Neisen was awarded an interesting project for the Ingolstadt subsidiary. It was to have a decisive influence on the work of the Bertrandt

During this time, Michael Neisen was given groupwide responsibility for AUDI AG. He subsequently became Managing Director of the Heilbronn and Ingolstadt subsidiaries and is now also responsible for integrating the Spanish Bertrandt site into the Audi network.

According to Neisen, his greatest success during his time at Bertrandt has been in establishing the close partnership with AUDI AG, which recently culminated in the complete vehicle project Audi Q7. But he also sees his strategic responsibilities within the Bertrandt Group as a driving force behind his career development. For example, he was partly responsible for establishing competence centres for the development of modules and whole vehicles. Today, the Ingolstadt subsidiary is one of the largest in the Bertrandt Group and has a workforce of more than 400 employees, who work mainly in module and function development and in the powertrain and electronics competence centres. For a year now, as Head of the Technology Board and together with top management, Neisen has been responsible for determining the company's technological orientation. The main areas of focus are complete vehicle development, function development and CAx technologies.

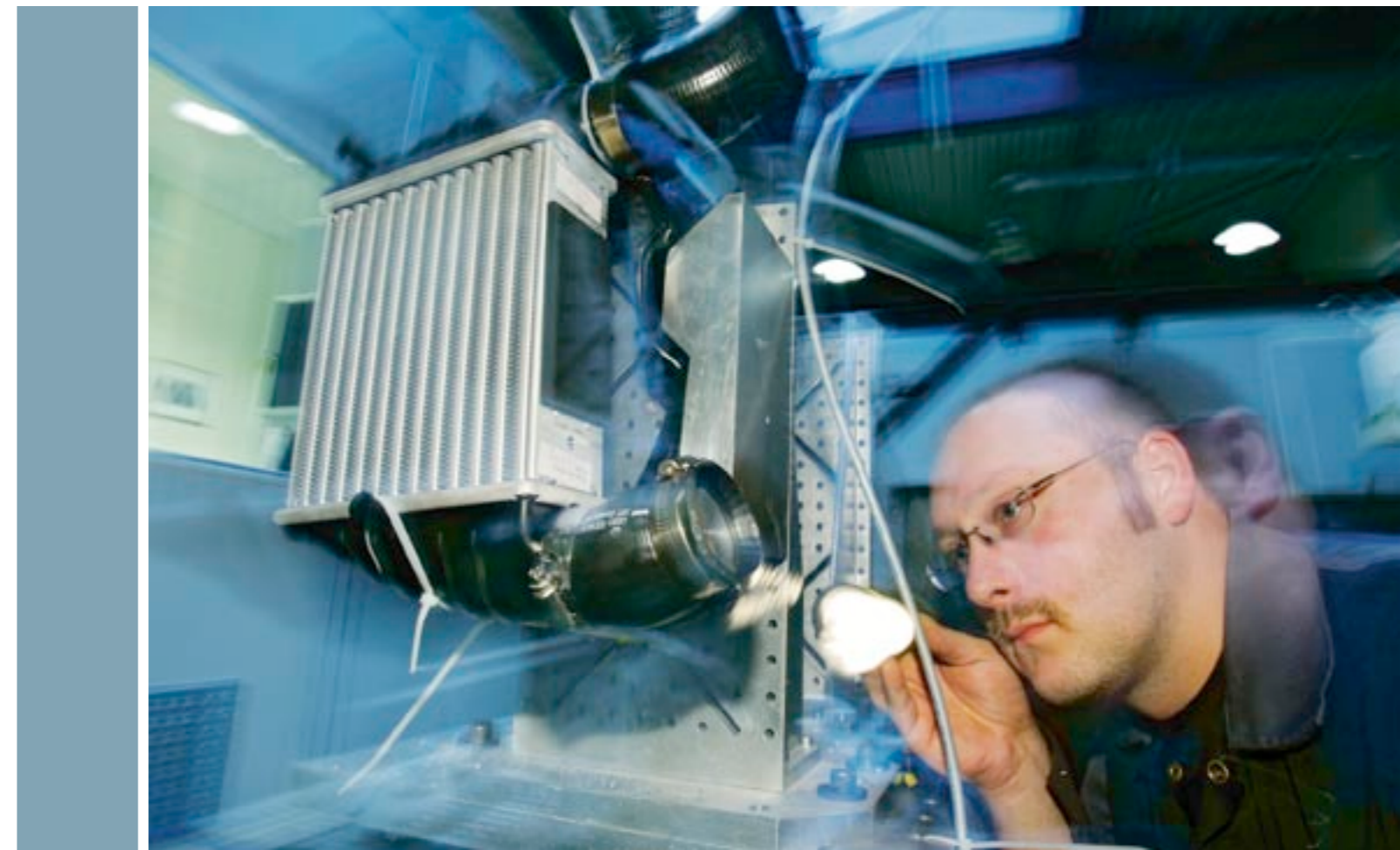
When asked which factors he considers important for successful and well-balanced activity, Michael Neisen names physical and mental fitness. He finds relaxation from his strenuous work by spending time with his family. Neisen is married and has two daughters aged 7 and 5 who keep him on the go. He lists his hobbies as playing golf, classic cars, music and good friends. ■

team over the next two years: the development of the entire body and the interior of the second generation of the Audi A3. At times, more than 100 of the approximately 250 Bertrandt engineers were involved in this development project.

Michael Neisen studied automotive engineering at the Fachhochschule Hamburg (University of Applied Sciences in Hamburg). His main focus was on car body design. While still a student, he worked for a firm of engineering consultants on a freelance basis in order to gain

Services for a Mobile World

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## At your Service

### Bertrandt – 19 Offices in Europe and the USA

<b>Bertrandt AG – Head office</b>	<b>Altenburg</b>	<b>Barcelona</b>	<b>Bremen</b>
Birkensee 1 D-71139 Ehningen Phone +49 7034 656-0 Fax +49 7034 656-4100 info@bertrandt.com	Mühlporfte 2 D-04600 Altenburg Phone +49 3447 8900-00 Fax +49 3447 8900-10 altenburg@de.bertrandt.com	Poligono Industrial Can Comelles Sud C/Gresol,1 - Ap. Correos 183 ES 08292 Barcelona Esparreguera Phone +34 93 777 87-00 Fax +34 93 777 87-13 barcelona@es.bertrandt.com	Hanna-Kunath-Straße 4 28199 Bremen Phone +49 421 897614-60 Fax +49 421 897614-69 bremen@de.bertrandt.com
	<b>Bretzfeld</b>	<b>Detroit</b>	<b>Dunton</b>
	ZR Automotive Moosbachstraße 8 D-74626 Bretzfeld-Schwabbach Phone +49 7946 9105-0 Fax +49 7946 9105-120 bretzfeld@de.bertrandt.com	1775 W. Hamlin Road Rochester Hills MI 48309 US Phone +1 248 598 5100 Fax +1 248 598 5106 detroit@us.bertrandt.com	Unit 34 Hornsby Square, Southfields Industrial Park, Laindon Basildon GB Essex SS 15 6SD Phone +44 1268 564 300 Fax +44 1268 564 301 dunton@uk.bertrandt.com
	<b>Ehningen</b>	<b>Ehningen</b>	<b>Garching</b>
Bertrandt Projektgesellschaft Birkensee 1 D-71139 Ehningen Phone +49 7034 656-0 Fax +49 7034 656-8700 bpg@de.bertrandt.com	Technikum Birkensee 1 D-71139 Ehningen Phone +49 7034 656-5000 Fax +49 7034 656-5100 ehningen@de.bertrandt.com	Dieselstraße 16 D-85748 Garching-Hochbrück Phone +49 89 32706-0 Fax +49 89 32706-101 garching@de.bertrandt.com	
	<b>Hamburg</b>	<b>Ingolstadt</b>	<b>Cologne</b>
Channel 9 Blohmstraße 10 D-21079 Hamburg Phone +49 40 7975129-0 Fax +49 40 7975129-2100 hamburg@de.bertrandt.com	Lilienthalstraße 50-52 D-85080 Gaimersheim Phone +49 8458 3407-0 Fax +49 8458 3407-111 ingolstadt@de.bertrandt.com	Oskar-Schindler-Straße 10 D-50769 Köln-Feldkassel Phone +49 221 7022-0 Fax +49 221 7022-100 koeln@de.bertrandt.com	
	<b>Munich</b>	<b>Neckarsulm</b>	<b>Paris</b>
Anton-Ditt-Bogen 16 D-80939 München Phone +49 89 316089-0 Fax +49 89 316089-121 muenchen@de.bertrandt.com	Friedrich-Gauss-Straße 5 D-74172 Neckarsulm Phone +49 7132 386-0 Fax +49 7132 386-119 neckarsulm@de.bertrandt.com	Burospace, Bâtiment 10 Route de Gisy, B.P. 35 F-91572 Bièvres Phone +33 1 69351505 Fax +33 1 69351506 paris@fr.bertrandt.com	
	<b>Rüsselsheim</b>	<b>Sochaux</b>	<b>Stadthagen</b>
Im Weierfeld 1 D-65462 Ginsheim-Gustavsburg Phone +49 6134 2566-0 Fax +49 6134 2566-100 ruesselsheim@de.bertrandt.com	Technoland 364, rue Armand Japy F-25461 Etupes Cedex Phone +33 3 81993500 Fax +33 3 81993501 sochaux@fr.bertrandt.com	Erlenweg 6 D-31715 Meerbeck Phone +49 5721 9274-50 Fax +49 5721 9274-51 stadthagen@de.bertrandt.com	
	<b>Trollhättan</b>	<b>Wolfsburg</b>	
Nohabgatan 12 E S-46153 Trollhättan Phone +46 520 4865-00 Fax +46 520 4865-01 trollhattan@se.bertrandt.com	Krümke 1 D-38479 Tappenbeck Phone +49 5366 9611-0 Fax +49 5366 9611-100 wolfsburg@de.bertrandt.com		

## Masthead

### Publisher:

Bertrandtmagazine is published by Bertrandt AG  
Birkensee 1  
D-71139 Ehningen  
Phone +49 7034 656-0  
Fax +49 7034 656-4100  
Internet: www.bertrandt.com  
E-Mail: info@bertrandt.com

### Editorial Responsibility:

Anja Schauser

### Editorial of this Issue:

Silke Allendörfer, Claudia Conrad-Hofmann, Michaela Frank, Anke Janik, Hartmut Mezger, Monique Saier, Agnès Vogt

### Layout:

Hartmut Mezger  
Bertrandt Technikum GmbH

### Cover Picture:

Hartmut Mezger  
Bertrandt Technikum GmbH

### Editorial Office:

Bertrandt AG  
Anja Schauser  
Phone +49 7034 656-4037  
Fax +49 7034 656-4090  
E-Mail: unternehmenskommunikation@de.bertrandt.com

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### Production:

Druckerei Mack GmbH  
Schönaich

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